



To fill the gap of empirical knowledge on neural mechanisms underlying cognitive dissonance, we used a modified free-choice paradigm and scanned healthy young Chinese adults as they rated a set of CDs both before and after making a series of choices between these CDs. During the choice, the CDs were paired in such a way that the two CDs in each pair were equally attractive, as previous work shows that dissonance arises only when choices are difficult (Brehm, 1956; Sharot et al., 2009; Jarcho et al., in press). Moreover, in order to increase choice justification during the post-choice sessions, subjects were reminded which choice they had made earlier. We had two primary aims.

First, we aimed to investigate the brain regions recruited when subjects justified their choices. Previous research has found that choice justification is eliminated when one's sense of the self is affirmed after making a difficult choice (Hoshino-Browne et al., 2005; Steele, 1988). This supports the proposal that individuals justify their choice in order to eliminate a threat to the self. On the basis of this literature, we predicted that self-related brain areas such as the ventral MPFC (Kelley et al., 2002) and the dorsal/ventral lateral prefrontal cortex (Liberman, 2010) would be engaged in post-decisional choice justification. Furthermore, because the public sense of the self involves taking the perspectives of others (Imada and Kitayama, 2010; Kitayama et al., 2004), we anticipated that brain areas implicated in mind reading such as temporal-parietal junction (TPJ, e.g., Saxe and Kanwisher, 2003) and dorsal MPFC (e.g., Gallagher et al., 2000) might also be related to choice justification. In addition, since individuals justify their choices by inhibiting choice-inconsistent information while augmenting choice-consistent information (Jarcho et al., in press), we predicted that the brain areas implicated in regulation, such as the dorsal MPFC (Venkatraman et al., 2010), the dorsal LPFC (Ochsner and Gross, 2008), and the inferior frontal gyrus (Jarcho et al., in press), would also be involved.

Second, we aimed to examine whether, similar to the Sharot et al. (2009) study, choice justification might be tracked by neural activity that is related to subjectively experienced preferences. We expected that neural activities reflecting subjects' preferences, such as caudate (Sharot et al., 2009), ventral MPFC (McClure et al., 2004), and/or PCC (Kawabata and Zeki, 2008), would be altered by choice justification. In addition, given cultural differences in cognitive dissonance (Hoshino-Browne et al., 2005; Imada and Kitayama, 2010) and considerable variation within cultures in the extent to which they endorse their cultural norms, we assessed the relationship between change in the neural signatures related to subjects' preference and individual differences in independent self-construals (i.e., the view the self as an autonomous entity separate from others) and interdependent self-construals (i.e., the view of the self as interconnected with others as well as the social contexts; Markus and Kitayama, 1991).

## Materials and methods

### Subjects

Sixteen undergraduate and graduate students from Peking University, China (5 males, 11 females; 19–26 years of age, mean  $22.3 \pm 1.91$ , values are given as mean  $\pm$  SD throughout), participated in this study as paid volunteers. All subjects were right-handed, had normal or corrected-to-normal vision, and had no neurological or psychiatric history. Informed consent was obtained prior to scanning. This study was approved by a local ethics committee.

### Stimuli

Stimuli consisted of 60 popular music CDs, including 48 Chinese CDs and 12 European/American CDs. The artists of the CDs were known to college students. The cover of each CD was scanned and saved as a .jpg file.

### Pre-scanning procedure 148

Subjects were asked to rank 60 CDs according to their degree of liking by categorizing the CDs into 10 boxes with 6 CDs in each box. The ten boxes were marked with numbers from 1 to 10 (1 = slightly like the CD, 10 = extremely like the CD). 150 151 152

### fMRI Scanning sessions and "free-choice" session 153

After the pre-scanning CD categorization task, subjects were scanned to get anatomical structures. This was followed by eight functional scanning sessions and intervened by a "free-choice" session. 154 155 156 157

