1   The good person is me: Spontaneous self-referential process prioritizes moral character in

2   perceptual matching

3   Hu Chuan-Peng[1,2], Kaiping Peng[2], & Jie Sui[3]

4   [1] Nanjing Normal University, 210024 Nanjing, China

5   [2] Tsinghua University, 100084 Beijing, China

6   [3] University of Aberdeen, Aberdeen, Scotland

7   Author Note

17   Abstract

18   Moral character is central to social evaluation and moral judgment. People can infer moral

19   character from a human face in less than one second. However, whether moral

20   character-related information is prioritized, as compared to neutral characters, in

21   perceptual decision-making was debated. Here we investigated the effect of moral character

22   on perceptual decision-making through an associative learning task. Participants first

23   learned associations between different geometric shapes and moral characters and then

24   performed a simple perceptual matching task. Across five experiments (N = 192), we found

25   a robust prioritization effect of good character-related shapes, i.e., participants responded

26   faster and more accurately to shapes that were associated with good characters than

27   shapes associated with neutral or bad characters. We then examine whether the

28   prioritization of good character was due to valence alone or an interaction between valence

29   and self-referential processing. Results of three experiments (N = 108) demonstrated that

30   the prioritization effect of good character was robust when referred to the self but weak or

31   non-exist when referred to others. Additional two experiments (N = 104) further revealed

32   that the mutual facilitation between good character and the self occurred even when one of

33   them was task-irrelevant. Together, these results not only provide evidence for a robust

34   prioritization effect of good character but also the crucial role of spontaneous

35   self-referential process in the prioritization of good character.

36   *Keywords:* Perceptual matching, Self positivity bias, moral character

37   Word count: X

The good person is me: Spontaneous self-referential process prioritizes moral character in perceptual matching

Introduction

Morality is one of the basic dimensions in social evaluation (Dunbar, 2004; Ellemers, 2018; Goodwin, Piazza, & Rozin, 2014). People can form an impression of others' moral character in less than one second (Willis & Todorov, 2006). It is intriguing whether moral character-related information is prioritized in perception. This question evoked much heat a few years ago but remains unsolved. Previous studies have found that stimuli that are also important to humans, e.g., threatening stimuli (e.g., Ohman, Lundqvist, & Esteves, 2001), rewards (B. A. Anderson, Laurent, & Yantis, 2011), or self-related stimuli (Sui & Rotshtein, 2019), are prioritized when attentional resources are limited. Given the importance of morality in social life, moral information should be more salient than morally neutral information and thus be prioritized. Indeed, a few studies reported that bad characters are prioritized in visual processing (E. Anderson, Siegel, Bliss-Moreau, & Barrett, 2011; Eiserbeck & Abdel Rahman, 2020), suggesting that bad people are detected faster than neutral or good people. However, results that morally bad information is prioritized are debated. First, the opposite effect, positive bias, was also reported. For example, Shore and Heerey (2013) found that faces with positive interaction in a trust game were prioritized in the pre-attentive process. Second, the robustness of previous results is questioned (eg., Stein, Grubb, Bertrand, Suh, & Verosky, 2017). Third, the prioritization effect of morality might be confounded with other factors (Firestone & Scholl, 2015, 2016b; Jussim, Crawford, Anglin, Stevens, & Duarte, 2016). In short, while the importance of morality is widely recognized, whether moral information is prioritized in perceptual decision-making is still an open question.

Here, we conducted a series of experiments to examine the prioritization effect of moral character. We investigated how immediately acquired moral character information

modulates the processing of neutral geometric shapes in a perceptual matching task. The associative learning task is based on the well-established fact that humans can quickly learn the associations between symbols and change subsequent behaviors accordingly. This associative learning task is widely used in aversive learning and value-based learning (Atlas et al., 2022; Deltomme, Mertens, Tibboel, & Braem, 2018). Unlike previous studies relies on faces or words as materials, stimuli used in the social associative task are geometric shapes, which acquire moral meaning before the perceptual matching task. Moreover, associations between shapes and different labels of moral characters are counter-balanced between participants, thus eliminating confounding effects by stimuli. Also, because we repeatedly presented a few pairs of shapes and labels to participants during the task, our results can not be explained by semantic priming (Unkelbach, Alves, & Koch, 2020), which is the center of the debate on previous results (Firestone & Scholl, 2015, 2016a; Gantman & Bavel, 2015, 2016; Jussim et al., 2016). We found a robust effect that shapes associated with good character are prioritized in the perceptual matching task. In a series of control experiments, we further confirmed that it is the moral content that drove the prioritization effect, instead of other factors such as familiarity.

