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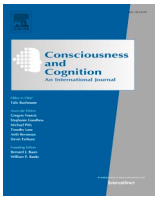

Vicarious ostracism reduces observers' sense of agency

Yingbing Sun [a], Bernhard Hommel [b,*], Ke Ma [a,*]

[a] Key Laboratory of Personality and Cognition, Faculty of Psychological Science, Southwest University, Beibei, Chongqing, China
[b] Department of Psychology, Shandong Normal University, Jinan, China

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ABSTRACT

Previous findings revealed that social ostracism reduces people's implicit sense of agency. Based on theoretical claims that observed behavior of others may be cognitively represented similarly to one's own behavior, we conducted two experiments to test whether people's own sense of agency can also be impaired by observed social exclusion of others. In Experiment 1, participants recalled episodes referring to vicarious ostracism or inclusion before completing a temporal interval estimation task to assess intentional binding effects (an established implicit measure of the sense of agency). In Experiment 2, participants immersed into a newly designed virtual Cyberball game, in which they witnessed a vicarious ostracism or inclusion scenario, before completing a Libet-style temporal estimation task and an agency questionnaire (an explicit measure of the sense of agency). The findings show, for the first time, that vicarious ostracism reduces both implicit and explicit measures of agency in observers.

1. Introduction

As the 17th century English poet John Donne said, "No man is an island". Human beings are social animals and have basic needs to belong to a specific social group, to be accepted and to form positive, stable, and lasting social relationships with others in this group (Baumeister & Leary, 1995). However, ostracism, in which the relationship between self and other breaks down, is a common phenomenon (Williams, 2001). Being ignored and even actively excluded from a social group can be a terrible experience that threatens basic human needs, including sense of belonging, self-esteem, sense of control, and meaningful existence (Williams, 2009). Studies have shown that when individuals suffer from ostracism, they may display more pro-social behavior (Maner et al., 2007; for a review, see Malik & Obhi, 2019) and seek out new groups to establish a sense of belonging, but they may also exhibit anti-social behaviors including extreme risk-taking and aggression that threatens the safety of others, in an attempt to regain their sense of control (Halabi, Dovidio, & Nadler, 2021; Warburton et al., 2006; Williams, 2009; Twenge et al., 2001).

It seems that people's sense of control, which represents the extent to which individuals feel they have personal power and control over their life and environment (Zarit et al., 2003; Obhi & Hall, 2011; Williams, 2009), is especially important in this respect. Belonging may also be obtained by pro-social behaviors, but when control is thwarted in ostracism, the desire to re-gain control can outweigh the desire to be liked by the group, which in turn can promote various forms of aggression as a control-regaining strategy (Warburton & Williams, 2005; Warburton et al., 2006). Indeed, people's sense of control is predicted to play a very important role in both physical and psychological well-being (Goode et al., 2017), and in developing a positive social identity (Halabi et al., 2021). Having or regaining a sense of control enables individuals to cope with stressful and threatening life events by helping to maintain a

* Corresponding authors.
E-mail addresses: bh@bhommel.onmicrosoft.com (B. Hommel), psyke1@swu.edu.cn (K. Ma).

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belief that the social world is orderly and predictable (Kay et al., 2014).

Given the close relationship between ostracism and sense of control, it is necessary to understand exactly how and under which circumstances ostracism affects people's sense of control. Importantly for our purposes, a previous study (Malik & Obhi, 2019) found that ostracism reduces the sense of agency (SoA). SoA refers to the perception of control over one's own actions and their consequent effects on the external world (Moore & Obhi, 2012; Malik & Obhi, 2019; Barlas & Obhi, 2013; Haggard et al., 2002; Moore & Fletcher, 2012). As predicted, SoA was closely associated with sense of control, which can be considered as a feeling of being the agent of control (Wen & Haggard, 2018). SoA has been studied extensively (Haggard, 2008; Moore & Obhi, 2012), has a wide range of structural effects on cognitive processes from perception to outcome evaluation (Bednark & Franz, 2014), and is fundamental to the development of a feeling of responsibility that fosters social cohesion (Frith, 2014).

Recent studies found that SoA is a multi-faced experience that comprises explicit and implicit components (David et al., 2008). In SoA studies, if individuals feel that their intentions lead to behavior and the effects it produces, measurements of both explicit (Wenke et al., 2010) and implicit SoA (Haggard et al., 2002) increase. Explicit measures commonly consist of verbal reports or questionnaires in which subjects are asked to answer or rate questions related to the feeling of agency for self-generated events (Ma et al.., 2019; Moore & Obhi, 2012; Saito et al., 2015). To assess implicit SoA, research has used the so-called intentional binding (IB) effect (Imaizumi & Tanno, 2019; Moore & Fletcher, 2012; Saito et al., 2015). IB is the subjective compression (relative under-estimation) of the interval between the onset of one's voluntary action and its consequent effect, in the sense that people estimate this interval to be shorter for self-produced action effects than for effects that are independent from their action or generated by involuntary movements (Moore & Obhi, 2012; Haggard et al., 2002).

There are two commonly used paradigms to assess IB effects. One uses the Libet-style clock paradigm (Haggard et al., 2002), in which participants pay attention to a clock and its rotating pointer while pressing a key and listening to a following sound. In one experiment of Haggard et al. (2002), the participant was asked to press the key voluntarily or was made to press it, and then report the time point with the help of the clock and pointer. Results show that the time of action onset was perceived later, and the time of sound onset was perceived earlier, when the action was voluntary as compared to involuntary. The second paradigm uses a temporal interval estimation task, in which participants directly estimate how long the interval between action and sound was (Moore et al., 2009; Ebert & Wegner, 2010). Again, shorter interval estimations are observed when the action is voluntary as compared to involuntary. The common interpretation of IB effect is that, in the voluntary condition, the causality relationship between action and sound serves to "bind" the sound to the action, and thus they seem to occur closer in time.

