

# The pursuit of social acceptance: aberrant conformity in social anxiety disorder

Chunliang Feng,<sup>3,4</sup> Jianqin Cao,<sup>5</sup> Yingli Li,<sup>5</sup> Haiyan Wu,<sup>1,2,6</sup> and Dean Mobbs<sup>6</sup>

<sup>1</sup>CAS Key Laboratory of Behavioral Science, Institute of Psychology, Beijing, China, 100101, <sup>2</sup>Department of Psychology, University of Chinese Academy of Sciences, Beijing, China, 100101, <sup>3</sup>College of Information Science and Technology, Beijing Normal University, China, 100071, <sup>4</sup>State Key Laboratory of Cognitive Neuroscience and Learning, Beijing Normal University, China, 100071, <sup>5</sup>Department of Nursing, Harbin Medical University, Daqing, China, 163319, and <sup>6</sup>Division of Humanities and Social Sciences and Computation and Neural Systems Program, California Institute of Technology, Pasadena, CA 91125, USA

Correspondence should be addressed to Haiyan Wu, CAS Key Laboratory of Behavioral Science, Institute of Psychology, Beijing 100101, China and Division of Humanities and Social Sciences and Computation and Neural Systems Program, California Institute of Technology, Pasadena, CA 91125, USA. E-mail: wuhy@psych.ac.cn

## Abstract

The defining pathological features of social anxiety disorder primarily concern the social landscape, yet few empirical studies have examined the potentially aberrant behavioral and neural patterns in this population using socially interactive paradigms. We addressed this issue by investigating the behavioral and neural patterns associated with social conformity in patients with social anxiety disorder. We recorded event-related potentials when healthy subjects ( $n = 19$ ), and patients with social anxiety disorder ( $n = 20$ ) made attractiveness judgements of unfamiliar others, while at the same time, being exposed to congruent/incongruent peer ratings. Afterwards, participants were asked to rerate the same faces without the presence of peer ratings. When compared with healthy controls, social anxiety disorder patients exhibited more positive attitudes to unfamiliar others and conformed more with peers-higher feedback. These behavioral effects were in parallel with neural responses associated with social conflict in the N400 signal, showing higher conformity to peers-higher feedback compared with peers-lower or peers-agree feedback among social anxiety disorder patients. Our findings provide evidence on the behavioral and neural patterns of social anxiety disorder during social interactions, and support the hypothesis that individuals with social anxiety disorder are more motivated to pursue social acceptance and possibly avoid social rejection.

**Key words:** social anxiety disorder; social conformity; event-related potential; N400; kindness; social acceptance

## Introduction

Social anxiety disorder is one of the most common anxiety disorders, with an estimated lifetime prevalence of ~12% (Kessler et al., 2005). A defining feature of social anxiety disorder is elevated anxiety and consequently the avoidance, of being criticized or rejected by others (Heimberg, 1995; American Psychiatric Association, 2013; National Collaborating Centre for

Mental Health, 2013). With the advent of neuroscientific techniques such as functional MRI (fMRI) and event-related potential (ERP), the past decade has witnessed an increasing interest in exploring neural substrates underlying the abnormalities in socioemotional processing among individuals with social anxiety disorder (Etkin and Wager, 2007; Hattingh et al., 2012; Brühl et al., 2014; Harrewijn et al., 2017; Qi et al., 2017). Although

Received: 19 March 2018; Revised: 29 May 2018; Accepted: 28 June 2018

© The Author(s) (2018). Published by Oxford University Press.

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited. For commercial re-use, please contact [journals.permissions@oup.com](mailto:journals.permissions@oup.com)

symptoms of social anxiety disorder are closely related to social encounters, few studies have examined behavioral and neural patterns of individuals with social anxiety disorder during interpersonal interactions. The current study addressed this gap by assessing the behavioral and neural correlates of social conformity in social anxiety disorder patients (Berns et al., 2005; Klucharev et al., 2009; Nook and Zaki, 2015).

Extant research has implicated the critical roles of social rejection/exclusion in developing and maintaining symptoms of social anxiety disorder (Voncken et al., 2008; Levinson et al., 2013; Cao et al., 2015; Fung and Alden, 2017; Linardon et al., 2017). Perceived social exclusion results in a pain-like experience (Eisenberger et al., 2003), which are believed to constitute a primary source of social anxiety (Baumeister and Tice, 1990; Leary, 1990). Moreover, individuals with social anxiety disorder compared with healthy controls reported increased feelings of distress (Burklund et al., 2017; Heeren et al., 2017) and exhibited more prolonged recovery in response to social exclusion (Zadro et al., 2006; Oaten et al., 2008). These findings together suggest that patients with social anxiety disorder are particularly sensitive to social exclusions. Therefore, it is conceivable that the pursuit of social acceptance is significantly higher in social anxiety patients. Indeed, socially anxious individuals are at elevated risk for smoking and drinking due to peer pressure (Patton et al., 1998; Stewart et al., 2006).

Previous studies employing social conformity paradigms have consistently demonstrated that people often change their initial ratings during second rating session to align with group ratings. Importantly, however, not all social influence emit their effects equally, such that people are more prone to conforming with group opinions that are more matched with intrinsic opinions of one's own (Chung et al., 2015). At the neural level, the consensus between oneself and groups consistently engages the ventral striatum, a region important in valuation and reward processing. Conversely, disagreement with group norms evokes activity in the dorsal anterior cingulate cortex and anterior insula that are implicated in encoding aversive feelings and monitoring conflict (Montague and Lohrenz, 2007; Klucharev et al., 2009; Campbell-Meiklejohn et al., 2010; Nook and Zaki, 2015).

Complementing fMRI findings, recent ERP studies have demonstrated that the discrepancy between oneself and majority opinions induces ERP components previously implicated in error or conflict detection, such as feedback-related negativity (FRN) (Chen et al., 2012; Kim et al., 2012; Shestakova et al., 2013; Schnuerch et al., 2014; Schnuerch and Gibbons, 2015) and N400 (Huang et al., 2014). For instance, disagreement with group opinions evoked more pronounced N400 component than agreement with group opinions, and amplitudes of the N400 were modulated as a function of levels of disagreement with normative opinions (Huang et al., 2014). Moreover, the N400 was induced by counter-conformity choices that inherently resulted in disagreement with group opinions (Chen et al., 2010). Therefore, the N400 component provides a promising measure for the sensitivity to disagreement with majority others.