If moral character information is prioritized, the next question is how? Previous studies explain the effect based on valence. For example, the negative bias toward moral information is explained by aligning moral information with affective stimuli and threat detection was supposed to be the potential mechanism (B. A. Anderson et al., 2011). The positive bias toward moral information, on the other hand, is explained by value-based attention (Shore & Heerey, 2013). However, these explanations often ignore the fact the value is subjective *per se* (Juechems & Summerfield, 2019). Merely associating with the self can prioritize the stimuli in perception, attention, working memory, and long-term memory (Sui & Humphreys, 2015; Sui & Rotshtein, 2019). Here, we introduced self-relevance in the social associative learning task. In the experiment, we explicitly instructed participants on which moral character is self-referencing and which is not. In this way, we tested whether

the prioritization of moral character is by valence *per se* or by the self-referential of moral valence. In the subsequent experiments, we further tested the interaction between valence and self-referential processing more implicitly. The results revealed a mutual facilitation effect of good character and the self, suggesting spontaneous moral self-referential as a novel mechanism underlying the prioritization of good character in perceptual decision-making.

Disclosures

We reported all the measurements, analyses, and results in all the experiments in the current study. Participants whose overall accuracy was lower than 60% were excluded from analyses. Also, accurate responses with less than 200ms reaction times were excluded from the analysis. Because there were a few participants participated multiple experiments, we only included their data from first participation in the three-level hierarchical model (see Methods for details). All excluded data can be found in the shared raw data files.

All the experiments reported were not pre-registered. Most experiments (1a ~ 4b, except experiment 3b) reported in the current study were first finished between 2013 to 2016 at Tsinghua University, Beijing, China. Participants in these experiments were recruited from the local community. To increase the sample size of experiments to 50 or more (Simmons, Nelson, & Simonsohn, 2013), we recruited additional participants from Wenzhou University, Wenzhou, China, in 2017 for experiments 1a, 1b, 4a, and 4b. Experiment 3b was finished at Wenzhou University in 2017 (See Table 1 for an overview of these experiments).

All participants received informed consent and were compensated for their time. These experiments were approved by the ethics board in the Department of Psychology, Tsinghua University.

₁₁₄   **General methods**

₁₁₅ **Design and Procedure**

₁₁₆   This series of experiments used the social associative learning paradigm (or

₁₁₇ self-tagging paradigm, see Sui, He, and Humphreys (2012)), in which participants first

₁₁₈ learned the associations between geometric shapes and labels of different moral characters

₁₁₉ (e.g., in the first three studies, the triangle, square, and circle and Chinese words for "good

₁₂₀ person", "neutral person", and "bad person", respectively). The associations of shapes and

₁₂₁ labels were counterbalanced across participants. The paradigm consists of a brief learning

₁₂₂ stage and a test stage. During the learning stage, participants were instructed about the

₁₂₃ association between shapes and labels. Participants started the test stage with a practice

₁₂₄ phase to familiarize themselves with the task, in which they viewed one of the shapes above

₁₂₅ the fixation while one of the labels below the fixation and judged whether the shape and

₁₂₆ the label matched the association they learned. If the overall accuracy reached 60% or

₁₂₇ higher at the end of the practicing session, participants proceeded to the experimental task

₁₂₈ of the test stage. Otherwise, they finished another practices sessions until the overall

₁₂₉ accuracy was equal to or greater than 60%. The experimental task shared the same trial

₁₃₀ structure as in the practice.

₁₃₁   Experiments 1a, 1b, 1c, 2, 5, and 6a were designed to explore and confirm the effect

₁₃₂ of moral character on perceptual matching. All these experiments shared a 2 (matching:

₁₃₃ match vs. nonmatch) by 3 (moral character: good vs. neutral vs. bad person)

₁₃₄ within-subject design. Experiment 1a was the first one of the whole series of studies, which

₁₃₅ aimed to examine the prioritization of moral character and found that shapes associated

₁₃₆ with good character were prioritized. Experiments 1b, 1c, and 2 were to confirm that it is

₁₃₇ the moral character that caused the effect. More specifically, experiment 1b used different

₁₃₈ Chinese words as labels to test whether the effect was contaminated by familiarity.

₁₃₉ Experiment 1c manipulated the moral character indirectly: participants first learned to

associate different moral behaviors with different Chinese names, after remembering the association, they then associate the names with different shapes and finished the perceptual matching task. Experiment 2 further tested whether the way we presented the stimuli influence the prioritization of moral character, by sequentially presenting labels and shapes instead of simultaneous presentation. Note that a few participants in experiment 2 also participated in experiment 1a because we originally planned a cross-task comparison. Experiment 5 was designed to compare the prioritization of good character with other important social values (aesthetics and emotion). All social values had three levels, positive, neutral, and negative, and were associated with different shapes. Participants finished the associative learning task for different social values in different blocks, and the order of the social values was counterbalanced. Only the data from moral character blocks, which shared the design of experiment 1a, were reported here. Experiment 6a, which shared the same design as experiment 2, was an EEG experiment aimed at exploring the neural mechanism of the prioritization of good character. Only behavioral results of experiment 6a were reported here.