### Pre-choice session 158

The pre-choice session consisted of four event-related functional scanning sessions. On each trial, subjects were presented with a picture of a CD cover. They were then asked to either indicate "How much do you like the CD?" (preference judgment task) or "How new is the CD?" (recency judgment task) on a 4-point scale (1 = slightly like/slightly new; 2 = somewhat like/somewhat new; 3 = like/new; 4 = extremely like/extremely new). Subjects responded to each stimulus by pressing one of the four buttons as accurately and quickly as possible using the index and middle fingers of their left and right hands. Thirty preference judgments and 15 recency judgments were conducted in a random order in each scanning session. 159 160 161 162 163 164 165 166 167 168 169

Each trial started with the presentation of an instruction for 1000 ms, which defined the task (i.e., preference or recency judgments). Then the cover of a CD was presented for 3000 ms followed by an inter-stimulus interval that varied randomly among 1500, 2000, 2500 ms. Sixty CDs were used for the preference judgment task and, of those, 30 CDs were randomly selected for the recency judgment task. In order to collect enough data, these tasks consisted of two functional scanning sessions and were repeated once in an additional two scanning sessions. 170 171 172 173 174 175 176 177 178

### Free choice 179

After the pre-choice session, subjects engaged in 30 free-choice trials. On each trial, two CD covers were presented on either side of the screen (i.e., right or left). Each CD was shown only once. Subjects were instructed to indicate which CD they wanted more by pressing one of the two buttons using the left or the right index finger. Prior to this, subjects were informed that one CD would be randomly selected from the CDs they chose and given to them as a token of appreciation for their participation at the end of the study. CDs pairs were determined by each subject's ranking of the CDs during the pre-scanning categorization task. That is, each pair was randomly selected from one of the 10 boxes so that each pair was equal in liking. Choices made during the free-choice session were used to classify the 60 CDs into the chosen and rejected items in the post-choice sessions. 180 181 182 183 184 185 186 187 188 189 190 191 192

### Post-choice session 193

The post-choice session also consisted of four functional scanning sessions. All aspects of the post-choice session were identical to those in the pre-choice session except that each CD was shown with a color frame (i.e., red = chosen; green = rejected; gray = used in the recency judgment task) to indicate the status of the CD. 194 195 196 197 198

### Post-scanning procedure 199

After the scanning procedure, each subject was asked to rate his/her independent/interdependent self-construal (Singelis, 1994) on a 7-point Likert-type scale (1 = strongly disagree to 7 = strongly agree). 200 201 202

## 203 fMRI Data acquisition

204 Scanning was performed at Peking University First Hospital on a  
205 GE 3-T scanner with a standard head coil. Thirty-two transverse slices  
206 of functional images covering the whole brain were acquired using a  
207 gradient-echo echo-planar pulse sequence ( $64 \times 64 \times 32$  matrix with a  
208 spatial resolution of  $3.75 \times 3.75 \times 4$  mm, repetition time = 2000 ms,  
209 echo time = 30 ms, FOV =  $24 \times 24$  cm, flip angle =  $90^\circ$ ). Anatomical  
210 images were obtained using a 3D FSPGR T1 sequence ( $256 \times 256 \times 128$   
211 matrix with a spatial resolution of  $0.938 \times 0.938 \times 1.4$  mm,  
212 TR = 7.4 ms, TI = 450 ms, TE = 3.0 ms, flip angle =  $20^\circ$ ). Subjects'  
213 heads were immobilized during the scanning sessions using pieces  
214 of foam. Stimuli were presented via a mirror mounted on the head  
215 coil.

## 216 Data analysis

217 The mean rating scores of the preference judgments were calculated  
218 during the pre-choice and post-choice sessions were calculated for  
219 chosen and rejected CDs. The results were then submitted to a 2 (Choice:  
220 chosen/rejected)  $\times$  2 (Session: pre-choice/post-choice) repeated mea-  
221 sures analysis of variances (ANOVA).