In this study, we aimed to characterize behavioral and neural patterns of social anxiety disorder patients when they were engaged in social interactions, combining a social conformity paradigm with ERP technique (Chen et al., 2012; Kim et al., 2012; Shestakova et al., 2013; Schnuerch et al., 2014; Schnuerch and Gibbons, 2015). The conformity paradigm allowed for measures of prosocial tendency as initial attractiveness ratings (i.e. kindness to the presented people) as well as social conformity as changes in ratings in agreement with normative opinions

(Klucharev et al., 2009). We hypothesized that individuals with social anxiety disorder would report higher initial attractiveness ratings than healthy controls to establish increased positive reciprocity. We further hypothesized that social anxiety disorder patients would exhibit higher level of social conformity than controls, especially in the condition where their initial ratings were lower than those of group opinions. At the neural level, we expected that conflict-related ERP components such as N400 would be more pronounced in disagreement than agreement condition as well as more pronounced among social anxiety disorder patients than controls.

## Materials and methods

### Participants

Participants were 20 (11 females, mean age:  $20.42 \pm 0.77$ ) right-handed adults who met the DSM-IV criteria for current social anxiety disorder and 19 (9 females, mean age:  $20.85 \pm 0.75$ ) demographically matched healthy control with no history of any DSM-IV psychiatric disorders. Participants were recruited from a public mental health clinic at Harbin Medical University (DaQing Campus). All participants provided written informed consent in accordance with the Harbin Medical University Review Board guidelines. All participants were diagnosed using the validated Chinese translation of the Structured Clinical Interview for DSM-IV (SCID-IV; Ruying et al., 1997). The interviewers were two clinical psychiatrists who received training for the administration of the SCID-IV. Inclusion criteria for the social anxiety disorder group included (i) a primary diagnosis of social anxiety disorder according to DSM-IV criteria, (ii) age between 18 and 25 and (iii) right handed. Exclusion criteria included (i) past or current diagnosis of schizophrenia and (ii) history of neurological disorders. Demographic data and the self-reported measures of the 39 participants in the two groups are presented in Table 1.

### Stimuli

A set of 160 faces with neutral expressions (80 Chinese males, 80 Chinese females), selected from the CAS-PEAL-R1 Face Database (Gao et al., 2008), were used as stimuli. We resized all face images to  $360 \times 480$  pixels, and removed the salient features on the faces by Adobe Photoshop software. Furthermore, prior to the formal experiment, we recruited an independent sample of 20 participants (10 males, 10 females) to rate the attractiveness of the selected faces (from 1 = 'not attractive at all' to 5 = 'extremely attractive'). The average facial attractiveness score was 2.09 (SD = 0.89), indicating that the attractiveness of the selected faces was moderate.

**Table 1.** Demographic information of Participants in the social anxiety disorder and healthy control groups.

	Social anxiety disorder group (n = 20)	Healthy control group (n = 19)	t-test (df = 37)
Age in years (SD)	20.85 (.75)	20.42 (0.77)	1.77
Gender (% females)	55%	42.1%	
IAS (SD)	52.25 (10.74)	28.53 (4.39)	2.998**
Trait anxiety (SD)	49.05 (14.00)	29.05 (4.61)	2.16**
State anxiety (SD)	51.05 (13.42)	33.05 (5.31)	3.01**

Note. SAD, social anxiety disorder; IAS, Interaction Anxiousness Scale. \*\* $P < 0.005$ .

## Experimental procedure

This study employed a social conformity task popularly used in prior research on social influence (Klucharev et al., 2009; Zaki et al., 2011). Participants were informed that they were taking part in a study on facial attractiveness and that a group of 200 university students had already participated in this study to rate the attractiveness for a series of faces. Participants then rated the attractiveness of the same faces (initial ratings) and, following the ratings of themselves, would be shown the average rating from 200 other peer participants (normative feedback). Unbeknownst to participants, the normative feedback was generated by a pseudorandom algorithm that resulted in three experimental conditions (Zaki et al., 2011; Huang et al., 2014): on ~30% of the trials, normative ratings were same as the participant's ratings (peers-agree condition); on ~30% of the trials, normative ratings were one to three points higher than the participant's ratings (peers-higher condition); whereas on the remaining approximately 30% of trials, normative ratings were one to three points lower than participant's ratings (peers-lower condition). Using an adaptive algorithm, we kept the overall ratio of 'lower' and 'higher' normative ratings approximately equal across the experiment. All face stimuli were randomized across conditions and participants. Approximately 30 min after completing the initial ratings, participants underwent an unexpected (unannounced) behavioral session to rerate the attractiveness of the same 160 faces that they rated in the initial rating session. Unlike the initial rating session, participants were not informed with the normative ratings in the second rating session.

Stimulus presentation and behavioral data collection were implemented using E-Prime software (Version 2.0, Psychology Software Tools, Inc.). On each trial of the initial rating session, participants viewed a face presented at the computer screen and evaluated the degree to which they perceived the face to be attractive on an 8-point scale ranging from 1, unattractive, to 8, very attractive. Participants completed their ratings for each face within 6 s. Their own rating was then highlighted with a blue rectangle frame to the chosen number for 0.5 s. Afterwards, the normative rating (i.e. how attractive the previous group of 200 participants had found that face) was presented (by a red rectangle frame) on the scale for 2 s (Figure 1a).

## Electroencephalographic recording and preprocessing

Electroencephalographic (EEG) data were recorded while participants were completing the initial rating session. Participants sat comfortably in an electrically shielded room ~80 cm from a computer screen. The EEG data were recorded with a 64-channel NeuroScan system (NeuroScan Inc, Herndon, VA). Raw EEG data were sampled at 1000 Hz/channel, with impedances < 5 k $\Omega$ . Online recordings were referenced to the nose, and re-referenced offline to the average bilateral mastoids. Vertical electrooculograms were recorded supra- and infra-orbitally at the left eye. Horizontal electrooculograms were recorded by electrodes at the left and right orbital rims. The online continuous data were digitized with a bandpass filter of 0.05–100 Hz.