Experiments 3a, 3b, and 6b were designed to test whether the prioritization of good character can be explained by the valence effect alone or by an interaction between the valence effect and self-referential processing. To do so, we included self-reference as another within-subject variable. For example, experiment 3a extended experiment 1a into a 2 (matching: match vs. nonmatch) by 2 (reference: self vs. other) by 3 (moral character: good vs. neutral vs. bad) within-subject design. Thus, in experiment 3a, there were six conditions (good-self, neutral-self, bad-self, good-other, neutral-other, and bad-other) and six shapes (triangle, square, circle, diamond, pentagon, and trapezoids). Experiment 6b was an EEG experiment based on experiment 3a but presented the label and shape sequentially. Because of the relatively high working memory load (six label-shape pairs), participants finished experiment 6b in two days. On the first day, participants completed the perceptual matching task as a practice, and on the second day, they finished the task

again while the EEG signals were recorded. We only focus on the first day's data here. Experiment 3b was designed to test whether the effect found in experiments 3a and 6b is robust if we separately present the self-referential trials and other-referential trials. That is, participants finished two different types of blocks: in the self-referential blocks, they only made matching judgments to shape-label pairs that related to the self (i.e., shapes and labels of good-self, neutral-self, and bad-self), in the other-referential blocks, they only responded to shape-label pairs that related to the other (i.e., shapes and labels of good-other, neutral-other, and bad-other).

Experiments 4a and 4b were designed to further test the interaction between valence and self-referential process in prioritization of good character. In experiment 4a, participants were instructed to learn the association between two shapes (circle and square) with two labels (self vs. other) in the learning stage. In the test stage, they were instructed only respond to the shape and label during the test stage. To test the effect of moral character, we presented the labels of moral character in the shapes and instructed participants to ignore the words in shapes when making matching judgments. In the experiment 4b, we reversed the role of self and moral character in the task: Participants learned associations between three labels (good-person, neutral-person, and bad-person) and three shapes (circle, square, and triangle) and made matching judgments about the shape and label of moral character, while words related to identity, "self" or "other", were presented within the shapes. As in 4a, participants were told to ignore the words inside the shape during the perceptual matching task.

Stimuli and Materials

We used E-prime 2.0 for presenting stimuli and collecting behavioral responses. Data were collected from two universities located in two different cities in China. Participants recruited from Tsinghua University, Beijing, finished the experiment individually in a dim-lighted chamber. Stimuli were presented on 22-inch CRT monitors and participants

rested their chins on a brace to fix the distance between their eyes and the screen around 60 cm. The visual angle of geometric shapes was about $3.7° \times 3.7°$, the fixation cross is of $0.8° \times 0.8°$ visual angle at the center of the screen. The words were of $3.6° \times 1.6°$ visual angle. The distance between the center of shapes or images of labels and the fixation cross was of $3.5°$ visual angle. Participants from Wenzhou University, Wenzhou, finished the experiment in a group consisting of $3 \sim 12$ participants in a dim-lighted testing room. They were instructed to finish the whole experiment independently. Also, they were told to start the experiment at the same time so that the distraction between participants was minimized. The stimuli were presented on 19-inch CRT monitors with the same set of parameters in E-prime 2.0 as in Tsinghua University, however, the visual angles could not be controlled because participants' chins were not fixed.

In most of these experiments, participants were also asked to fill out questionnaires after finishing the behavioral tasks. All the questionnaire data were open (see, dataset 4 in Liu et al., 2020). See Table 1 for a summary of information about all the experiments.

Data analysis

We used the `tidyverse` of r (see script `Load_save_data.r`) to preprocess the data. The data from all experiments were then analyzed using Bayesian hierarchical models.

We used the Bayesian hierarchical model (BHM, or Bayesian generalized linear mixed models, Bayesian multilevel models) to model the reaction time and accuracy data because BHM provided three advantages over the classic NHST approach (repeated measure ANOVA or *t*-tests). First, BHM estimates the posterior distributions of parameters for statistical inference, therefore providing uncertainty in estimation (Rouder & Lu, 2005). Second, BHM, where generalized linear mixed models could be easily implemented, can use distributions that fit the distribution of real data instead of using the normal distribution for all data. Using appropriate distributions for the data will avoid misleading results and

218 provide a better fitting of the data. For example, Reaction times are not normally

219 distributed but are right skewed, and the linear assumption in ANOVAs is not satisfied

220 (Rousselet & Wilcox, 2020). Third, BHM provides a unified framework to analyze data

221 from different levels and different sources, avoiding information loss when we need to

222 combine data from different experiments.