222 SPM2 (Wellcome Department of Cognitive Neurology, London,  
223 UK) was used for the imaging data analysis. The time-series for the  
224 voxels within each slice were realigned temporally to the acquisition  
225 of the middle slice. The functional images were realigned to the first  
226 scan to correct for the head movement between scans, and the  
227 anatomical image was co-registered with the mean functional image  
228 produced during the process of realignment. All images were  
229 normalized to a  $2 \times 2 \times 2$  mm Montreal Neurological Institute (MNI)  
230 template using bilinear interpolation. Functional images were  
231 spatially smoothed using a Gaussian filter with a full-width at half  
232 maximum (FWHM) parameter set to 8 mm.

233 We first conducted whole-brain exploratory analysis. The image  
234 data were modeled using a canonical hemodynamic response  
235 function (HRF) and a general linear model (GLM). The time  
236 derivatives and the head motion parameters were included to account  
237 for extra variance of onset and residual movements (the three rigid-  
238 body translations and rotations determined from the realignment  
239 stage). All data were globally normalized with proportional scaling of  
240 the image means. High-pass filtering was used with a cutoff of 128 s.  
241 Effects at each voxel were estimated, and regionally specific effects  
242 were compared using linear contrasts.

243 There were six types of trials in our experiment. There were four  
244 types of preference judgment trials, each classified according to the  
245 subjects' choices during the "free-choice" session: (1) preference  
246 judgments for chosen CDs during pre-choice session, (2) preference  
247 judgments for rejected CDs during pre-choice session, (3) preference  
248 judgments for chosen CDs during post-choice session, and (4)  
249 preference judgments for rejected CDs during post-choice session.  
250 There were also two types of recency judgment trials: (1) recency  
251 judgment during pre-choice session and (2) recency judgment during  
252 post-choice session. We contrasted and reversely contrasted blood  
253 oxygenation level-dependent (BOLD) signal of the preference judgment  
254 trials for the chosen CDs with those for the rejected CDs, and BOLD signal  
255 of preference judgment trials of chosen/rejected CDs with recency  
256 judgment trials, during both pre-choice and post-choice sessions. Areas  
257 of significant activation were identified using threshold of  $p < 0.001$   
258 (uncorrected) and a spatial extent threshold of  $k = 100$ .

259 Conjunction analysis implemented in SPM2 (ANOVA with inclusive  
260 masking) was used to determine areas of activation common to  
261 preference judgment of chosen CDs during pre-choice and post-choice  
262 sessions, areas of activation common to preference judgment of rejected  
263 CDs during pre-choice and post-choice sessions, areas of activation  
264 common to preference judgment of chosen and rejected CDs in pre-  
265 choice session, and areas of activation common to preference judgment

of chosen and rejected CDs in the post-choice session. All inclusive 266  
masking analyses used an uncorrected  $p$  value of 0.05 for their masks. 267

268 To examine brain areas linked with attitude change during choice  
269 justification, we first conducted parametric modulation analysis using  
270 an independent GLM model for post-choice session that used change  
271 in the preference rating score for each trial as the regressor. Then we  
272 constructed a simple regression analysis. Parametric maps contrasting  
273 preference judgment of chosen CDs vs. that of rejected CDs during  
274 post-choice session were taken as the dependent variables for each  
275 subject, and the corresponding attitude change scores (the absolute  
276 amount of preference increase for chosen items plus the absolute  
277 amount of preference decrease for rejected items) served as  
278 covariates. The resulting maps were identified using a threshold of  
279  $p < 0.001$  (uncorrected) and a spatial extent threshold of  $k = 100$ .

280 To assess the relationship between change of neural activities  
281 (post-choice session minus pre-choice session) in the brain areas that  
282 are likely to reflect subjects' preferences (i.e., ventral mPFC, PCC, and  
283 caudate) and individual differences in attitude change and self-  
284 construal, we also conducted another parametric modulation analysis  
285 for pre-choice and post-choice session respectively using participants'  
286 rating score on each preference judgment trial as the regressor.  
287 Conjunction analysis (ANOVA with inclusive masking) was used to  
288 identify the areas of activation generally related to subject's  
289 preference. A relatively stringent threshold, cluster level  $p < 0.05$   
290 (corrected), was used because this analysis included 120 trials. We  
291 then calculated correlations between change of activities in the brain  
292 areas reflecting subjects' preferences and their attitude change. A  
293 similar analysis was conducted on the brain areas that were shown to  
294 be linked to subjects' preference in previous studies, the vMPFC  
295 ( $x = 8$ )

