

# When “Your” reward is the same as “My” reward: Self-construal priming shifts neural responses to own vs. friends' rewards



Michael E.W. Varnum<sup>a</sup>, Zhenhao Shi<sup>b,c</sup>, Antao Chen<sup>d</sup>, Jiang Qiu<sup>d</sup>, Shihui Han<sup>b,c</sup>

<sup>a</sup> Department of Psychology, Arizona State University, Tempe, AZ 85287, USA

<sup>b</sup> Department of Psychology, Peking University, Beijing, China

<sup>c</sup> PKU-IDG/McGovern Institute for Brain Research, Peking University, Beijing, China

<sup>d</sup> Faculty of Psychology, Southwest University, Beibei, Chongqing, China

---

## article info

### Article history:

Accepted 19 October 2013

Available online 31 October 2013

### Keywords:

Vicarious reward

fMRI

Self-construal priming

Ventral striatum

Insula

---

## abstract

Is it possible for neural responses to others' rewards to be as strong as those for the self? Although prior fMRI studies have demonstrated that watching others get rewards can activate one's own reward centers, such vicarious reward activation has always been less strong than responses to rewards for oneself. In the present study we manipulated participants' self-construal (independent vs. interdependent) and found that, when an independent self-construal was primed, subjects showed greater activation in the bilateral ventral striatum in response to winning money for the self (vs. for a friend) during a gambling game. However, priming an interdependent self-construal resulted in comparable activation in these regions in response to winning money for the self and for a friend. Our

the VS responds to rewards for the self (e.g. Bjork and Hommer, 2007; Delgado et al., 2000; Fareri et al., 2012; Mobbs et al., 2009; O'Doherty et al., 2003) and to vicarious rewards ( Fareri et al., 2012; Mobbs et al., 2009), we predicted that this effect would be present in the VS.

## Methods

### Participants

Fifteen students from Southwest University (after excluding 4 participants with excessive motion; age ranging from 19 to 24, 10 females) participated in the main study. An independent sample of 16 students (age ranging from 18 to 25, 9 females) participated in the localizer study. All were Chinese, right-handed, had normal or corrected-to-normal vision, and reported no abnormal neurological or psychiatric history. Participants provided informed consent, and the study was approved by a local ethics committee.

### Stimuli and procedure

All materials were presented in Chinese. For the main study, 10 pairs of sex-matched friends were recruited for the main study. The two friends that comprised each pair were scanned successively (except for one participant whose friend, unbeknownst to her until the completion of the study, was precluded from scanning due to a metal implant). That is, participants actually believed that their friend was also participating in the study (and with one exception this was the case). Participants were told that the study involved a card-guessing game, and that they would have a chance to win extra monetary rewards for themselves and their friends in addition to their basic payment (CNY ¥70, USD \$11.2). Adapting our procedure from [Delgado et al. \(2000\)](#)

whole brain were acquired using the following parameters:  $64 \times 64 \times 32$  matrix with  $3.75 \times 3.75 \times 5 \text{ mm}^3$  spatial resolution, inter-slice gap = 1 mm, field of view (FOV) =  $24 \times 24 \text{ cm}^2$ , repetition time (TR) = 2000 ms, echo time (TE) = 30 ms, flip angle (FA) =  $90^\circ$ . For each run, a total of 154 volumes were acquired in the main study and 184 volumes in the localizer study.

SPM8 (Wellcome Trust Centre for Neuroimaging, London, UK) was used to preprocess and analyze the imaging data. Images were adjusted for slice timing, realigned to the first scan to correct for head motion, normalized into stereotactic Montreal Neurological Institute (MNI) space with 3-mm cubic voxels, and spatially smoothed by a Gaussian filter with full-width/half-maximum parameter (FWHM) set to 8 mm. We then modeled trials of different conditions by including regressors convolved with canonical hemodynamic response function (HRF) at the onset of the presentation of outcomes. For the main study, five regressors were generated for Self Win, Self Loss, Friend Win, Friend Loss, and neutral trials. For the localizer study, three regressors were generated for Win, Loss, and neutral trials. Six motion parameters (translation: x, y, z; rotation: pitch, roll, yaw) and run-specific constant terms were also included in the model to account for effects of no interest, and whole-brain intensity was normalized using global scaling. Linear contrasts were used to identify regionally specific effects in individual participants with a fixed effect model. Random effect analyses were then conducted based on contrast images to allow population inference. For the localizer study, brain regions encoding monetary reward, specifically bilateral VS, were identified at a corrected  $p < 0.05$  threshold (using a combined threshold of uncorrected  $p < 0.001$  and cluster extent  $\geq 21$  voxels, determined by a 1000-iteration Monte-Carlo simulation; Slotnick et al., 2003) for the contrast of Win  $\geq$  Loss in the localizer study. This threshold was

insula encodes monetary loss (e.g. [Delgado et al., 2000](#); [Paulus et al., 2003](#)), while the supplementary motor area underlies reward-related decision-making (e.g. [Gläscher et al., 2008](#); [Haruno et al., 2004](#); [Kouneiher et al., 2009](#)). Although none of these regions showed a significant Prime  $\times$  Target  $\times$  Outcome interaction ( $F$  s b 3.13, ps N 0.09), we did observe a marginally significant Prime  $\times$  Target interaction in the right insula in the Loss condition ( $F(1,14) = 3.95$ ,  $p = 0.067$ ), such that the activation tended to be stronger for self trials vs. friend trials ( $M = 0.55$ ,  $SD = 0.24$  vs.  $M = 0.21$ ,  $SD = 0.25$ ) after Independent self-construal priming, and tended to be stronger for friend trials vs. self trials ( $M = 0.37$ ,  $SD = 0.19$  vs.  $M = 0.19$ ,  $SD = 0.23$ ) after Interdependent self-construal priming. However, pair-wise comparisons failed to reach statistical significance (ps N .15).