223 We used the `r` package `BRMs` (Bürkner, 2017), which used Stan (Carpenter et al.,

224 2017) as the back-end, for the BHM analyses. We estimated the overall effect across

225 experiments that shared the same experimental design using one model, instead of a

226 two-step approach that was adopted in mini-meta-analysis (e.g., Goh, Hall, & Rosenthal,

227 2016). More specifically, a three-level model was used to estimate the overall effect of

228 prioritization of good character, which included data from five experiments: 1a, 1b, 1c, 2,

229 5, and 6a. Similarly, a three-level HBM model is used for experiments 3a, 3b, and 6b.

230 Method and data of individual experiments can be found in the supplementary materials

231 and open datasets. Because a few participants had participated multiple experiments, we

232 only included their data of first paticipation to avoid practice effect. For experiments 4a

233 and 4b, which tested the implicit interaction between the self and good character, we used

234 HBM for each experiment separately.

235 For questionnaire data, we only reported the subjective distance between different

236 persons or moral characters in the supplementary results and did not analyze other

237 questionnaire data, which are described in (Liu et al., 2020).

238 **Response data.** We followed previous studies (Hu, Lan, Macrae, & Sui, 2020; Sui

239 et al., 2012) and used the signal detection theory approach to analyze the response data.

240 More specifically, the match trials are treated as signals and non-match trials are noise.

241 The sensitivity and criterion of signal detection theory are modeled through BHM (Rouder

242 & Lu, 2005).

243 We used the Bernoulli distribution for the signal detection theory. The probability

that the jth subject responded "match" ($y_{ij} = 1$) at the ith trial p_{ij} is distributed as a

Bernoulli distribution with parameter p_{ij}:

$$y_{ij} \sim Bernoulli(p_{ij})$$

The reparameterized value of p_{ij} is a linear regression of the independent variables:

$$\Phi(p_{ij}) = 0 + \beta_{0j}Valence_{ij} + \beta_{1j}IsMatch_{ij} * Valence_{ij}$$

where the probits (z-scores; Φ, "Phi") of ps is used for the regression.

The subjective-specific intercepts ($\beta_0 = -zFAR$) and slopes ($\beta_1 = d'$) are described

by multivariate normal with means and a covariance matrix for the parameters.

$$\begin{bmatrix} \beta_{0j} \\ \beta_{1j} \end{bmatrix} \sim N(\begin{bmatrix} \theta_0 \\ \theta_1 \end{bmatrix}, \sum)$$

We used the following formula for experiments 1a, 1b, 1c, 2, 5, and 6a, which have a

2 (matching: match vs. non-match) by 3 (moral character: good vs. neutral vs. bad)

within-subject design:

```
saymatch ~ 0 + Valence + Valence:ismatch + (0 + Valence +
Valence:ismatch | Subject) + (0 + Valence + Valence:ismatch |
ExpID_new:Subject) , family = bernoulli(link="probit")
```

in which the `saymatch` is the response data whether participants pressed the key

corresponding to "match", `ismatch` is the independent variable of matching, `Valence` is

the independent variable of moral character, `Subject` is the index of participants, and

`Exp_ID_new` is the index of different experiments. Not that we distinguished data collected

from two universities.

For experiments 3a, 3b, and 6b, an additional variable, i.e., reference (self vs. other),

was included in the formula:

263   `saymatch ~ 0 + ID:Valence + ID:Valence:ismatch + (0 + ID:Valence +`

264 `ID:Valence:ismatch | Subject) + (0 + ID:Valence + ID:Valence:ismatch |`

265 `ExpID_new:Subject), family = bernoulli(link="probit")` in which the ID is the

266 independent variable "reference", which means whether the stimulus was self-referential or

267 other-referential.

268   **Reaction times.**   We used log-normal distribution

269 (https://lindeloev.github.io/shiny-rt/#34_(shifted)_log-normal) to model the RT data.

270 This means that we need to estimate the posterior of two parameters: μ, and σ. μ is the

271 mean of the `logNormal` distribution, and σ is the disperse of the distribution.