While the available evidence suggests that being the victim of ostracism reduces ones SoA, the probability of observing social-exclusion behavior is often much higher than the probability of becoming a target of such behavior oneself (Wesselmann et al., 2009). According to the Theory of Event Coding (Hommel et al., 2001; Hommel, 2018), observed behavioral events related to others can often have the same effect on people than behavioral events involving oneself. If so, vicarious ostracism may have the same or similar effects than ostracism targeting oneself. Indeed, previous research has shown that, very similarly to suffering from ostracism oneself, observing others being ostracized is also distressing (Giesen & Echterhoff, 2018; Wesselmann et al., 2009; Williams, 2009; Wesselmann et al., 2013). In previous studies (Masten et al., 2010), participants observed a three-player Cyberball game, in which the target player was socially included or ostracized, and results found that four basic needs (belonging, self-esteem, the sense of control, and meaningfulness of existence) of the observer were severely impaired after having witnessed ostracism targeting others. This suggests that the perception of ostracism is sufficient for experiencing negative affect and threat to fundamental needs (Wesselmann et al., 2009). Similarly, physiological evidence suggests that the pain network of first-hand ostracism experience is activated while watching a friend suffering from social rejection (Beeney et al., 2011). Developmental studies revealed that it is not just adolescents and adults who report a decrease in perceived control when observing ostracism, but young children also show evidence of elevated need for control (Marinović & Träuble, 2021) and need to belong (Marinović, Wahl, & Traeuble, 2017) in social situations with vicarious ostracism.

Taken altogether, we conclude that there is considerable evidence suggesting that vicarious ostracism might indeed threaten peoples' need of control, just like while being ostracized oneself or when recalling an episode of being ostracized (Malik & Obhi, 2019). Accordingly, we aimed to test whether observing ostracism would indeed cause negative affect of the observer and threaten his or her sense of control, thus reducing SoA. In Experiment 1, we followed the line of Malik and Obhi (2019) in manipulating vicarious ostracism vs inclusion by asking participants to recall and write down an episode about witnessed ostracism or inclusion. However, in contrast to Malik and Obhi (2019), participants were not to recall an episode in which they were a target of ostracism or inclusion themselves, but one in which they had observed someone else to be such a target. Like Malik and Obhi (2019), we used the interval estimation task to assess IB, which rendered Experiment 1 a test of the impact of vicarious ostracism on implicit SoA. In Experiment 2, we used virtual reality (VR) and designed more ecologically valid ostracism and inclusion scenarios. Participants wore head-mounted VR displays to experience (other-targeted) ostracism or inclusion among three virtual avatars in a virtual Cyberball tossing game (Kassner et al., 2012) before IB was assessed by means of a Libet-style clock paradigm (Ma et al., 2019; Qu, Ma, & Hommel, 2021; Qu, Sun, Yang, Hommel, Ma, 2021) and explicit SoA measures were obtained with a questionnaire.

2. Experiment 1

2.1. Method

2.1.1. Participants

The study was approved by the local ethics committee. Thirty-eight right-handed female participants took part (mean age = 20.58,

SD = 1.55, range: 18–23 years). Only female participants were tested in order to control for potential effects of gender, as previous evidence indicated that females tend to be more easily influenced by social exclusion (Benenson et al., 2013). All participants in this study individually provided informed consent and received reward for their participation. This sample size of 38 participants was determined using a-priori G*power analysis (Faul, Erdfelder, Lang, & Buchner, 2007), the power was set to be as 0.95, and α to be 0.05, the effect size (Cohen's dz = 0.608) was set according to previous studies (Borhani, Beck, & Haggard 2017; Caspar, Lo Bue, Magalhães De Saldanha da Gama, Haggard, & Cleeremans, 2020 ; Malik & Obhi, 2019).

2.1.2. Design

To determine how vicarious ostracism modulates the SoA, we manipulated one independent factor within participants: the social condition, with baseline, vicarious ostracism and vicarious inclusion. The social condition was manipulated by requiring participants to recall and write down a previously witnessed episode of ostracism or inclusion (Malik & Obhi, 2019; Rudert et al., 2018) targeting another person. The dependent variable was the interval estimation in milliseconds by participants, from which we computed the IB effect to assess implicit SoA. Thus, Experiment 1 had a one-factorial (social condition: baseline, vicarious inclusion, vicarious ostracism) within-participants design. Participants were not informed about the kind of social condition and the sequence of the two social conditions was fully counterbalanced across participants.

2.1.3. Apparatus and materials

We manipulated social condition by asking participants to recall and write down an episode of observed ostracism or inclusion targeting a person other than themselves (Rudert et al., 2018). The instructions to recall and write down were presented on the computer screen. The written description should contain more than 150 words in Chinese, and the writing took about 5–10 min. The instructions were as follows: "Please carefully recall a time in your life when you observed the rejection/ignored or acceptance of one person (referred to as A) by the other people, where you felt a strong sense of ostracism/inclusion and knew that the others clearly or directly showed their dislike/liking to A. For example, ignoring/accepting what A says during discussions. Or, when A wants to make (more) friends, the other people behave indifferent/friendly towards A and refuse/accept to make friends with A. Please think back carefully about the situation and how you felt inside, then write down on paper how this went, what the outcome was, and how you felt and thought how A felt. While writing this up, try to recall the situation as good as possible, as if it would be happening right in front of your eyes. Your answers are anonymous and the report will be kept strictly confidential.

2.1.4. Interval estimation task

The task was programmed in E-prime™. For each trial, a fixation point was presented in the middle of the computer screen, after which participants were to press the space bar whenever s/he wants. 100 ms, 400 ms or 700 ms after the onset of the keypress the action-effect sound was presented (Malik & Obhi, 2019). Participants had to estimate the temporal interval between the key press and the sound, enter the number into the input box, and then press the space bar to start the next trial. Participants were asked to make discrete and fast press movements to ensure that the estimate of interval onset could be easily identified and were encouraged to estimate the time accurately (i.e., not just reporting full or tens of seconds (Ma et al., 2019). Each interval estimation task consisted of 30 trials, with 10 trials for each time delay (100, 400 or 700 ms). The presentation of the three time delays was fully randomized within each participant.

2.1.5. Manipulation check

Participants' reports of the vicarious ostracism and inclusion episodes were coded by four independent raters who were blind to the research purpose. The coders used a scale from −3 (no vicarious ostracism content, no emotional content) to + 3 (strong degree of vicarious ostracism content, strong emotional content) (Malik & Obhi, 2019).