EEG data were filtered with a low pass of 30 Hz (24 dB/oct) off-line. Epochs were locked to the normative feedback, beginning 200 ms before feedback onset to 600 ms after. Trials exceeding the threshold of  $\pm 80 \mu\text{V}$  were excluded from further analysis. Trials without a response were excluded from both behavioral and EEG average analyses. To examine the effect of social influence, trials from three conditions (i.e. peers-agree, peers-higher, and peers-lower) were respectively averaged, and

a –200 to 0 ms baseline was used to perform a baseline correction.

## Statistical analysis: behavioral data

**Initial ratings.** Participant's initial ratings on the face stimuli were compared between social anxiety disorder and healthy control groups with a two-sample t-test.

**Behavioral updates.** Social conformity was calculated as changes of attractiveness ratings between second and initial ratings on the same faces (Klucharev et al., 2009). In order to control for the overall changes in ratings across initial and second sessions, we first calculated the mean rating for each rating session and participant. Afterwards, the distance of each rating from the mean was computed for each trial, and the difference in the mean-corrected scores between two sessions was calculated as a 'behavioral update' for each face stimulus (Sharot et al., 2009, 2012). A mixed  $3 \times 2$  analysis of variance (ANOVA) on the behavioral updates was applied with Feedback (peers-higher vs peers-lower vs peers-agree) as a within-subjects factor and Group (social anxiety disorder vs healthy control) as a between-subjects factor.

**Conformity scores.** To establish an even closer association between normative ratings and individual behavior, we performed a correlation analysis between (i) the magnitude of the conflict (i.e. the difference value between participants' own and group ratings) and (ii) the subsequent changes in the perceived facial attractiveness for each participant (i.e. the difference between the participant's follow-up ratings and their initial ratings). The correlation coefficients (Pearson's  $r$ ) were computed across all trials within each participant, and for peers-higher/peers-lower condition, respectively. The correlation analysis cannot be performed for the peers-agree condition since the conflict value was always zero in this condition. We then transformed raw  $r$  scores to  $z$  scores through Fisher's  $r$ -to- $z$  transformation to as 'conformity scores'. Higher conformity scores indicated a stronger within-individual tendency to shift follow-up ratings toward group ratings on a trial-by-trial level. A mixed  $2 \times 2$  ANOVA on the conformity scores was applied with Feedback (peers-higher vs peers-lower) as a within-subjects factor and Group (social anxiety disorder vs healthy control) as a between-subjects factor.

## Statistical analysis: ERP data

The amplitude of the N400 was measured as the mean amplitude in a time window of 300–500 ms post-onset of the feedback (i.e. normative ratings) over frontocentral electrodes (Fz, F1, F2, FC1, FC2 and FCz). The resulting N400 amplitude was analyzed with a mixed  $3 \times 2$  ANOVA with Feedback (peers-higher vs peers-lower vs peers-agree) as a within-subjects factor and Group (social anxiety disorder vs healthy control) as a between-subjects factor.

## Correlation analyses

Bivariate (Pearson's  $r$ ) correlations were computed to determine associations among dispositional (anxiety scores), behavioral (attractive ratings), and ERP (amplitudes) measures. All statistical analyses for behavioral and ERP data were conducted by IBM SPSS Statistics version 18.

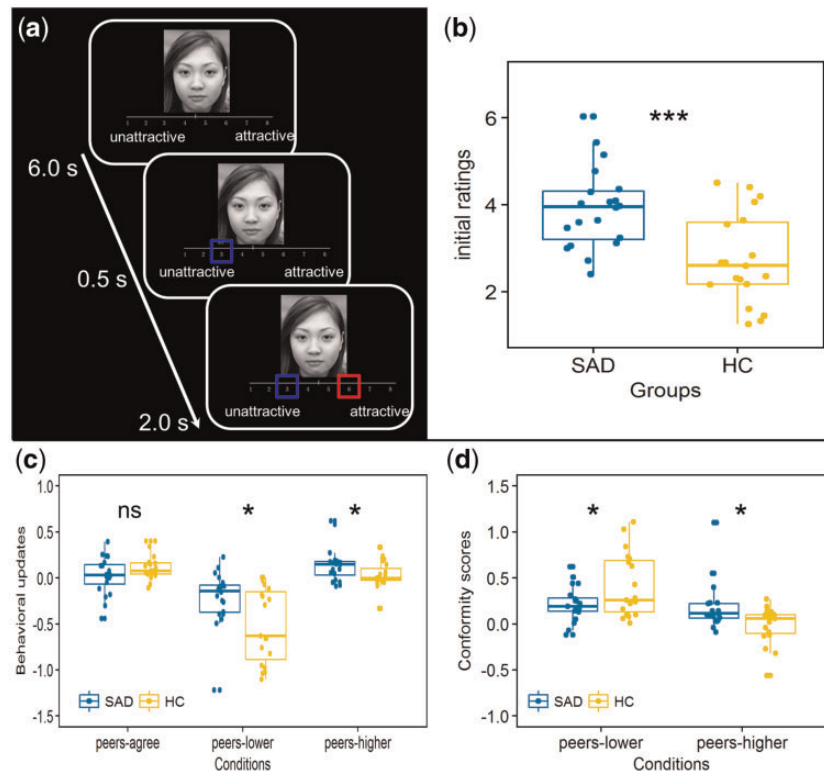


Fig. 1. Experimental procedure and behavioral results. (a) Experimental procedure on each trial. (b) Initial ratings as a function of group. (c) Behavioral updates as a function of group and condition. (d) Conformity scores as a function of group and condition. SAD, social anxiety disorder; HC, healthy controls; ns, not significant; \* $P < 0.05$ ; \*\*\* $P < 0.005$ .

## Results

### Behavioral results

**Initial ratings.** On average, social anxiety disorder group ( $M = 3.92$ ,  $SE = 0.21$ ) reported higher ratings of facial attractiveness than healthy control group ( $M = 2.74$ ,  $SE = 0.24$ ) during the initial rating session ( $t_{37} = 3.74$ ,  $P < 0.005$ , Cohen's  $d = 0.98$ , Figure 1b).