272   The reaction time of the jth subject on ith trial, y_{ij}, is log-normal distributed:

$$log(y_{ij}) \sim N(\mu_j, \sigma_j)$$

273   The parameter μ_j is a linear regression of the independent variables:

$$\mu_j = \beta_{0j} + \beta_{1j} * IsMatch_{ij} * Valence_{ij}$$

274   and the parameter σ_j does not vary with independent variables:

$$\sigma_j \sim HalfNormal()$$

275   The subjective-specific intercepts (β_{0j}) and slopes (β_{1j}) are described by multivariate

276 normal with means and a covariance matrix for the parameters.

$$\begin{bmatrix} \beta_{0j} \\ \beta_{1j} \end{bmatrix} \sim N(\begin{bmatrix} \theta_0 \\ \theta_1 \end{bmatrix}, \sum)$$

277   The formula used for experiments 1a, 1b, 1c, 2, 5, and 6a, which have a 2 (matching:

278 match vs. non-match) by 3 (moral character: good vs. neutral vs. bad) within-subject

279 design, is as follows:

280   `RT_sec ~ 1 + Valence*ismatch + (Valence*ismatch | Subject) +`

281   `(Valence*ismatch | ExpID_new:Subject), family = lognormal()` in which `RT_sec` is

282   the reaction times data with the second as a unit. The other variables in this formula have

283   the same meaning as the response data.

284   For experiments 3a, 3b, and 6b, which have a 2 by 2 by 3 within-subject design, the

285   formula is as follows: `RT_sec ~ 1 + ID*Valence + (ID*Valence | Subject) +`

286   `(ID*Valence | ExpID_new:Subject), family = lognormal()`

287   Note that for experiments 3a, 3b, and 6b, the three-level model for reaction times

288   only included the matched trials to avoid divergence when estimating the posterior of the

289   parameters.

290   **Testing hypotheses.**   To test hypotheses, we used the Sequential Effect eXistence

291   and sIgnificance Testing (SEXIT) framework suggested by Makowski, Ben-Shachar, Chen,

292   and Lüdecke (2019). In this approach, we directly use the posterior distributions of model

293   parameters or other effects that can be derived from posterior distributions. The SEXIT

294   approach reports centrality, uncertainty, existence, significance, and size of the input

295   posterior, which is intuitive for making statistical inferences. We used `bayestestR` for

296   implementing this approach (Makowski, Ben-Shachar, & Lüdecke, 2019). Following the

297   SEXIT framework, we reported the median of the posterior distribution and its 95% HDI

298   (Highest Density Interval), along the probability of direction (pd), the probability of

299   significance. The thresholds beyond which the effect is considered as significant (i.e.,

300   non-negligible).

301   ***Prioritization of moral character.***   We tested whether moral characters are

302   prioritized by examining the population-level effects (also called fixed effect) of the

303   three-level Bayesian hierarchical model of experiments 1a, 1b, 1c, 2, 5, and 6a. More

304   specifically, we calculated the differences between the posterior distributions of the

305   good/bad character and the neutral character and then tested these posterior distributions

with the SEXIT approach.

Modulation of self-referential processing.   We tested the modulation effect of self-referential processing by examining the interaction between moral character and self-referential process for the three-level Bayesian hierarchical model of experiments 3a, 3b, and 6b. More specifically, we tested two possible explanations for the prioritization of good character: the valence effect alone or an interaction between the valence effect and the self-referential process. If the former is correct, then there will be no interaction between moral character and self-referential processing, i.e., the prioritization effect exhibits a similar pattern for both self- and other-referential conditions. On the other hand, if the spontaneous self-referential processing account is true, then there will be an interaction between the two factors, i.e., the prioritization effect exhibits different patterns for self- and other-referential conditions. To test the interaction, we calculated the posterior distribution of the difference of difference: $(good - neutral)_{self}$ vs. $(good - neutral)_{other}$. We then tested the difference of difference with SEXIT framework.

Spontaneous binding between the self and good character.   For data from experiments 4a and 4b, we further examined whether the self-referential processing for moral characters is spontaneous (i.e., whether the good character is spontaneously bound with the self). For experiment 4a, if there exists a spontaneous binding between self and good character, there should be an interaction between moral character and self-referential processing. More specifically, we tested the posterior distributions of $good_{self} - neutral_{self}$ and $good_{other} - neutral_{other}$, as well as the difference between these differences with the SEXIT framework. For experiment 4b, if there exists a spontaneous binding between self and good character, then, there will be a self-other difference for some moral character conditions but not for other moral character conditions. More specifically, we tested the posteriors of $good_{self} - good_{other}$, $neutral_{self} - neutral_{other}$, and $bad_{self} - bad_{other}$ as well as the difference between them with SEXIT framework.

<div align="center">

Results

</div>

Prioritization of good character

To test whether moral characters are prioritized, we modeled data from experiments 1a, 1b, 1c, 2, 5, and 6a with three-level Bayesian hierarchical models. All these experiments shared similar designs and can be used for testing the prioritization effect of moral character. The valid and unique sample size is 192. Note that for both experiments 1a and 1b, two datasets were collected at different time points and locations, thus we treated them as independent samples. Here we only reported the population-level results of three-level Bayesian models, the detailed results of each experiment can be found in supplementary materials.