2.1.6. Procedure

Participants came to the lab under the guise of participating in two separate studies: one being a recall and writing task and the

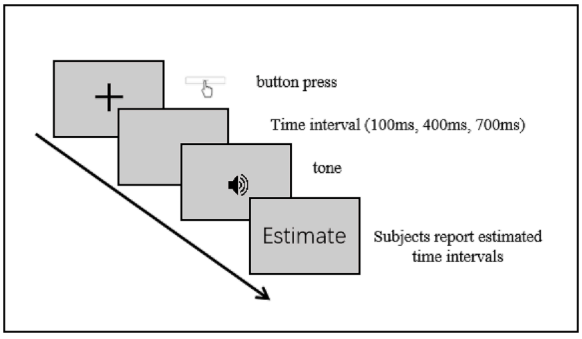

Fig. 1. Procedure for the interval estimation task. Participants pressed the key, after 100 ms, 400 ms, or 700 ms a sound was played, followed by a screen asking the participant to enter the time interval between the key being pressed and the sound being played.

other a motor-control experiment. Participants were told that the writing task was performed in the middle of the motion control task in order to save time (Malik & Obhi, 2019).

The experiment began with a practice phase of 10 interval estimation trials, in which the intervals varied between 100 and 1000 ms (Dewey & Knoblich, 2014). In each trial, after reporting the interval estimation, participants were given the correct answers as feedback. The aim of this practice was to help participants to acquaint with the estimation procedure and the short time intervals, so to reduce gross errors in the upcoming task.

Then the experiment started, in which three interval estimation tasks and two writing tasks were interleaved. First, an interval estimation task was run to compute the baseline IB effect; then participants were to write up a vicarious ostracism or inclusion episode; followed by another interval estimation task; then a two-minute break; the write-up of a vicarious inclusion or ostracism episode; and concluded by the third interval estimation task. Please see Fig. 1.

2.2. Result

Four outliers were removed from the analysis of IB, because their time estimations were beyond three standard deviations from the mean of that condition (Malik & Obhi, 2019; Lafleur et al, 2020; Qu, Ma et al., 2021; Qu, Sun et al., 2021). Data were analyzed by means of SPSS 26.0 and JASP 0.17.

2.2.1. Manipulation checks

Inter-rater correlations (Kendall's concordance coefficient) were significant for both conditions (Malik & Obhi, 2019): vicarious exclusion content correlation $W = 0.528$, $\chi^2 = 67.615$, $p < 0.001$; emotional content correlation $W = 0.666$, $\chi^2 = 85.289$, $p < 0.001$; vicarious inclusion condition: vicarious exclusion content correlation $W = 0.614$, $\chi^2 = 78.529$, $p < 0.001$; emotional content correlation $W = 0.568$, $\chi^2 = 72.766$, $p < 0.001$. The coders' scores for vicarious exclusion and emotional content were averaged and analyzed separately. Two-tailed paired-sample t tests on this coded data indicated that recalling a vicarious exclusion episode differed significantly from recalling the vicarious inclusion episode on both vicarious exclusion and emotional content. Vicarious exclusion episodes contained more ostracism content and more negative emotional content than vicarious inclusion episodes, please see Table 1.

2.2.2. Interval estimation task

There are usually-two ways to calculate the IB effect using the estimated intervals.

The first method (Barlas et al., 2018) is to directly analyze the interval estimations between action and sound with all independent variables. We conducted a repeated measures analysis of variance (ANOVA) to examine the effects of social condition (baseline, vicarious inclusion, or vicarious exclusion) and delay (100, 400, or 700 ms) on interval estimations. Mauchly's test of Sphericity was significant ($p < 0.001$) and estimated epsilon(ε) is higher than 0.75, therefore the Huynd-Feldt corrections were applied. The analysis yielded a significant main effect of social condition, $F(1.74, 55.72) = 29.39$, $p < 0.001$, $p\eta^2 = 0.48$. The main effect of delay was also significant, $F(1.51, 49.86) = 480.46$, $p < 0.001$, $p\eta^2 = 0.94$. In addition, the interaction effect of delay and social conditions was significant, $F(3.54, 113.38) = 7.07$, $p < 0.001$, $p\eta^2 = 0.18$. We further ran post hoc comparisons with JASP 0.17 to compare different social conditions at each delay (Table 2, 3, 4), p values were adjusted with the Holm-Bonferroni correction (Paul et al., 2013). We calculated the single degree of freedom contrasts using non-pooled error terms across the different levels of the repeated measure factor (Bouris et al., 2012). Please see Fig. 2.

In the second approach to IB (Dewey & Knoblich, 2014), the estimation percentages are computed and analyzed. We calculated interval estimation percentages separately for vicarious ostracism and inclusion, in two steps. First, we computed the estimations of the actual temporal interval in percentage ([actual interval - estimated interval]/actual interval) across all 30 trials (Braun et al., 2014), and used the median value (Dewey & Knoblich, 2014) as baseline IB, vicarious ostracism IB and inclusion IB value for each participant. According to Haggard et al. (2002), the stronger participants feel that they voluntarily pressed the key and caused the sound, the more compressed the estimated interval between key press and sound should be. Repeated measures ANOVA was performed, with within-subject factor (baseline, vicarious ostracism, vicarious inclusion). There was a main effect of condition, $F(2, 64) = 22.74$, $p < 0.001$, $p\eta^2 = 0.42$. We further ran post hoc comparisons with JASP to compare different social conditions, with Holm-Bonferroni correction. These tests revealed that the vicarious ostracism condition yielded significantly lower interval estimates than the baseline condition, with mean difference = 21.86, $t(32) = 6.27$, $p_{holm} < 0.001$, Cohen's $d = 0.96$; and than the vicarious inclusion, with mean difference = 6.57, $t(32) = 2.09$, $p_{holmt} = 0.044$, Cohen's $d = 0.29$. Also the vicarious inclusion condition yielded significantly lower interval estimates than the baseline condition, with mean difference = 15.29, $t(32) = 4.57$, $p_{holm} < 0.001$, Cohen's $d = 0.67$ Please see Fig. 3.

Table 1
Mean social ostracism and negative emotional content in recalling of vicarious ostracism and inclusion episodes.

Content	Social Exclusion observe episodes	Social Inclusion observe episodes	*t*-test
Ostracism	M = 2.17 SD = 0.48	M = -2.22 SD = 0.57	t(37) = 31.28 p < 0.001 d = 5.45
Negative Emotional	M = 2.02 SD = 0.62	M = -2.43 SD = 0.76	t(37) = 24.01 p < 0.001 d = 4.18

Table 2
The result of multiple comparisons using post hoc comparisons.