308  $p < 0.001$ ), suggesting that the preference for chosen over rejected CDs  
 309 was larger during the post-choice than pre-choice sessions. Post hoc  
 310 analysis confirmed that the rating scores for chosen CDs were higher  
 311 in the post-choice than pre-choice sessions ( $t(15) = 2.93, p < 0.05$ ),  
 312 whereas rating scores for rejected CDs did not differ significantly  
 313 between the post-choice than pre-choice sessions ( $t(15) = 2.03,$   
 314  $p = 0.06$ ).

### 315 fMRI Results

316 To identify neural activities associated with post-choice attitude  
 317 change, we calculated the change in preference rating by subtracting  
 318 the rating score of each CD in the pre-choice sessions from the rating  
 319 score of the same CD in the post-choice sessions. We then conducted  
 320 parametric modulation analysis during post-choice session using the  
 321 change in preference rating as a regressor. We found that attitude  
 322 change was associated with activations in the ventral MPFC ( $x = -12/$   
 323  $y = 54/z = 0, Z = 3.53$ ; cluster size = 165 voxel), right temporal-  
 324 parietal junction (TPJ) ( $x = 48/y = -60/z = 12, Z = 3.02$ ; cluster  
 325 size = 205 voxel), anterior insula ( $x = 42/y = -2/z = 6, Z = 3.05$ ;  
 326 cluster size = 66 voxel), and bilateral cerebellum ( $x = 28/y = -64/$   
 327  $z = -30, Z = 3.42$ ; cluster size = 131 voxel;  $x = -38/y = -66/z =$   
 328  $-30, Z = 3.12$ ; cluster size = 121 voxel) (Fig. 2a).

329 We also conducted a regression analysis using the individual  
 330 attitude change score (increase of preference for the chosen items  
 331 minus decrease of preference for the rejected items) as the regressor.  
 332 We found that activities in left LPFC ( $x = -24/y = 56/z = 8, Z = 3.73$ ;  
 333 cluster size = 133 voxel), dorsal MPFC ( $x = -4/y = 14/z = 54,$   
 334  $Z = 3.23$ ; cluster size = 111 voxel), and right precentral cortex

( $x = 54/y = -8/z = 44, Z = 3.09$ ; cluster size = 212 voxel) positively  
 335 correlated with subjects' attitude change scores (Fig. 2b).

336 Similar to the previous research (Sharot et al., 2009), we assessed  
 337 whether neural activities can predict individual differences in  
 338 preference. To do this, we identified preference related neural activity  
 339 by conducting parametric modulation analysis for pre-choice and  
 340 post-choice sessions, respectively, using participants' rating score of  
 341 each preference judgment trial as the covariate. We found significant  
 342 positive correlations between BOLD signal and subjects' preference in  
 343 the PCC ( $x = -2/y = -56/z = 22, Z = 3.95$ ; cluster size = 1240 voxel)  
 344 and right cerebellum ( $x = -46/y = -26/z = 48, Z = 5.50$ ; cluster  
 345 size = 1137 voxel) in pre-choice sessions. The same analysis  
 346 performed on the post-choice sessions showed significant positive  
 347 correlations between BOLD signal and subjects' preference in the  
 348 precuneus/PCC ( $x = 24/y = -54/z = -34, Z = 4.97$ ; cluster size =  
 349 2568 voxel) and ventral MPFC ( $x = 2/y = 64/z = -2, Z = 4.07$ ; cluster  
 350 size = 919 voxel). The conjunction analysis of the data in pre-choice  
 351 and post-choice sessions identified the PCC ( $x = 4/y = -62/z = 12,$   
 352  $Z = 4.48$ ; cluster size = 1039 voxel) as the common brain areas related  
 353 to subject's preference.  
 354