**Behavioral updates.** A 3 (Feedback: peers-higher vs peers-lower vs peers-agree)  $\times$  2 (Group: social anxiety disorder vs healthy control) ANOVA on the behavioral updates yielded a significant main effect of Feedback ( $F_{2, 74} = 35.64$ ,  $P < 0.0005$ ,  $\eta_p^2 = 0.49$ ), indicating that participants' follow-up ratings shifted in the direction of normative ratings (i.e. social conformity). Furthermore, a Feedback  $\times$  Group interaction was significant ( $F_{2, 74} = 5.19$ ,  $P < 0.01$ ,  $\eta_p^2 = 0.12$ ), demonstrating differences in behavioral updates for the social anxiety disorder and healthy control groups (Figure 1c). In particular, social anxiety disorder group ( $M = 0.14$ ,  $SE = 0.038$ ) exhibited stronger conformity to group ratings than healthy control group ( $M = 0.033$ ,  $SE = 0.039$ ) in the peers-higher condition ( $P < 0.05$ , Figure 2a); whereas social anxiety disorder group ( $M = -0.22$ ,  $SE = 0.080$ ) showed lower conformity to group ratings than healthy control group ( $M = -0.51$ ,  $SE = 0.082$ ) in the peers-lower condition ( $P < 0.05$ , Figure 2b). In the peers-agree condition, there was no significant difference between social anxiety disorder ( $M = 0.023$ ,  $SE = 0.039$ ) and healthy control ( $M = 0.12$ ,  $SE = 0.040$ ) groups in the changes of ratings ( $P > 0.05$ ).

**Conformity scores.** A 2 (Feedback: peers-higher vs peers-lower)  $\times$  2 (Group: social anxiety disorder vs healthy control) ANOVA on

the conformity scores revealed a significant main effect of Feedback ( $F_{1, 37} = 14.58$ ,  $P < 0.0005$ ,  $\eta_p^2 = 0.28$ ), revealing that conformity scores were higher in the peers-lower condition ( $M = 0.32$ ,  $SE = 0.044$ ) than the peers-higher condition ( $M = 0.088$ ,  $SE = 0.037$ ). In addition, a Feedback  $\times$  Group interaction was significant ( $F_{1, 37} = 10.96$ ,  $P < 0.005$ ,  $\eta_p^2 = 0.23$ , Figure 1d), indicating that social anxiety disorder group ( $M = 0.19$ ,  $SE = 0.052$ ) exhibited higher conformity scores than healthy control group ( $M = -0.01$ ,  $SE = 0.053$ ) in the peers-higher condition ( $P < 0.05$ , Figure 2c); while social anxiety disorder group ( $M = 0.22$ ,  $SE = 0.061$ ) showed lower conformity scores than healthy control group ( $M = 0.42$ ,  $SE = 0.063$ ) in the peers-lower condition ( $P < 0.05$ , Figure 2d).

**Correlations.** Initial ratings exhibited positive correlations with behavioral updates in peer-higher conditions for both social anxiety disorder group ( $r = 0.64$ ,  $P < 0.005$ ) and healthy control group ( $r = 0.62$ ,  $P < 0.005$ ) (Figure 3a). In contrast, Initial ratings showed negative correlations with conformity scores in peer-lower condition for both social anxiety disorder group ( $r = -0.47$ ,  $P < 0.05$ ) and healthy control group ( $r = -0.50$ ,  $P < 0.05$ ) (Figure 3b).

### ERP results

The ANOVA of N400 amplitude revealed a significant social influence  $\times$  group interaction effect,  $F_{2, 74} = 3.34$ ,  $P < 0.05$ ,  $\eta_p^2 = 0.08$  (Figure 4). Post-hoc comparisons indicated that peers-higher feedback evoked more negative N400 amplitude than peers-agree feedback among social anxiety disorder group ( $P < 0.01$ ) but not among healthy control group ( $P > 0.05$ ). Furthermore, N400 amplitude induced by peers-higher feedback

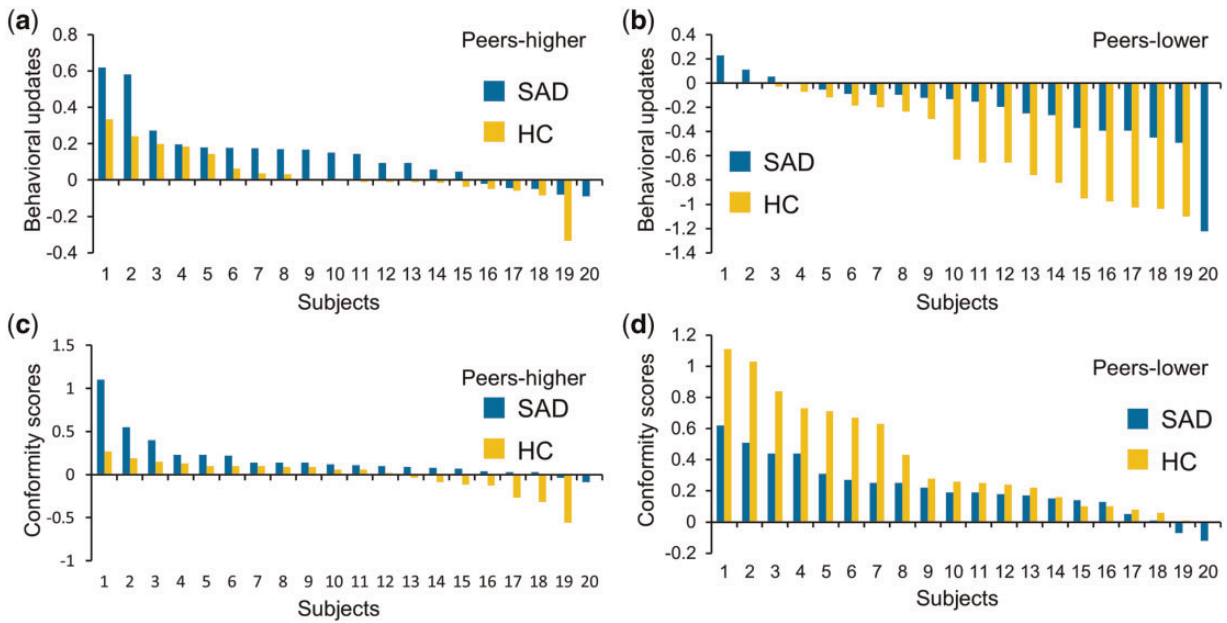


Fig. 2. Individual differences in social conformity. (a and b) Behavioral updates across participants in both groups in the peers-high and peers-low conditions, respectively. (c and d) Conformity scores across participants in both groups in the peers-high and peers-low conditions, respectively. SAD, social anxiety disorder; HC, healthy controls.