		Mean Difference	t	p_{holm}	Cohen's d
100 ms	Baseline - Vicarious inclusion	−41.25	2.53	0.06	0.36
	Baseline - Vicarious exclusion	−31.49	1.93	0.17	0.28
	Vicarious inclusion - exclusion	9.77	0.60	0.55	0.09
400 ms	Baseline - Vicarious inclusion	−94.90	5.81	<0.001	0.83
	Baseline - Vicarious exclusion	−134.71	8.25	<0.001	1.18
	Vicarious inclusion - exclusion	−39.82	2.44	0.06	0.35
700 ms	Baseline - Vicarious inclusion	−62.66	3.84	0.001	0.55
	Baseline - Vicarious exclusion	−91.62	5.61	<0.001	0.80
	Vicarious inclusion - exclusion	−28.97	1.77	0.17	0.25

Table 3
The result of post hoc comparisons of delay.

		Mean Difference	t	p_{holm}	Cohen's d
100 ms	400 ms	−233.53	14.74	<0.001	2.05
	700 ms	−516.04	24.91	<0.001	4.52
400 ms	700 ms	−282.51	22.79	<0.001	2.47

Table 4
The result of post hoc comparisons of social condition.

		Mean Difference	t	p_{holm}	Cohen's d
Baseline	Vicarious inclusion	−66.27	5.28	<0.001	0.58
	Vicarious exclusion	−85.94	6.41	<0.001	0.75
Vicarious inclusion	Vicarious exclusion	−19.67	2.24	0.03	0.17

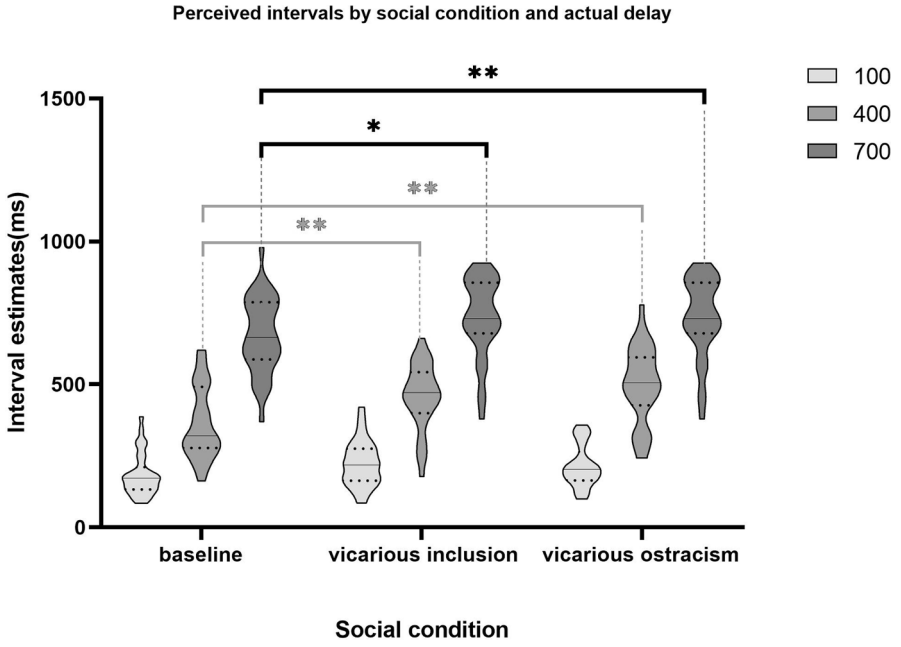

Fig. 2. IB values in Experiment 1 as a function of social condition (baseline, vicarious ostracism and vicarious inclusion) and delay (100, 400, and 700 ms). The black line in violin plot indicates median value and the dashed line represents 95 % confidential interval. *represents < 0.05, ** represents < 0.001.

2.3. Discussion

The aim of Experiment 1 was to explore the effects of vicarious ostracism on implicit SoA, by measuring IB with the temporal interval estimation paradigm. Manipulation checks suggest that our vicarious ostracism manipulation worked, as participants recalled and reported more ostracism and negative emotional content in vicarious ostracism conditions. Consistent with our hypotheses, and similarly to studies of self-targeted ostracism (Malik & Obhi, 2019), vicarious ostracism increased the estimated interval compared to the vicarious inclusion, which implies a reduced IB effect and, thus, a reduced implicit SoA. This is consistent with previous studies (Paolini et al., 2017; Wesselmann et al., 2009), in which witnessing ostracism causes physical and psychological damage.

Even though the outcome of Experiment 1 provides preliminary support for our hypothesis that vicarious ostracism reduces personal agency, two aspects of the experiment can be considered suboptimal. The first one relates to the induction of the social situation. The perceived severity or justification of observed ostracism targeting others, and the affective consequences thereof, will often depend on numerous factors and considerations, including the particular target of ostracism, the agent of ostracism, and the relationship between target and agent (Nezlek et al., 2012; 2015). Even though the pain network is activated both in direct and in vicarious ostracism (Beeney et al., 2011), the degree of people's empathy for strangers is different from their empathy for friends (Meyer et al., 2013), so that seeing close friends being ostracized may induce more empathy than in the case of strangers (Beeney et al., 2011). Another important factor is the assumed reason for acts of ostracism (Rudert et al., 2018), if this act seems unjustified, observers are likely to blame the agent and sympathize with the target, but the opposite may be true if the act seems justified (see Wesselmann et al. 2009).

These considerations suggest a considerable degree of dependency of the impact of observed ostracism on social context conditions, on the particular targets and the particular agents, and on their relationship. Accordingly, participants might have differed substantially in their concrete reactions depending on the targets and agents in the episodes they recalled. Indeed, our participants recalled rather different kinds of targets and agents: 24 participants recalled episodes of ostracism targeting friends and close others; 10 considered acquaintances; 3 referred to strangers; and one participant even to characters in TV shows. The recalled social situations also differed: 32 participants considered unjustified ostracism, like a person ostracized because of good grades; 2 participants referred to situations where justification was not clear, for instance two roommates having problems and ignoring each other; and 4 participants recalled justified ostracism, such as punitive attacks after an abuse. Given that these inconsistencies are likely to have introduced unwanted variability and noise in the data, we were interested to develop a research scenario that would allow streamlining the ostracism/inclusion scenario in Experiment 2.