For the d prime, results from the Bayesian model revealed a robust effect of moral character. Shapes associated with good characters ("good person", "kind person" or a name associated with good behaviors) have higher sensitivity (median = 2.45, 95% HDI = [2.24 2.72]) than shapes associated with neutral characters (median = 2.15, 95% HDI = [1.92 2.45]), the difference ($median_{diff}$ = 0.31, 95% HDI [0, 0.62]) has a 97.31% probability of being positive (> 0), 94.91% of being significant (> 0.05). But we did not find a difference between shapes associated with bad characters (median = 2.21, 95% HDI = [2.00 2.48]) and neutral character, the difference ($median_{diff}$ = 0.05, 95% HDI [-0.27, 0.38]) only has a 60.56% probability of being positive (> 0), 49.34% of being significant (> 0.05).

The results from reaction times data also found a robust effect of moral character for both match trials (see figure 1 C) and nonmatch trials (**see supplementary materials**). For match trials, shapes associated with good characters were faster (median = 583 ms, 95% HDI = [506 663]) than shapes associated with neutral characters (median = 626 ms, 95% HDI = [547 710]), the effect ($median_{diff}$ = -44, 95% HDI [-67, -24]) has a 99.94% probability of being negative (< 0), 99.94% of being significant (< -0.05). We also found that RTs to shapes associated with bad characters (median = 643 ms, 95% HDI = [564

729]) were slower as compared to the neutral character, the effect ($median_{diff}$ = 17, 95%

HDI [-6, 36]) has a 93.58% probability of being positive (> 0), 93.55% of being significant

(> 0.05).

For the nonmatch trials, we found a similar pattern but a much smaller effect size.

Shapes associated with good characters (median = 657 ms, 95% HDI = [571 739]) were

faster than shapes associated with neutral characters (median = 673 ms, 95% HDI = [589

761]), the difference ($median_{diff}$ = -18, 95% HDI [-27, -8]) has a 99.91% probability of

being negative (< 0), 99.91% of being significant (< -0.05). In contrast, the shapes

associated with bad characters (median = 678 ms, 95% HDI = [592 764]) were slower than

shapes associated with neutral characters, the effect ($median_{diff}$ = 5, 95% HDI [-3, 13])

has a 92.43% probability of being positive (> 0), 92.31% of being significant (> 0.05).

Modulation effect self-referential processing

To test the modulation effect of self-referential processing, we also modeled data from

three experiments (3a, 3b, and 6b) with three-level Bayesian models. These three

experiments included 108 unique participants. We focused on the population-level effect of

the interaction between self-referential processing and moral valence. Also, we examined

the differences of differences, i.e., how the differences between good/bad characters and the

neutral character under the self-referential conditions differ from that under

other-referential conditions. The detailed results of each experiment can be found in

supplementary materials.

For the d prime, we found an interaction between the moral valence and

self-referential processing: the good-neutral differences are larger for the self-referential

condition than for the other-referential condition: The difference ($median_{diff}$ = 0.48, 95%

HDI [-0.62, 1.65]) has a 93.04% probability of being positive (> 0), 91.92% of being

significant (> 0.05). However, the bad-neutral differences ($median_{diff}$ = 0.0087, 95% HDI

[-0.96, 1.00]) only have a 51.85% probability of being positive (> 0), 41.29% of being

significant (> 0.05). Further analyses revealed that the prioritization effect of good

character (as compared to neutral) only appeared for self-referential conditions but not

other-referential conditions. The estimated d prime for good-self was greater than

neutral-self ($median_{diff} = 0.54$, 95% HDI [-0.30, 1.41]), with a 95.99% probability of being

positive (> 0), 95.36% of being significant (> 0.05). The differences between bad-self and

neutral-self, good-other and neutral-other, and bad-other and neutral-other are all centered

around zero (see Figure 2, B, D).