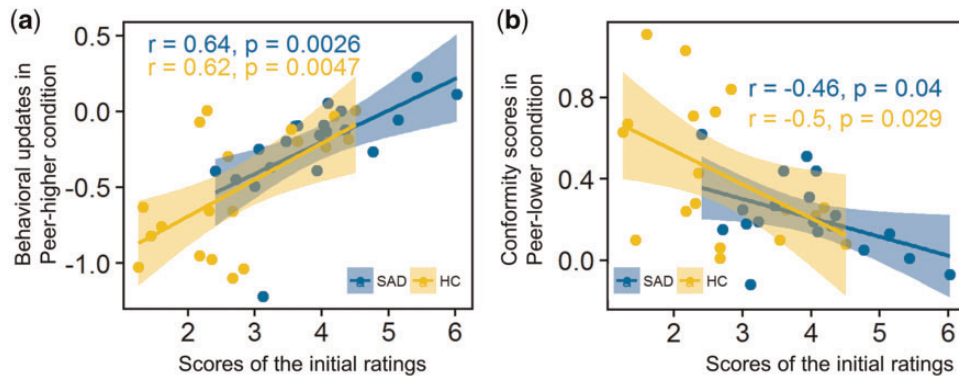


Fig. 3. Correlations between initial ratings and social conformity. (a) Correlations between initial ratings and behavioral updates in peers-higher condition within both groups. (b) Correlations between initial ratings and conformity scores in peers-lower condition within both groups. SAD, social anxiety disorder; HC, healthy controls.

tended to be more negative among social anxiety disorder group than healthy control group ( $P = 0.078$ ).

## Discussion

The key symptoms of social anxiety disorder mainly concern interpersonal interactions, however, far few studies have examined behavioral and neural patterns of social anxiety disorder in social and interactive contexts. Combining ERP technique with a commonly used social conformity paradigm, our study explored the neural dynamics underlying the social behavior patterns of social anxiety disorder in an interactive context. We demonstrated that social anxiety disorder patients compared with healthy controls reported enhanced attractiveness ratings during initial rating, implicating higher motivations to establish positive reciprocity among individuals with social anxiety disorder than controls. We further revealed differential patterns of social conformity among social anxiety disorder patients and healthy participants; such that social anxiety disorder patients

were more subject to social influence when their initial ratings were lower than group ratings (i.e. peers-higher), whereas healthy controls were more subject to social influence when their initial ratings were higher than group ratings (i.e. peers-lower). Underlying these behavioral effects were differential patterns of N400 responses among social anxiety disorder patients and healthy controls. In particular, among social anxiety disorder patients, amplitudes of N400 were more pronounced for peers-higher condition compared with other conditions, whereas among healthy controls no reliable differences were identified. Together, our findings provide evidence regarding behavioral and neural patterns of how social influence is heightened in social anxiety disorder.

We first demonstrated that individuals with social anxiety disorder expressed more positive attitudes towards unfamiliar others than healthy controls, manifesting as higher attractiveness ratings during the initial rating session. In daily life, praising others is a common and effective way to develop and maintain positive interpersonal relationship across a variety of