Furthermore, as stated in previous studies (Sommer et al., 2001), the validity of our paradigm, in which participants recalled vicarious ostracism or inclusion episodes, may not be optimal. Specifically, the recollections of exclusion/inclusion events may not exactly fit what the researchers intended (Loftus & Pickrell, 1995). For example, the recalled experience of vicarious exclusion/inclusion may be different from what really occurred, because of meaning reinterpretations (Baumeister et al. 2007); individuals may mainly recall extreme or highly emotional parts of the experience, which means that individuals are less likely to recall the entire experience (Wirth, 2016); and it is unclear in the real memorized scenario, whether one specific participant was a simple observer or actually related to the exclusion/inclusion of the target, and thus other potential feelings may also be a confound (Kandaurova & Lee (2018); Mazzone et al., 2021). Indeed the use of the recall-writing paradigm to induce vicarious exclusion was relatively rare in previous studies (Rudert et al., 2018).

We also note one puzzling finding showing that, when participants recalled the experience of vicarious inclusion, the IB effect was also reduced as compared to baseline. This is inconsistent with the result of experiencing inclusion (Malik & Obhi, 2019), in which

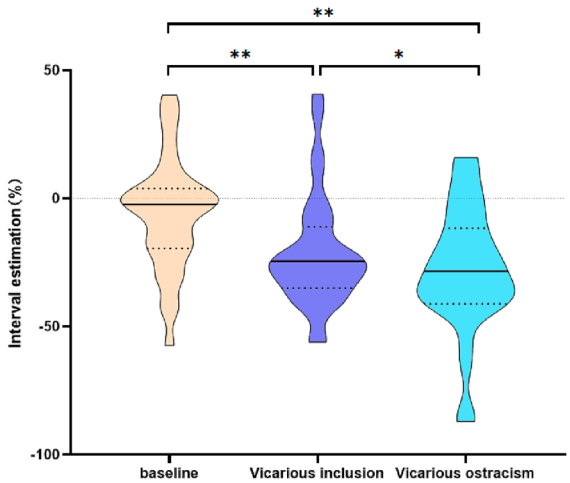

Fig. 3. IB values in Experiment 1 as a function of social condition (baseline, vicarious ostracism and vicarious inclusion) using the intervals estimation percentages.The black line in violin plot indicates median value and the dashed line represents 95 % confidential interval. *represents $<$ 0.05, ** represents $<$ 0.001.

experiencing inclusion did not reduce the IB effect. We assume that, on the one hand, as discussed above, the recollection paradigm to induce vicarious inclusion or exclusion might be problematic, as participants in the vicarious inclusion condition may have recalled something else, and their perceived ostracism and emotional content may have been influenced by many other factors. On the other hand, the witnessing inclusion might be different from experiencing inclusion by oneself. As an observer, due to the lack of direct information, participants are more inclined to seek other information, such as the motivation of exclusion or inclusion (Rudert & Greifeneder, 2019), the impression on the observers (Paolini et al., 2017), group categorization (Arpin et al., 2017), even perceive facial warmth and competence (Rudert et al., 2017). This information helps observers to make moral judgments and attributions, thus affecting observers' feelings and interpretations of exclusion and inclusion situations, as well as attitudes and behaviors toward the ostracized victims (Rudert et al., 2020). In other words, observers may be more likely to take a general and impersonal perspective, while targets may focus mainly on themselves. Indeed, some of our participants wrote content indicating that they were unhappy, or had feelings of unfairness or even jealousy, when recalling an unwanted witnessed inclusion. Thus, vicarious inclusion and self-targeted inclusion may differ.

Another possible limitation of Experiment 1 is that, like Malik and Obhi (2019), we only considered implicit SoA. If the perception and the affective consequence of vicarious ostracism depend on rather complex factors and respective considerations, some of them may have a stronger impact on explicit, rather than implicit SoA. Explicit and implicit measures of agency are assumed to rely on overlapping representations and processes, they are also likely to differ with regard of the amount and type of information and representations involved, with implicit measures being assumed to integrate more low-level multisensory information and explicit judgments more high-level reasoning (Synofzik et al., 2008a). For example, explicit SoA and IB effect are both affected by many factors including internal motor signals and external multisensory information about the source of actions and effects (Haering & Kiesel, 2014; Haggard & Cole, 2007; Moore et al., 2009; Moore & Obhi, 2012; Wen, 2019), which emerge from an interplay between pre-motor prediction and post-hoc reconstructive processes (Moore & Fletcher, 2012; Haggard, 2017). But some studies showed diverging result patterns for explicit SoA and IB effect (Ebert & Wegner, 2010). For example, some higher-order cognitive factors, like prior knowledge of the human body (Braun et al., 2014), contextual information from a prior task (Ma et al., 2019; Majchrowicz & Wierzchoń, 2018), and the relationship between sequential keypresses (Obhi & Hall, 2011; Lafleur et al., 2020) affect explicit, but not implicit SoA. Conversely, perceptual arousal affects implicit, but not explicit SoA (Wen et al., 2015).

Accordingly, we adopted another widely used paradigm to exclude the possible confusion caused by the recollection paradigm, and also included both implicit and explicit measures of SoA in Experiment 2, expecting that this social context might have a stronger impact on the explicit measure, and to see whether vicarious exclusion or even inclusion can reduce SoA.

3. Experiment 2

3.1. Method

3.1.1. Participants

The same method as in Experiment 1 was used in Experiment 2 to determine the sample size. Thirty-eight, right-handed, native Chinese university female students (mean age = 20.18 years, SD = 1.49 years, range = 18–24), different from Experiment 1, voluntarily participated in this study for reward. All participants signed the informed consent.

3.1.2. Design

We adopted VR to design a more ecologically valid scenario, in which vicarious ostracism and inclusion episodes were presented as part of a VR Cyberball tossing task. A Libet-style clock paradigm (Haggard et al., 2002) was used to assess IB (implicit SoA) and an agency questionnaire (Ma et al., 2016) was used to assess explicit SoA. The analytical design was as in Experiment 1.

Fig. 4. (a) The front view of a participant; (b) the virtual Cyberball tossing game.