355 We also examined whether changes in PCC activity between post-  
 356 choice and pre-choice sessions could predict subjects' attitude change.  
 357 We also carried out comparable analyses to see if changes in neural  
 358 activities might be related to self-construals. These analyses, however,  
 359 failed to show any significant correlations between changes in brain  
 360 activities and attitude change. We then conducted similar correlation  
 361 analysis on two additional ROIs that have been associated with  
 362 behavioral preference (ventral MPFC,  $x = 8/y = 56/z = 0,$  McClure  
 363 et al., 2004) and hedonic rating scores (caudate,  $x = 10/y = 22/z = 0,$   
 364 Sharot et al., 2009) in previous studies. Interestingly, we found that  
 365 changes in the ventral MPFC activity between post-choice and pre-  
 366 choice sessions were negatively correlated with interdependent self-  
 367 construal ( $r = -0.569, p = 0.027$  for 15 subjects without an outlier  
 368 subject;  $r = -0.480, p = 0.060$  for all 16 subjects, Fig. 3).

369 To assess which brain regions were involved in subjects'  
 370 preference for the chosen and rejected CDs, we contrasted the neural  
 371 activity linked to preference judgment for chosen CDs versus rejected  
 372 CDs. These revealed activations in the PCC/precuneus and middle  
 373 cingulate cortex (Table 1: Pre-choice). The reverse contrast showed  
 374 activations in the right postcentral/paracentral cortex, left paracentral  
 375 cortex/precuneus, left superior temporal cortex, and right insula.  
 376 Similar results were found for the same contrasts during post-choice  
 377 session (Table 1: Post-choice). The conjunction analysis for the pre-  
 378 choice and post-choice sessions identified that the PCC/precuneus

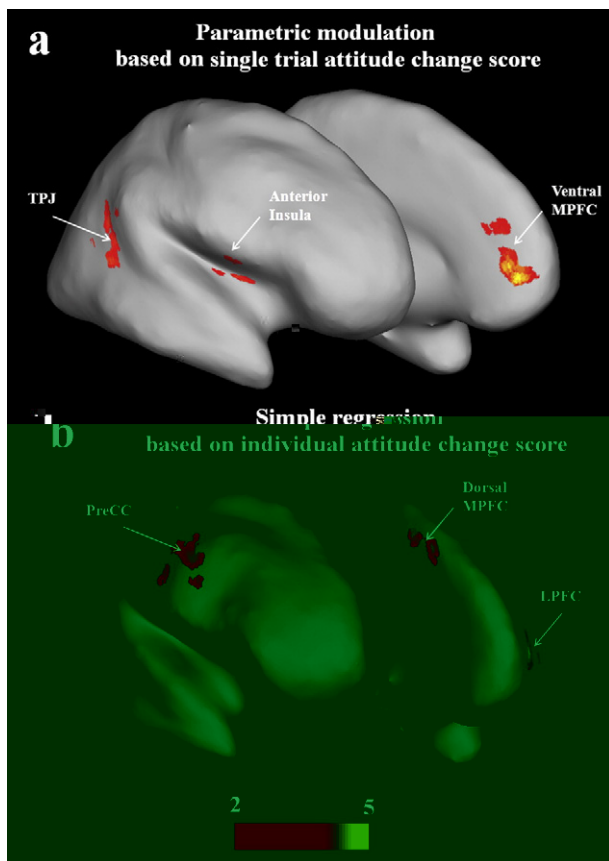


Fig. 2. (a) Parametric analysis revealed neural activities related to subjects' attitude change. (b) Simple regression analysis revealed neural activities positively correlated with individual attitude change score. Ventral MPFC = ventral medial prefrontal cortex; TPJ = temporal-parietal junction; dorsal LPFC = dorsal lateral prefrontal cortex; dorsal MPFC = dorsal medial prefrontal cortex; PreCC = precentral cortex.