For the RTs of matched trials, we also found an interaction between moral valence

and self-referential processing: the good-neutral differences were larger for the self- than

the other-referential conditions ($median_{diff} = -148$, 95% HDI [-413, 73]) has a 96.05%

probability of being negative (< 0), 96.05% of being significant (< -0.05). However, this

pattern was much weaker for bad-neutral differences ($median_{diff} = -47$, 95% HDI [-280,

182]) has a 79.91% probability of being negative (< 0) and 79.88% of being significant ($<

-0.05$). Bayes analyses revealed a robust good-self prioritization effect as compared to

neutral-self ($median_{diff} = -59$, 95% HDI [-115, -22]) has a 98.87% probability of being

negative (< 0) and 98.87% of being significant (< -0.05)) and good-other ($median_{diff} =

-109$, 95% HDI [-227, -31]) has a 98.65% probability of being negative (< 0) and 98.65% of

being significant (< -0.05)) conditions. Similar to the results of d', we found that

participants responded slower for both good character than for the neutral character when

they referred to others, $median_{diff} = 85.01$, 95% HDI [-112, 328]) has a 92.16%

probability of being positive (> 0) and 92.15% of being significant (> 0.05). A similar

pattern was also found for the bad character when referred to others: bad-other responded

slower than neutral-other, $median_{diff} = 44$, 95% HDI [-146, 268]) has an 80.03%

probability of being positive (> 0) and 79.99% of being significant (> 0.05). See Figure 2.

These results suggested that the prioritization of good character is not solely driven

by the valence of moral character. Instead, the self-referential processing modulated the

410 prioritization of good character: good character was prioritized only when it was

411 self-referential. When the moral character was other-referential, responses to both good

412 and bad characters were slowed down.

413 Spontaneous binding between the good character and the self

414   Experiments 4a and 4b were designed to test whether the good character and

415 self-referential processing bind together spontaneously. Because these two experiments

416 have different experimental designs, we model their data separately.

417   In experiment 4a, where "self" vs. "other" were task-relevant and moral character

418 were task-irrelevant, we found the "self" conditions performed better than the "other"

419 conditions for both d prime and reaction times. This pattern is consistent with previous

420 studies (e.g., Sui et al. (2012)).

421   More importantly, we found evidence, albeit weak, that task-irrelevant moral

422 character also played a role. For shapes associated with "self", d' was greater when shapes

423 had a good character inside (median = 2.82, 95% HDI [2.64 3.03]) than shapes that have

424 neutral character (median = 2.74, 95% HDI [2.58 2.94]), the difference (median = 0.08,

425 95% HDI [-0.10, 0.27]) has an 81.60% probability of being positive (> 0), 64.33% of being

426 significant (> 0.05). For shapes associated with "other", the pattern reversed: d prime was

427 smaller when shapes had a good character inside (median = 1.87, 95% HDI [1.70 2.04])

428 than had neutral (median = 1.96, 95% HDI [1.79 2.14]), the difference (median = -0.09,

429 95% HDI [-0.25, 0.05]) has an 89.03% probability of being negative (< 0), 71.38% of being

430 significant (< -0.05). The difference between these two effects (median = 0.18, 95% HDI

431 [-0.06, 0.43]) has a 92.88% probability of being positive (> 0), 85.08% being significant ($>$

432 0.05). See Figure 3.

433   A similar pattern was found for RTs in matched trials. For the "self" condition, when

434 a good character was presented inside the shapes, the RTs (median = 633, 95% HDI [614

654]) were faster than when a neutral character (median = 647, 95% HDI [628 666]) was inside, the effect (median = -8, 95% HDI [-17, 2]) has a 94.55% probability of being negative (< 0) and 94.50% of being significant (< -0.05). In contrast, RTs for shapes associated with good character inside (median = 733, 95% HDI [707 756]) were slower than those with neutral character (median = 713, 95% HDI [691 734]) inside, the effect (median = 12, 95% HDI [-4, 28]) has a 93.00% probability of being positive (> 0) and 92.83% of being significant (> 0.05). The difference between the effects (median = -19, 95% HDI [-43, 4]) has a 94.90% probability of being negative (< 0) and 94.88% of being significant (< -0.05).

In experiment 4b, where moral characters were task-relevant and "self" vs "other" were task-irrelevant, we found a main effect of moral character: performance for shapes associated with good characters was better than other-related conditions on both d' and reaction times. This pattern, again, shows a robust prioritization effect of good character.

Most importantly, we found evidence that task-irrelevant labels, "self" or "other", also played a role. For shapes associated with good character, the d prime was greater when shapes had a "self" inside than with "other" inside ($mean_{diff}$ = 0.14, 95% HDI [-0.05, 0.34]) has a 92.35% probability of being positive (> 0) and 81.80% of being significant (> 0.05). However, the difference did not occur when the target shape where associated with "neutral" ($mean_{diff}$ = 0.04, 95% HDI [-0.13, 0.22]) and has a 67.20% probability of being positive (> 0) and 44.80% of being significant (> 0.05). Neither for the "bad" person condition: $mean_{diff}$ = 0.10, 95% HDI [-0.16, 0.37]) has a 77.03% probability of being positive (> 0) and 64.62% of being significant (> 0.05).