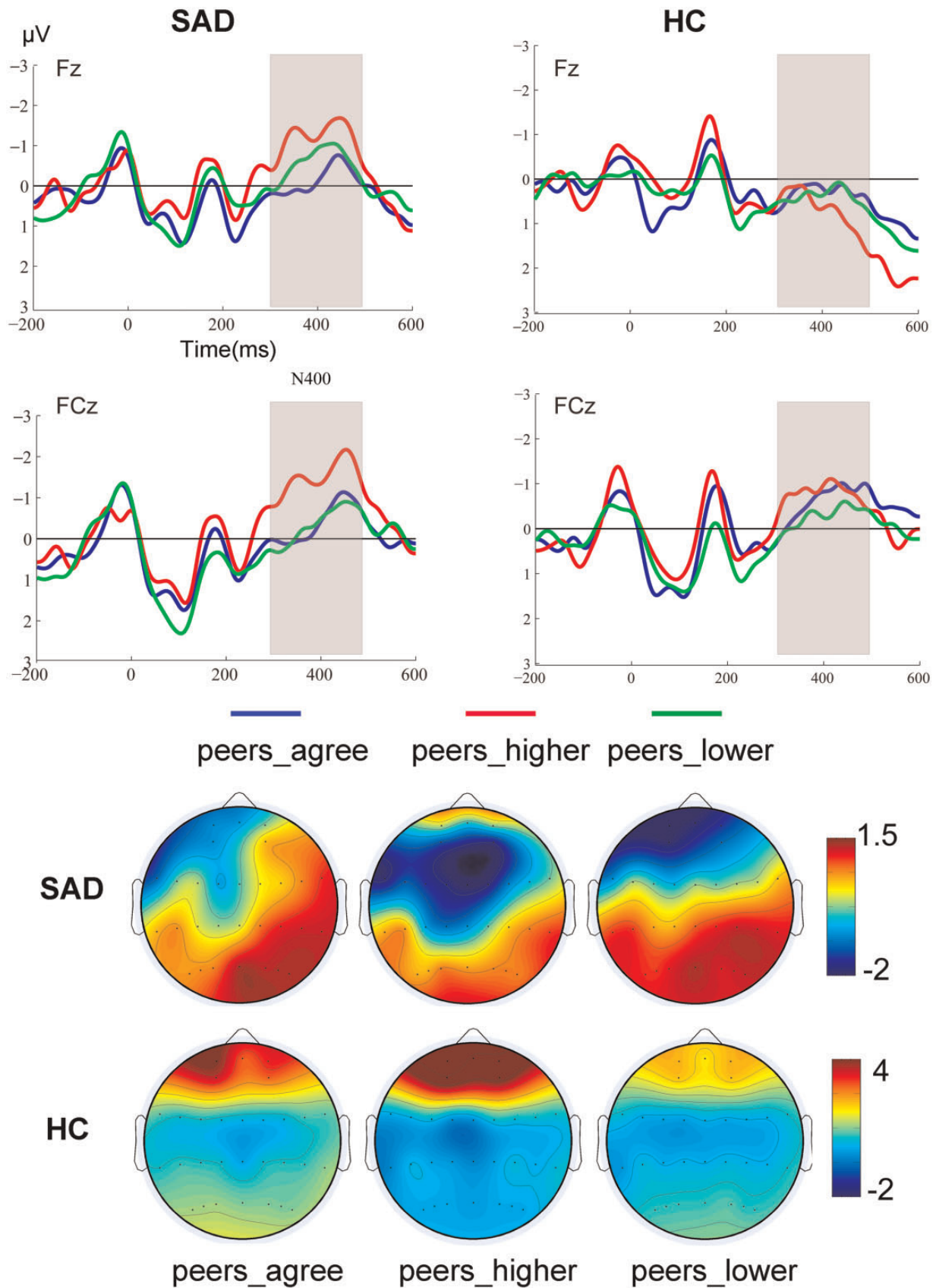


Fig. 4. ERP findings. Upper panel: the grand average ERPs evoked by peers-higher, peers-lower, and peers-agree feedback for both social anxiety disorder and healthy control groups were illustrated. Lower panel: the voltage topographies for the N400 component in each group and condition were illustrated. SAD, social anxiety disorder; HC, healthy controls.

scenarios (Al-Ghamdi, 2017; Blizzard et al., 2017; Davies and Fafchamps, 2017; Luerssen et al., 2017). Furthermore, our analysis indicated that social anxiety disorder patients changed their ratings more than healthy controls when normative ratings are higher than one's own ratings (peers-higher); in contrast, social anxiety disorder patients changed their ratings less than controls when normative ratings are lower than one's own ratings (peers-lower). These findings suggest that social anxiety disorder patients did not simply exhibit more conformity to the opinions of the majority, but instead balanced positive reciprocity motivation and conformity during social interactions.

The current findings dovetail with the assertion that people incorporate social information in a biased way, depending on the extent to which social information and one's own opinions are matched (Chung et al., 2015). For instance, risk-averse individuals tend to conform more with safe decisions of others, whereas risk-seeking individuals tend to conform more with risky decisions of others (Chung et al., 2015). Likewise, people usually have positive self-evaluations (Alicke and Govorun, 2005; Beer and Hughes, 2010). Accordingly, people process self-relevant social feedback in a positively biased way, i.e. changing self-evaluations more toward desirable than toward undesirable feedback (Korn et al., 2012, 2014).

In light of these findings, the patterns of conformity behaviors observed in the current study resonate with observations of initial ratings. That is, more conformity to peers-higher feedback among social anxiety disorder patients could be attributed to their more positive attitudes to the presented faces during initial rating session. In a similar vein, more conformity to peers-lower social feedback among healthy controls could be attributed to their more negative attitudes to the presented faces. This conjecture is corroborated by correlational findings that initial ratings were positively correlated with behavioral changes in the peers-higher condition, but were negatively correlated with behavioral changes in the peers-lower condition.

Our ERP findings provided further insights into the neural dynamics underlying the behavioral findings. Specifically, peers-higher feedback induced more pronounced response in a conflict-related ERP component (i.e. N400) among social anxiety disorder patients but not among healthy controls. The N400 component has been found specifically sensitive to violations of social norms, suggesting that the component might serve as a social deviance marker in the human brain (Mu et al., 2015). Complementing the current findings, recent ERP studies have indicated that disagreement with other induced increased N400 deflection (Chen et al., 2010; Huang et al., 2014; Schnuerch et al., 2016), especially when one's own ratings were lower than group ratings (Huang et al., 2014). A possible explanation of these findings is that individuals, especially those with social anxiety disorder, might feel ashamed and guilty about rating others as less attractive than the average, which might be more unacceptable than the situation when their initial ratings were above group ratings (see also Huang et al., 2014). This is consistent with the hypothesis that individuals with social anxiety disorder compared with controls had stronger motivations to establish positive reciprocity by giving unfamiliar others higher attractiveness evaluations (Weeks et al., 2005). In brief, our ERP findings suggest that ratings lower than group ratings were encoded as a more aversive event among social anxiety disorder patients than healthy controls, which presumably drove higher conformity in this context for individuals with social anxiety disorder compared with controls.

Several limitations related to the current study should be noted. First, one could argue that higher attractiveness ratings

among social anxiety disorder patients than controls might reflect differences in impression forming processes rather than motivations for positive reciprocity between two groups. This alternative is unlikely, considering that individuals with social anxiety disorder often overestimate social threat from faces (Gutierrez-Garcia and Calvo, 2016). For instance, relative to non-anxious individuals, socially anxious individuals often interpret neutral facial expressions in a more negative manner (Mobini et al., 2013). Second, the current study did not identify changes in conflict-related FRN or N400 components among healthy controls, but those effects have been reported in previous studies (Chen et al., 2012; Kim et al., 2012; Shestakova et al., 2013; Huang et al., 2014; Schnuerch et al., 2014; Schnuerch and Gibbons, 2015). The reasons for the discrepancies between current and previous findings should be explored in future studies.

In summary, our work investigated behavioral and neural patterns of social anxiety disorder during social interactions and identified a plausible motivation to give positive evaluation to others and show prosocial conformity among individuals with social anxiety disorder. When compared with healthy controls, social anxiety disorders exhibited more positive attitudes to unfamiliar others during initial rating and were more willing to incorporate peers-higher feedback during a second evaluation. Those behavioral effects were parallel with neural responses in the N400, which was more pronounced in response to peers-higher feedback compared with peers-lower or peers-agree social feedback among social anxiety disorder patients. Our findings provide evidence on the behavioral and neural patterns of social anxiety disorder during social interactions and support the hypothesis that individuals with social anxiety disorder may show more prosocial motivation to pursue social acceptance or avoid social rejection. Our findings also endorse social neuroscience as a promising approach to shed light on the neuropsychological mechanisms of social anxiety disorder.