3.1.3. Virtual environment and apparatus

Previous research has shown that the sensory experience of being ostracized in a VR Cyberball game is similar to that in a real social environment (Kassner et al., 2012). The VR equipment we used in Experiment 2 was the same as in a previous study (Qu, Ma et al., 2021; Qu, Sun et al., 2021). We used the VR software Vizard to create a virtual reality environment and three VR avatars, in addition to a virtual hand module. Participants wore a right-hand data glove (Manus, 12 sensors, record frequency 200HZ, latency around 5 ms) and a Vive tracker to record the movements of their hands and finger joints. The real hand movement data was translated to the virtual hand, so that its motion fully corresponded to participants' real hand movement. Participants were immersed in the virtual environment through an HTC Vive head mounted display (HMD), please see Fig. 4a.

3.1.4. The Cyberball game

We set up a virtual reality Cyberball game scene with three avatars. At first the ball was in the hands of target avatar (referred to as A). Participants were told that they would observe a ball tossing game among three best friends. The ball-tossing behavior and receiving percentage of each avatar in the Cyberball avatars was preprogrammed. Participants observed the virtual environment and the avatars from a bystander viewpoint (Wesselmann et al., 2009), see Fig. 4b. The tossing game comprised 40 ball tosses. In the inclusion condition, all virtual avatars received the ball with one-third of the total toss time each. In the ostracism conditions, the target player (avatar A) received the ball only twice in the beginning but was ignored thereafter by the other two avatars.

3.1.5. The time estimation task

Our "virtual" version of the Libet-style time estimation task (adopted from Ma et al., 2019; Qu, Ma et al., 2021; Qu, Sun et al., 2021) was comparable to previous non-virtual versions (Haggard et al., 2002; Ruess et al., 2018; Saito et al., 2015). Participants in the virtual environment saw a virtual clock and its pointer, also the virtual hand and a virtual button (see Fig. 5). Participants were to press a real space bar freely with their real fingers on a real keyboard, which was placed in front of their real hand. Pressing the space bar would cause the virtual pointer to start moving clockwise from zero, with the virtual hand/finger and virtual button going down and then up again. With each press, the virtual clock pointer always rotated from zero to zero at a speed of 1200 ms for a round. At a random time point between 600 and 1000 ms after the space bar was pressed, the script generated a sound. Participants were asked to report the position of the pointer when the sound was played. The time estimation task for baseline, vicarious inclusion, vicarious exclusion comprised 10 IB trials each (Ma et al., 2019; Qu, Ma et al., 2021; Qu, Sun et al., 2021).

3.1.6. Manipulation check

The manipulation of ostracism content was checked by asking participants to answer two items assessing the subjective perception of ostracism (" I felt avatar A was included " or "I felt avatar A was excluded ") on Likert scale 1–7. The first question was reversed in score and then the average of the two questions was computed.

The manipulation of emotional content was checked by asking participants to answer two items assessing the subjective emotional feeling of ostracism (" I feel sad for what avatar A experienced" or "I feel sympathy for what avatar A experienced") on Likert scale 1–7 and the average of the two questions were computed.

Also, participants were asked to estimate the ball tosses percentage the avatar A received.

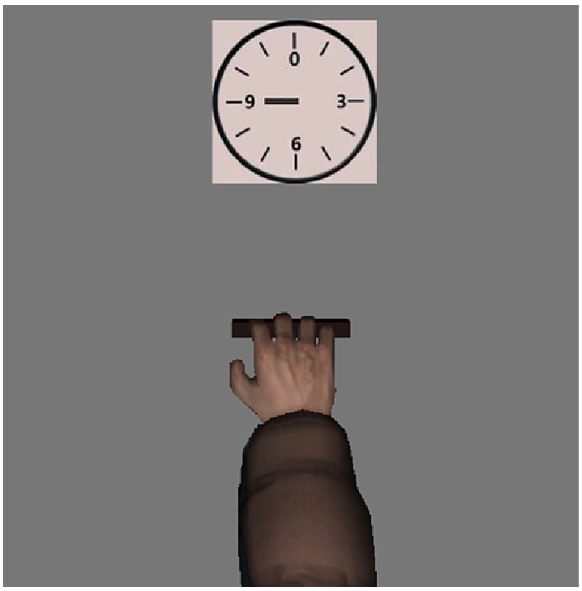

Fig. 5. The Libet-style time estimation task in Experiment 2.

3.1.7. Explicit SoA questionnaire

We used an adapted Chinese version of the Rubber/Virtual Hand questionnaire (Ma et al., 2019) to assess explicit SoA. For each sentence, participants responded by choosing a score on a 7-point (1–7) Likert scale, 1 meaning "strongly disagree," 4 meaning "uncertain," and 7 meaning "strongly agree." The sentences were:

Q1. The movement of the virtual hand and the sound was caused by me.

Q2. The virtual hand in the virtual environment moved as I wished.

3.1.8. Procedure

Before arriving at the lab, participants were informed that they will observe a Cyberball tossing game to practice their mental visualization skills (Giesen & Echterhoff, 2018; Williams et al., 2000) and a motor control experiment. When participants arrived at the laboratory, the experimenter helped them to put on the HMD, the data glove on their right hand, the orientation Vive tracker on their right wrist.

The procedure of Experiment 2 was similar to Experiment 1. Three time estimation tasks and two Cyberball tossing game observation tasks were interleaved: participants were asked to freely move or rotate their right hand and fingers while watching the corresponding movement of the virtual hand for two minutes, they then performed a time estimation task that served to compute baseline IB; and then observed a Cyberball tossing game in which vicarious ostracism or inclusion occurred; followed by another time estimation task. Participants also rated their perceived exclusion or inclusion about avatar A, their emotional feeling of avatar A, and estimated the ball tosses percentage the avatar A received. At last, participants filled in the SoA questionnaire to indicate their explicit SoA; and the Affect Grid scale (Russell et al., 1989) to indicate their own valence.

There was a two-minute break between the two experimental conditions for the purpose of reducing the tiredness of participant and prevent possible interference between conditions. Thereafter, participants were again to freely move their right hand and fingers for two minutes and to observe another Cyberball tossing game, in which vicarious inclusion or ostracism occurred; followed by another time estimation task, and participants again answered the four questions, followed by the ball receiving percentage estimation for manipulation check, the SoA questionnaire, and the Affect Grid.

3.2. Results

Two outliers were removed from the analysis of IB, because their time estimations were beyond three standard deviations from the mean of that condition (Malik & Obhi, 2019; Lafleur et al., 2020; Qu, Ma et al., 2021; Qu, Sun et al., 2021).