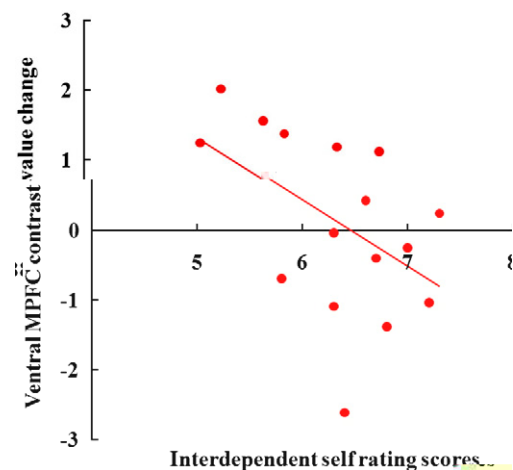


Fig. 3. Correlation between ventral MPFC activation level (contrast values) change and interdependent self rating scores.

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379 activity was linked to preference judgment for the chosen CDs,  
380 whereas the right insula and postcentral cortex were associated with  
381 preference judgment for the rejected CDs (Fig. 4a; Table 1: Conjunction).  
382 The neural activity linked to preference judgments was assessed

by contrasting preference and recency judgment tasks. These revealed 383  
activations in the precuneus as well as the right PCC in the pre-choice 384  
session and in the ventral MPFC in the post-choice session (Fig. 4b; 385  
Table 1: Conjunction). 386

### Discussion 387

Neural mechanisms of choice justification 388

Our behavioral measurements showed, consistent with the 389  
10ism 390

Parametric modulation analysis showed that PCC activity was positively correlated with subjects' preference. Consistent with this, the previous studies have shown that activation in the PCC is positively correlated with the perceived desirability of objects (Kawabata and Zeki, 2008) or the subjective value of delayed monetary rewards (Kable and Glimcher, 2007). Because the PCC is also implicated in self-referential processing and autobiographic memory (Rameson et al., 2010; Sab5.7k110(r)26z

hypothesis that choice justification may require regulation processes that are mediated by the dorsal MPFC and left LPFC (Venkatraman et al., 2010; Ochsner and Gross, 2008). However, the activations in the dorsal MPFC, left LPFC, and right precentral cortex did not overlap with regions that correlated with the trial-by-trial attitude change score. It is possible that there is a relatively stable individual difference in the degree to which the self-regulatory processes are engaged across all trials throughout the entire experimental session. The overall degree of choice justification may be expected to be greater for those who engage self-regulatory processes to justify their choices than those who do not. At the same time, however, across the 30 choices, people may engage their self-appraisals (vMPFC) mediated by perspective taking (TPJ) to varying extent. They may do so more on some trials than on some other trials. This may be expected to result in a trial-by-trial variation in choice justification. The two processes (i.e., self-regulation that varies across individuals and self-referential processing that varies within each individual) are distinct and, yet, we suspect within the specific experimental setting of the present study that they result in the same behavioral outcome of choice justification.

During the post-choice rating session of the present study, subjects were given an explicit marker of whether they had chosen or rejected each CD. This procedure might have resulted in top-down modulation of preference related brain response (de Araujo et al., 2005; Plassmann et al., 2008; Kirk et al., 2009). However, the brain areas that were associated with attitude changes in the present study included left LPFC (-24, 56, 8), dorsal MPFC (-4, 14, 54), and right precentral cortex (54, -8, 44). These brain regions are different from those involved in the top-down modulation of preference responses. For example, Kirk et al. (2009) found that neural activity in the right medial orbitofrontal cortex (12, 48, -20) and the ventral medial prefrontal cortex (-10, 60, 2) correlated with aesthetic ratings. Accordingly, it is unlikely that the present results were influenced by the top-down modulation of preference responses (Table 2).

One previous study (Sharot et al., 2009) found a similar effect, but the brain area that was implicated was very different. In this study, activity in the caudate nucleus predicted subsequent choices. Whereas our study tested incentive compatible choices of pop music CDs, Sharot et al. tested choices among various hypothetical vacation sites. Moreover, whereas our study tested Chinese subjects, Sharot et al. tested British subjects. These factors might prove to be important in explaining the different pattern of results.