We also conducted correlation analyses to test whether the magni-

changes in response to outcome feedback in general, but rather were specifically linked to reward feedback.

We did find a marginally significant interaction between Prime and Target on activation in the right insula during the Loss condition, such that losses for one's friend (vs. the self) produced greater activation after Interdependence priming, whereas the opposite was the case after Independence priming. Given that the insula has been implicated in empathy (for a review see [Bernhardt and Singer, 2012](#)), these results suggest that priming interdependence may have heightened empathic responses to losses for one's friend. This is broadly consistent with the previous finding that trait-level interdependence was correlated with increased error-related negativity (ERN) in response to trials where one lost points for a friend ([Kitayama and Park, 2013](#)). However, we should note that the pair-wise contrasts were not significant in the present study. This may be due to relatively limited power. We should also note that in [Kitayama and Park's \(2012\)](#) study, participants completed a banker task and incorrect answers led to losses for a friend; whereas in our paradigm incorrect guesses were framed as having to do with chance rather than ability or performance (and in fact in our case feedback was rigged). Further, our study was designed such that loss trials were of smaller monetary magnitude than win trials, thus

losses in general may not have been particularly painful. Future research with a larger sample (and hence greater statistical power) might explore whether modifying the relative value of loss vs. reward trials or perceived (or actual) responsibility for trial outcomes in order to test whether this might magnify the effects of self-construal priming on regions like the insula or ACC.

The present study did not measure subjective responses to individual trials (due to time constraints). As a result it was not possible to map the neural effects of the priming that were observed in the current study onto subjective reports. Future research may address this limitation by gathering real-time subjective ratings of pleasure and distress. It would also be useful in future work, if trial-by-trial ratings prove impractical, to measure subjective ratings of pleasure and distress after each set of runs (independent vs. interdependent) as this would be expected to confirm the neural results observed. In addition, it would be interesting to measure participants' physiological responses during

condition where wins for friends produced larger activations than wins for the self, as it might increase power to detect such effects. Although interspersing the trials may have increased power and decreased noise, self-construal primes are likely to have strong carry-over effects. Considering these trade-offs, we opted to employ a block design as we felt it would provide a better chance to capture the priming effects we were interested in.

Although the present study was conducted within a single culture, because of the observed effects of manipulating self-construal (a key dimension of cultural difference) the results raise the possibility that the reward system may be culturally influenced. In fact it may be that chronic cultural differences in self-construal and reward system responses to self and close others are mutually reinforcing. Our results may also have implications for research on culture and in-group/out-group phenomena. For example, the greater levels of in-group trust and favoritism that are present in interdependent societies (Yamagishi and Yamagishi, 1994; Yamagishi et al., 1998) may in part reflect greater sensitivity of the reward system to vicarious rewards for close others. Future studies might explore whether default neural responses to vicarious reward differ across cultures that differ in which type of self-construal is predominant, and whether the effects of priming are similar across different cultures. It may be illuminating to examine the effects of self-construal priming on bi-cultural participants for whom both types of self-construal may be defaults. It would also be worthwhile to test whether manipulating people's focus on their own rewards vs. rewards for close others may shift how people construe the self. That is, it would be interesting to see if having people focus on vicarious reward might lead to a more interdependent construal of the self (and whether focusing on personal rewards may lead to the self being construed in a more independent fashion). Finally, it would be interesting to test whether inducing an interdependent view of the self may also motivate people to engage in altruistic behavior toward close others, and whether individual differences in neural response to vicarious reward may be a useful predictor of future altruistic behavior.

#### Acknowledgments

MEWV and ZS contributed equally to this paper. The research was supported by grants from the National Basic Research Program of China (973 Program 2010CB833903), the National Natural Science Foundation of China (Project 30910103901, 91024032, 81161120539), and the China Postdoctoral Science Foundation, No. 2011M500170. We thank Xi Liu and Xiangpeng Wang for their aid in data collection.

#### References

- Ainslie, G., 1995. A utility-maximizing mechanism for vicarious reward: comments on Julian Simon's "Interpersonal allocation continuous with intertemporal allocation. *Ration. Soc.* 7, 393-403.
- Aron, A., Aron, E.N., Smollan, D., 1992. Inclusion of other in the self scale and the structure of interpersonal closeness. *J. Pers. Soc. Psychol.* 63, 596-612.
- Bandura, A., 1977. *Social Learning Theory*. Prentice Hall, Englewood Cliffs, NJ.
- Bernhardt, B.C., Singer, T., 2012. The neural basis of empathy. *Annu. Rev. Neurosci.* 35, 1-23.
- Bjork, J.M., Hommer, D.W., 2007. Anticipating instrumentally obtained and passively-received rewards: a factorial fMRI investigation. *Behav. Brain Res.* 177, 165-170.

Campbell-Meiklejohn, D., Frith, C.D., 2012. Social factors and preference change. In: Dolan, R.J., Sharot, T. (Eds.), *Neuroscience of Preference and Choice: Neural and Cognitive Mechanisms*. Academic Press, London, UK.