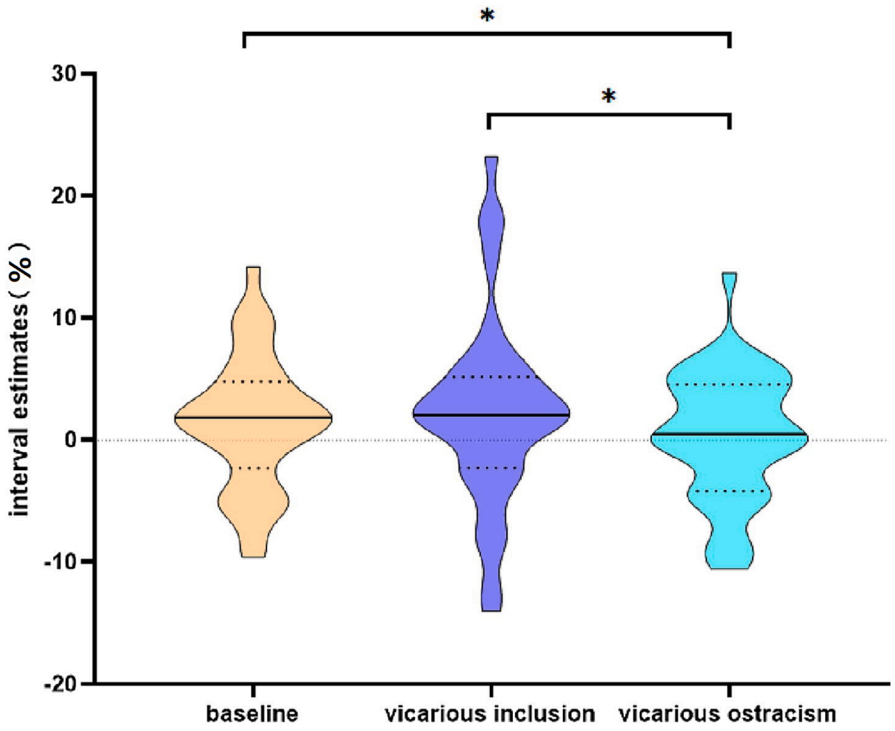

Fig. 6. IB values in Experiment 2 as a function of social condition (baseline, vicarious ostracism and vicarious inclusion) using the intervals estimation percentages. The black line in violin plot indicates median value and the dashed line represents 95 % confidential interval. *represents < 0.05.

3.2.1. Manipulation checks

First, we analyzed the correlation (Pearson's product-moment correlation) between the two items of each construct (perceived exclusion, emotion to the avatar A), in the vicarious inclusion condition, perceived exclusion correlation $r = 0.70$, $p < 0.001$, emotion correlation $r = 0.36$, $p = 0.031$; and in the vicarious exclusion condition, perceived exclusion correlation $r = 0.72$, $p < 0.001$, emotion correlation $r = 0.44$, $p = 0.008$.

Two-tailed paired-samples t-tests revealed that participants felt that the target player was more excluded and ignored in the ostracism condition ($M = 6.42$, $SE = 0.11$) than in the inclusion condition ($M = 1.65$, $SE = 0.14$), $t(35) = 26.99$, $p < 0.001$, $d = 4.50$, and they showed more negative feelings in the ostracism condition ($M = 4.19$, $SE = 0.13$) than in the inclusion condition ($M = 1.38$, $SE = 0.10$), $t(35) = -15.52$, $p < 0.001$, $d = 2.59$. They estimated that the target avatar received fewer ball tosses in the ostracism condition ($M = 69.78$, $SE = 3.42$) than in the inclusion ($M = 6.53$, $SE = 1.03$) condition, $t(35) = 17.65$, $p < 0.001$, $d = 2.94$. Analyses of the affect grid results showed lower valence ($M = 2.67$, $SE = 0.20$) after the ostracism condition than after the inclusion condition ($M = 7.25$, $SE = 0.22$), $t(35) = 14.02$, $p < 0.001$, $d = 2.34$.

3.2.2. Time estimation task

The data were treated as in the second method of Experiment 1. Mauchly's test of Sphericity was significant ($p < 0.001$) and the estimated epsilon (ε) was lower than 0.75, therefore the Greenhouse-Geisser corrections were applied. The ANOVA results indicated that the main effect of the condition was significant, $F(1.22, 42.66) = 5.10$, $p = 0.023$, $p\eta^2 = 0.13$. We further ran post hoc comparisons with JASP to compare different social conditions, the p-value was Holm-Bonferroni corrected. The result revealed that the time estimation was higher (i.e., the IB effect was stronger) under baseline condition than vicarious ostracism, with mean difference = 1.14, $t(35) = 2.84$, $p = 0.023$, Cohen's $d = 0.23$. Also the vicarious inclusion yielded significantly higher temporal estimates than the vicarious exclusion, with mean difference = 2.06, $t(35) = 2.41$, $p = 0.043$, Cohen's $d = 0.42$. No time estimation difference between baseline and vicarious inclusion, $p = 0.13$. Please see Fig. 6.

3.2.3. Explicit agency

We analyzed the correlation (Pearson's product-moment correlation) between the two items of explicit SoA questionnaire, in the vicarious inclusion condition, correlation $r = 0.659$, $p < 0.001$; and in the vicarious ostracism condition, correlation $r = 0.796$, $p < 0.001$. A two-tailed paired-samples *t*-test showed that participants perceived stronger explicit SoA after vicarious inclusion (mean = 6.33, $SE = 0.15$) than after vicarious exclusion (mean = 5.82, $SE = 0.23$), $t(35) = 2.22$, $p = 0.033$, Cohen's $d = 0.37$. Please see Fig. 7.

3.3. Discussion

The purpose of Experiment 2 was to investigate whether vicarious ostracism would reduce both implicit and explicit SoA in participants observing a virtual Cyberball tossing game. Given the scenario and the instructions, the social context should have been clear and comparable across participants: they were attending unjustified ostracism targeting a stranger. Our results are straightforward in showing that both kinds of SoA measures were affected equally, and showing that vicarious ostracism has an impact on both explicit and implicit agency. Furthermore, the reduced IB effect was only found in vicarious exclusion, but not in inclusion conditions, as compared to baseline.