## Conclusion

While the phenomenon of cognitive dissonance was discovered five decades ago and different theories have been proposed to interpret this phenomenon (see Harmon-Jones and Harmon-Jones, 2007 for a review), the underlying neural mechanisms remain undefined. Our fMRI study suggests that self-reflection (the ventral MPFC) that is mediated by perspective taking (TPJ) is crucially involved in choice justification. This finding goes along with the existing behavioral data that suggest the significance of a threat to the public self in mediating choice justification in Asian, interdependent cultural contexts. As the current work tested only Chinese subjects and found a correlation between the variation of the ventral MPFC activity and subjective ratings of interdependent self-construals, future work should expand the current work to Western, more independent cultural contexts.

## Uncited references

- Heine and Lehman, 1997  
 Kitayama and Imada, 2010  
 Lebreton et al., 2009  
 Zeki and Romaya, 2008

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## References

- Brehm, J.W., 1956. Postdecision changes in the desirability of alternatives. *J. Abnorm. Soc. Psychol.* 52, 384–389.  
 Carrington, S.J., Bailey, A.J., 2009. Are there theory of mind regions in the brain? A review of the neuroimaging literature. *Hum. Brain Mapp.* 30, 2313–2335.  
 de Araujo, I.E., Rolls, E.T., Velasco, M.I., Margot, C., Cayeux, I., 2005. Cognitive modulation of olfactory processing. *Neuron* 46, 671–679.  
 Decety, J., Lamm, C., 2007. The role of the right temporoparietal junction in social interaction: how low-level computational processes contribute to meta-cognition. *Neuroscientist* 13, 580–593.  
 Festinger, L., 1957. *A Theory of Cognitive Dissonance*. Stanford University Press, Stanford, California.  
 Frith, U., Frith, C.D., 2006. The neural basis of mentalizing. *Neuron* 50, 531–534.