## Acknowledgements

The author would like to thank Erik C. Nook for sharing their conformity paradigm.

## Funding

We acknowledge the funding from CAS Key Laboratory of Behavioral Science (Y5CX052003), Institute of Psychology, National Natural Science Foundation of China (31400963 and U1736125) to H.W.; the National Postdoctoral Program for Innovative Talents (BX201600019), the China Postdoctoral Science Foundation (2017M610055), National Natural Science Foundation of China (31500920) to C.F.

*Conflict of interest.* None declared.

## References

- Al-Ghamdi, A. (2017). Building a positive environment in classrooms through feedback and praise. *English Language Teaching*, 10(6), 37.
- Alicke, M.D., Govorun, O. (2005). The better-than-average effect. *The Self in Social Judgment*, 1, 85–106.
- American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders*. Arlington: American Psychiatric Publishing.

- Baumeister, R.F., Tice, D.M. (1990). Point-counterpoints: anxiety and social exclusion. *Journal of Social and Clinical Psychology*, 9(2), 165–95.
- Beer, J.S., Hughes, B.L. (2010). Systems of social comparison and the “above-average” effect. *Neuroimage*, 49(3), 2671–9.
- Berns, G.S., Chappelow, J., Zink, C.F., Pagnoni, G., Martin-Skurski, M.E., Richards, J. (2005). Neurobiological correlates of social conformity and independence during mental rotation. *Biological Psychiatry*, 58(3), 245–53.
- Blizzard, A.M., Barroso, N.E., Ramos, F.G., Graziano, P.A., Bagner, D.M. (2017). Behavioral parent training in infancy: what about the parent–infant relationship? *Journal of Clinical Child & Adolescent Psychology*, 53, 1–13.
- Brühl, A.B., Delsignore, A., Komossa, K., Weidt, S. (2014). Neuroimaging in social anxiety disorder—a meta-analytic review resulting in a new neurofunctional model. *Neuroscience and Biobehavioral Reviews*, 47, 260–80.
- Burklund, L.J., Torre, J.B., Lieberman, M.D., Taylor, S.E., Craske, M.G. (2017). Neural responses to social threat and predictors of cognitive behavioral therapy and acceptance and commitment therapy in social anxiety disorder. *Psychiatry Research: Neuroimaging*, 261, 52–64.
- Campbell-Meiklejohn, D.K., Bach, D.R., Roepstorff, A., Dolan, R.J., Frith, C.D. (2010). How the opinion of others affects our valuation of objects. *Current Biology*, 20(13), 1165–70.
- Cao, J.Q., Gu, R.L., Bi, X.J., Zhu, X.R., Wu, H.Y. (2015). Unexpected acceptance? Patients with social anxiety disorder manifest their social expectancy in ERPs during social feedback processing. *Frontiers in Psychology*, 6, 1745.
- Chen, J., Wu, Y., Tong, G., Guan, X., Zhou, X. (2012). ERP correlates of social conformity in a line judgment task. *BMC Neuroscience*, 13(1), 43.
- Chen, M., Ma, Q., Li, M., Lai, H., Wang, X., Shu, L. (2010). Cognitive and emotional conflicts of counter-conformity choice in purchasing books online: an event-related potentials study. *Biological Psychology*, 85(3), 437–45.
- Chung, D., Christopoulos, G.I., King-Casas, B., Ball, S.B., Chiu, P.H. (2015). Social signals of safety and risk confer utility and have asymmetric effects on observers’ choices. *Nature Neuroscience*, 18(6), 912–6.
- Davies, E., Fafchamps, M. (2017) *Pledging, Praising and Shaming: Experimental Labour Markets in Ghana*. IZA Discussion Paper No. 10520.
- Eisenberger, N.I., Lieberman, M.D., Williams, K.D. (2003). Does rejection hurt? An fMRI study of social exclusion. *Science*, 302(5643), 290–2.
- Etkin, A., Wager, T.D. (2007). Functional neuroimaging of anxiety: a meta-analysis of emotional processing in PTSD, social anxiety disorder, and specific phobia. *American Journal of Psychiatry*, 164(10), 1476–88.
- Fung, K., Alden, L.E. (2017). Once hurt, twice shy: social pain contributes to social anxiety. *Emotion*, 17(2), 231.
- Gao, W., Cao, B., Shan, S.G., et al. (2008). The CAS-PEAL large-scale Chinese face database and baseline evaluations. *Ieee Transactions on Systems Man and Cybernetics Part A-Systems and Humans*, 38(1), 149–61.
- Gutierrez-Garcia, A., Calvo, M.G. (2016). Social anxiety and trustworthiness judgments of dynamic facial expressions of emotion. *Journal of Behavior Therapy and Experimental Psychiatry*, 52, 119–27.
- Harrewijn, A., Schmidt, L.A., Westenberg, P.M., Tang, A., van der Molen, M.J.W. (2017). Electrocortical measures of information processing biases in social anxiety disorder: a review. *Biological Psychology*, 129, 324–48.
- Hattingh, C.J., Ipser, J., Tromp, S., et al. (2013). Functional magnetic resonance imaging during emotion recognition in social anxiety disorder: an activation likelihood meta-analysis. *Frontiers in Human Neuroscience*, 6, 347.
- Heeren, A., Dricot, L., Billieux, J., et al. (2017). Correlates of social exclusion in social anxiety Disorder: an fMRI study. *Scientific Reports*, 7(1), 260.
- Heimberg, R.G. (1995) *Social Phobia: Diagnosis, Assessment, and Treatment*. New York: Guilford Press, pp. 9–11.
- Huang, Y., Kendrick, K.M., Yu, R. (2014). Social conflicts elicit an N400-like component. *Neuropsychologia*, 65, 211–20.
- Kessler, R.C., Berglund, P., Demler, O., Jin, R., Merikangas, K.R., Walters, E.E. (2005). Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey Replication. *Archives of General Psychiatry*, 62(6), 593–602.
- Kim, B.-R., Liss, A., Rao, M., Singer, Z., Compton, R.J. (2012). Social deviance activates the brain’s error-monitoring system. *Cognitive, Affective, and Behavioral Neuroscience*, 12(1), 65–73.
- Klucharev, V., Hytonen, K., Rijpkema, M., Smidts, A., Fernandez, G. (2009). Reinforcement learning signal predicts social conformity. *Neuron*, 61(1), 140–51.
- Korn, C.W., Fan, Y., Zhang, K., Wang, C., Han, S., Heekeren, H.R. (2014). Cultural influences on social feedback processing of character traits. *Frontiers in Human Neuroscience*, 8, 192.
- Korn, C.W., Prehn, K., Park, S.Q., Walter, H., Heekeren, H.R. (2012). Positively biased processing of self-relevant social feedback. *Journal of Neuroscience*, 32(47), 16832–44.
- Leary, M.R. (1990). Responses to social exclusion: social anxiety, jealousy, loneliness, depression, and low self-esteem. *Journal of Social and Clinical Psychology*, 9(2), 221–9.
- Levinson, C.A., Langer, J.K., Rodebaugh, T.L. (2013). Reactivity to exclusion prospectively predicts social anxiety symptoms in young adults. *Behavior Therapy*, 44(3), 470–8.
- Linardon, J., Braithwaite, R., Cousins, R., Brennan, L. (2017). Appearance-based rejection sensitivity as a mediator of the relationship between symptoms of social anxiety and disordered eating cognitions and behaviors. *Eating Behaviors*, 27, 27–32.
- Luerssen, A., Jhita, G.J., Ayduk, O. (2017). Putting yourself on the line: self-esteem and expressing affection in romantic relationships. *Personality and Social Psychology Bulletin*, 43, 940–56.
- Mobini, S., Reynolds, S., Mackintosh, B. (2013). Clinical implications of cognitive bias modification for interpretative biases in social anxiety: an integrative literature review. *Cognitive Therapy and Research*, 37(1), 173–82.
- Montague, P.R., Lohrenz, T. (2007). ‘To detect and correct: norm violations and their enforcement’. *Neuron*, 56(1), 14–8.
- Mu, Y., Kitayama, S., Han, S., Gelfand, M.J. (2015). How culture gets embrained: cultural differences in event-related potentials of social norm violations. *Proceedings of the National Academy of Sciences of the United States of America*, 112(50), 15348–53.
- National Collaborating Centre for Mental Health. (2013). Social anxiety disorder: recognition, assessment and treatment. *British Psychological Society*, pp. 9–10.
- Nook, E.C., Zaki, J. (2015). Social norms shift behavioral and neural responses to foods. *Journal of Cognitive Neuroscience*, 27(7), 1412–26.
- Oaten, M., Williams, K.D., Jones, A., Zadro, L. (2008). The effects of ostracism on self-regulation in the socially anxious. *Journal of Social and Clinical Psychology*, 27(5), 471–504.