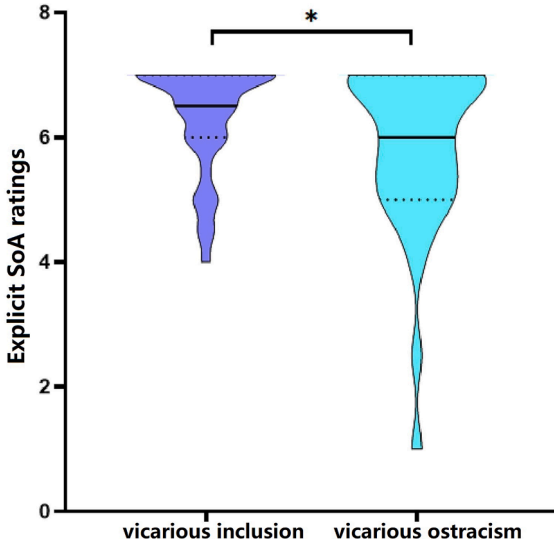

Fig. 7. Explicit SoA ratings in Experiment 2 as a function of social condition (vicarious ostracism and vicarious inclusion). The black line in violin plot indicates median value and the dashed line represents 95 % confidential interval. *represents < 0.05.

4. General discussion

In both experiments of this study, we were able to confirm our hypothesis that vicarious ostracism reduces perceived agency. To our knowledge, this study is the first to demonstrate a link between vicarious ostracism and SoA with respect to one's own actions and their effects—a link reflected in both subjective and objective measures. Why does vicarious ostracism have this impact on mere observers? We think that understanding this impact requires the integration of three lines of research and theorizing.

First, our findings are consistent with previous claims suggesting that humans are particularly sensitive to violations of social rules and the social threat caused by ostracism. This sensitivity might have developed on the basis of evolutionary pressures of group and cooperative living, and because of the considerable social importance of rejection from other group members (Kerr & Levine, 2008; Spoor & Williams, 2007). Participants have been shown to respond to experimental manipulations of rejection in an automatic, reflexive, and almost universal manner, and rejected participants universally report pain, feelings of injury, and frustration after being exposed to ostracism for<5 min already (Williams & Zadro, 2005). Children were even shown to be sensitive to ostracism of geometric shapes by other shapes to a degree that was reflected in their behavior to other group members (Over & Carpenter, 2009), and adults are very sensitive to the observation of ostracism of others (Wesselmann et al., 2009; Giesen & Echterhoff, 2018), and report negative affect, threat of their own need and need satisfaction like when being ostracized themselves (Paolini et al., 2017; Wesselmann et al., 2009; Wesselmann et al., 2013). This suggests that self- and other-targeted ostracism is related to a basic need, a chronic concern of humans.

Second, our findings are consistent with previous observations showing that both self-experienced and observed ostracism is associated with negative affect. As the manipulation check results showed, more negative emotional content was reported in the vicarious ostracism condition. Thus, observing others being targeted by ostracism is unpleasant, which may trigger the recall of one's own previous experiences of ostracism and indirectly threaten one's own need to belong (Giesen & Echterhoff, 2018). Our findings also fit with previous evidence that participants' affective state can bias their SoA. For example, positive affective priming increases IB (Aarts et al., 2012), while negative priming, such as recalling a depressing episode (Obhi et al., 2013) or experiencing induced fear and anger (Christensen et al., 2019) reduces implicit SoA. Along the same lines, anxiety and depression are associated with a perceived loss of personal control (DeWall et al., 2012).

Third, perceived agency is generally assumed to be associated with the violation of action-outcome expectations. According to the comparator model (Frith et al., 2000) and cue integration theory (Moore & Fletcher, 2012), internal and external cues related to people's actions and the respective context are weighted and integrated to estimate and predict the likely outcomes of one's voluntary actions, and the degree to which the actual outcomes match with the predicted ones, people experience personal agency (Moore & Fletcher, 2012). Interestingly, this connection between prediction (or prediction failure) and agency measures is particularly strong in moral contexts (Synofzik et al.,2008b; Moretto et al., 2011), presumably because unexpected outcomes can violate multiple kinds of expectations, including normative and cultural ones. The need of individual belonging and the expectation that people in social life are mutually accepted are particularly pronounced in collectivistic cultures like in China—the origin of the participant tested in our study. Hence, ostracism was likely to have violated the social norms of our participants to a particular degree (see Rudert et al., 2018).

Taken together, these three elements (high sensitivity to social exclusion, strong affective responses to exclusion, and a reduction of perceived agency as a function of action-outcome prediction failures) provide a solid basis for the theoretical understanding of our findings. According to GOALIATH (GOALs guide Intentional Actions THrough criteria) (Hommel, 2022), a theory of voluntary action based on the Theory of Event Coding (Hommel et al., 2001), intentional actions are often motivated by multiple goals, depending on the degree to which these goals are activated by the context. Given the high degree of sensitivity to social exclusion of self and others, belonging to a group can be assumed to constitute a basic need, a chronic concern of people, especially in a social context. The stronger the current impact of a given goal, need, or concern on information processing, the more strongly violations of social expectations, like in the case of ostracism, will affect the individual. Failures of expectations in action control are known to come with strong negative affect (Botvinick, 2007; Festinger, 1957), so that the degree of negative affect can be taken to indicate the degree of experienced violation (Hommel, 2019). Considering that people often process observed events more or less independently from whether the main agent is themselves or another individual (Hommel, 2018), and that they often experience affective consequences of observed norm violations as if they would be facing such violations themselves (Masten et al., 2011; Meyer et al., 2013), it makes sense that ostracism targeting another individual can reduce one's own perceived agency. While both of our experiments provide first evidence demonstrating this link, the outcomes of Experiment 2 are particularly timely: in an age of digital revolution, we all will be increasingly susceptible to cyberostracism on internet (Williams et al., 2000; Coyne et al.,2011) or through VR interactions.

We note that our study did have certain limitations. For example, future research should expand the sample size, explore changes in the SoA of males when observing exclusion or inclusion, and differentiate the effects of perceived exclusion and affective content of the target on SoA after vicarious ostracism.

CRediT authorship contribution statement

Yingbing Sun: Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Bernhard Hommel:** Investigation, Writing – review & editing. **Ke Ma:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

We have shared a link to our data.

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Declarations

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article. All procedures performed in this study were in accordance with the ethical standards of the ethics committee of Southwest University and with the 1964 Helsinki declaration and its later amendments. Informed consents were obtained from all participants included in this study.

Open practices statement

Raw data of the study are available on the Open Science Framework (https://osf.io/ymuh8/); the Experiment was not preregistered.

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