- Gallagher, H.L., Happé, F., Brunswick, N., Fletcher, P.C., Frith, U., Frith, C.D., 2000. Reading the mind in cartoons and stories: an fMRI study of 'theory of mind' in verbal and nonverbal tasks. *Neuropsychologia* 38, 11–21.  
 Han, S., Mao, L., Gu, X., Zhu, Y., Ge, J., Ma, Y., 2008. Neural consequences of religious belief on self-referential processing. *Soc. Neurosci.* 3, 1–15.  
 Harmon-Jones, E., Harmon-Jones, C., 2007. Cognitive dissonance theory after 50 years of development. *Z. Sozialpsychologie* 38, 7–16.  
 Heine, S.J., Lehman, D.R., 1997. Culture, dissonance, and self-affirmation. *Pers. Soc. Psychol. Bull.* 23, 389–400.  
 Hoshino-Browne, E., Zanna, A.S., Spencer, S.J., Zanna, M.P., Kitayama, S., Lackenbauer, S., 2005. On the cultural guises of cognitive dissonance: the case of Easterners and Westerners. *J. Pers. Soc. Psychol.* 89, 294–310.  
 Imada, T., Kitayama, S., 2010. Social eyes and choice justification: culture and dissonance revisited. *Soc. Cogn.* 28, 589–608.  
 Jarcho, J.M., Berkman, E.T., Lieberman, M.D., in press. The neural basis of rationalization: cognitive dissonance reduction during decision-making. *Soc. Cogn. Affect. Neurosci.*  
 Kable, J.W., Glimcher, P.W., 2007. The neural correlates of subjective value during intertemporal choice. *Nat. Neurosci.* 10, 1625–1633.  
 Kawabata, H., Zeki, S., 2008. The neural correlates of desire. *PLoS ONE* 3 (8), e3027. doi:10.1371/journal.pone.0003027.  
 Kelley, W.M., Macrae, C.N., Wyland, C.L., Caglar, S., Inati, S., Heatherton, T.F., 2002. Finding the self? an event-related fMRI study. *J. Cogn. Neurosci.* 14, 785–794.  
 Kirk, U., Skov, M., Hulme, O., Christensen, M.S., Zeki, S., 2009. Modulation of aesthetic value by semantic context: an fMRI study. *Neuroimage* 44, 1125–1132.  
 Kitayama, S., Imada, T., 2010. Implicit independence and interdependence: a cultural task analysis. In: Mesquita, B., Barrett, L.F., Smith, E.R. (Eds.), *The mind in context*. Guilford Press, New York, pp. 174–200.  
 Kitayama, S., Snibbe, A.C., Markus, H.R., Suzuki, T., 2004. Is there any "free" choice? Self and dissonance in two cultures. *Psychol. Sci.* 15, 527–533.  
 Lebreton, M., Jorge, S., Michel, V., Thirion, B., Pessiglione, M., 2009. An automatic valuation system in the human brain: evidence from functional neuroimaging. *Neuron* 64, 431–439.  
 Markus, H.R., Kitayama, S., 1991. Culture and the self: implication for cognition, emotion and motivation. *Psychol. Rev.* 98, 224–253.  
 McClure, S.M., Li, J., Tomlin, D., Cypert, K.S., Montague, L.M., Montague, P.R., 2004. Neural correlates of behavioral preferences for culturally familiar drinks. *Neuron* 44, 379–387.  
 Ochsner, K.N., Gross, J.J., 2008. Cognitive emotion regulation insights from social cognitive and affective neuroscience. *Curr. Dir. Psychol. Sci.* 17, 153–158.  
 Plassmann, H., O'Doherty, J., Shiv, B., Rangel, A., 2008. Marketing actions can modulate neural representations of experienced pleasantness. *Proc. Natl Acad. Sci. USA* 105, 1050–1054.  
 Rameson, L.T., Satpute, A.B., Lieberman, M.D., 2010. The neural correlates of implicit and explicit self-relevant processing. *Neuroimage* 50, 701–708.  
 Sajonz, B., Kahnt, T., Margulies, D.S., Park, S.Q., Wittmann, A., Stoy, M., Bermpohl, F., 2010. Delineating self-referential processing from episodic memory retrieval: common and dissociable networks. *Neuroimage* 50, 1606–1617.  
 Saxe, R., Kanwisher, N., 2003. People thinking about thinking people: the role of the temporo-parietal junction in "theory of mind". *Neuroimage* 19, 1835–1842.  
 Sharot, T., De Martino, B., Dolan, R.J., 2009. How choice reveals and shapes expected hedonic outcome. *J. Neurosci.* 29, 3760–3765.  
 Shultz, T.R., Léveillé, E., Lepper, M.R., 1999. Free choice and cognitive dissonance revisited: choosing "lesser evils" versus "greater goods". *Pers. Soc. Psychol. Bull.* 25, 40–48.  
 Steele, C.M., 1988. The psychology of self-affirmation: sustaining the integrity of the self. In: Berkowitz, L. (Ed.), *Advances in Experimental Social Psychology*. Academic Press, San Diego, California, pp. 261–302.  
 Tedeschi, J.T., Reiss, M., 1981. Identities, the phenomenal self, and laboratory research. In: Tedeschi, J.T. (Ed.), *Impression Management Theory and Social Psychological Research*. Academic Press, New York, pp. 3–22.  
 van Veen, V., Krug, M.K., Schooler, J.W., Carter, C.S., 2009. Neural activity predicts attitude change in cognitive dissonance. *Nat. Neurosci.* 12, 1469–1475.  
 Venkatraman, V., Rosati, A.G., Taren, A.A., Huettel, S.A., 2010. Resolving response, decision, and strategic control: evidence for a functional topography in dorsomedial prefrontal cortex. *J. Neurosci.* 29, 13158–13164.  
 Zeki, S., Romaya, J.P., 2008. Neural correlates of hate. *PLoS ONE* 3 (10), e3556. doi:10.1371/journal.pone.0003556.  
 Zhu, Y., Zhang, Li., Fan, J., Han, S., 2007. Neural basis of cultural influence on self representation. *Neuroimage* 34, 1310–1317.