- Patton, G., Carlin, J., Coffey, C., Wolfe, R., Hibbert, M., Bowes, G. (1998). Depression, anxiety, and smoking initiation: a prospective study over 3 years. *American Journal of Public Health*, *88*(10), 1518–22.
- Qi, Y.Y., Gu, R.L., Cao, J.Q., Bi, X.J., Wu, H.Y., Liu, X. (2017). Response bias-related impairment of early subjective face discrimination in social anxiety disorders: an event-related potential study. *Journal of Anxiety Disorders*, *47*, 10–20.
- Ruying, Z., Yuanhui, Z., Bin, P. (1997). Comparison of three diagnostic criteria for the diagnosis of schizophrenia and mood disorders. *Chinese Journal of Psychiatry*, *30*(1), 45–9.
- Schnuerch, R., Gibbons, H. (2015). Social proof in the human brain: electrophysiological signatures of agreement and disagreement with the majority. *Psychophysiology*, *52*(10), 1328–42.
- Schnuerch, R., Richter, J., Koppehele-Gossel, J., Gibbons, H. (2016). Multiple neural signatures of social proof and deviance during the observation of other people's preferences. *Psychophysiology*, *53*(6), 823–36.
- Schnuerch, R., Trautmann-Lengsfeld, S.A., Bertram, M., Gibbons, H. (2014). Neural sensitivity to social deviance predicts attentive processing of peer-group judgment. *Society for Neuroscience*, *9*(6), 650–60.
- Sharot, T., De Martino, B., Dolan, R.J. (2009). How choice reveals and shapes expected hedonic outcome. *Journal of Neuroscience*, *29*(12), 3760–5.
- Sharot, T., Fleming, S.M., Yu, X., Koster, R., Dolan, R.J. (2012). Is choice-induced preference change long lasting? *Psychological Science*, *23*(10), 1123–9.
- Shestakova, A., Rieskamp, J., Tugin, S., Ossadtchi, A., Krutitskaya, J., Klucharev, V. (2013). Electrophysiological precursors of social conformity. *Social Cognitive and Affective Neuroscience*, *8*(7), 756–63.
- Stewart, S.H., Morris, E., Mellings, T., Komar, J. (2006). Relations of social anxiety variables to drinking motives, drinking quantity and frequency, and alcohol-related problems in undergraduates. *Journal of Mental Health*, *15*(6), 671–82.
- Voncken, M.J., Alden, L.E., Bögels, S.M., Roelofs, J. (2008). Social rejection in social anxiety disorder: the role of performance deficits, evoked negative emotions and dissimilarity. *British Journal of Clinical Psychology*, *47*(4), 439–50.
- Weeks, J.W., Heimberg, R.G., Fresco, D.M., et al. (2005). Empirical validation and psychometric evaluation of the Brief Fear of Negative Evaluation Scale in patients with social anxiety disorder. *Psychological Assessment*, *17*(2), 179–90.
- Zadro, L., Boland, C., Richardson, R. (2006). How long does it last? The persistence of the effects of ostracism in the socially anxious. *Journal of Experimental Social Psychology*, *42*(5), 692–7.
- Zaki, J., Schirmer, J., Mitchell, J.P. (2011). Social Influence Modulates the Neural Computation of Value. *Psychological Science*, *22*(7), 894–900.