The same trend appeared for the RT data. For shapes associated with good character, having a "self" inside shapes reduced the reaction times as compared to having an "other" inside the shapes ($mean_{diff}$ = -55, 95% HDI [-75, -35]) has a 100% probability of being negative (< 0) and 100.00% of being significant (< -0.05). However, when the

shapes were associated with the neutral character, having a "self" inside shapes increased the RTs: $mean_{diff} = 11$, 95% HDI [1, 21]) has a 98.20% probability of being positive (> 0) and 98.15% of being significant (> 0.05). While having "self" slightly increased the RT than having "other" inside the shapes for the bad character: $mean_{diff} = 5$, 95% HDI [-17, 27]) has a 69.45% probability of being positive (> 0) and 69.27% of being significant (> 0.05), See Figure 3.

Discussion

Across nine experiments, we explored the prioritization effect of moral character and the underlying mechanism by a combination of social associative learning and perceptual matching task. First, we found a robust effect that good character was prioritized in the shape-label matching task across five experiments. Second, across three experiments, we found that the prioritization of good character was not solely driven by moral valence itself, i.e., "good" vs "bad". Instead, this effect was modulated by self-referential processing: prioritization only occurred when moral characters are self-referential. Finally, the prioritization of the combination of good character and self occurred, albeit weak, even when either the self- or character-related information was irrelevant to the experimental task (experiment 4a and 4b). In contrast, performance to the combination of good character and "other", explicitly or implicitly, was worse than the combination of neutral character and "other". Together, these results highlighted the importance of the self in perceiving information related to moral characters, suggesting a spontaneous self-referential process when making perceptual decision-making for moral characters. These results are in line with a growing literature on the social and relational nature of perception (Xiao, Coppin, and Bavel (2016); Freeman, Stolier, and Brooks (2020); hafri_perception_2021) and deepened our understanding of mechanisms of perceptual decision-making of moral information.

The current study provided robust evidence for the prioritization of good character in

perceptual decision-making. The existence of the effect of moral valence on perception has been disputed. For instance, (E. Anderson et al., 2011) reported that faces associated with bad social behavior capture attention more rapidly, however, an independent team failed to replicate the effect (Stein et al., 2017). Another study by Gantman and Van Bavel (2014) found that moral words are more likely to be judged as words when it was presented subliminally, however, this effect may be caused by semantic priming instead of morality (Firestone & Scholl, 2015; Jussim et al., 2016). In the current study, we found the prioritization effect across five experiments, the sample size of individual experiments and combined provide strong evidence for the existence of the effect. Moreover, the associative learning task allowed us to eliminate the semantic priming effect for two reasons. First, associations between shapes and moral characters were acquired right before the perceptual matching task, semantic priming from pre-existed knowledge was impossible. Second, there were only a few pairs of stimuli were used and each stimulus represented different conditions, making it impossible for priming between trials. Importantly, a series of control experiments (1b, 1c, and 2) further excluded other confounding factors such as familiarity, presenting sequence, or words-based associations, suggesting that it was the moral content that drove the prioritization of good character.

The robust prioritization of good character found in the current study was incongruent with previous moral perception studies, which usually reported a negativity effect, i.e., information related to bad character is processed preferentially (E. Anderson et al., 2011; Eiserbeck & Abdel Rahman, 2020). This discrepancy may be caused by the experimental task: while in many previous moral perception studies, the participants were asked to detect the existence of a stimulus, the current task asked participants to recognize a pattern. In other words, previous studies targeted early stages of perception while the current task focused more on decision-making at a relatively later stage of information processing. This discrepancy is consistent with the pattern found in studies with emotional stimuli (Pool, Brosch, Delplanque, & Sander, 2016).

⁵¹⁴   We expanded previous moral perception studies by focusing on the agent who made

⁵¹⁵ the perceptual decision-making and examined the interaction between moral valence and

⁵¹⁶ self-referential processing. Our results revealed that prioritization of good character is

⁵¹⁷ modulated by self-referential processing: the good character was prioritized when it was

⁵¹⁸ related to the "self", even when the self-relatedness was task-irrelevant. By contrast, good

⁵¹⁹ character information was not prioritized when it was associated with "other". The

⁵²⁰ modulation effect of self-referential processing was large when the relationship between

⁵²¹ moral character and the self was explicit, which is consistent with previous studies that only

⁵²² positive aspects of the self are prioritized (Hu et al., 2020). More importantly, the effect

⁵²³ persisted when the relationship between moral character and self-information was implicit,

⁵²⁴ suggesting spontaneous self-referential processing when both pieces of information were

⁵²⁵ presented. A possible explanation for this spontaneous self-referential of good character is

⁵²⁶ that the positive moral self-view is central to our identity (Freitas, Cikara, Grossmann, &

⁵²⁷ Schlegel, 2017; Strohminger, Knobe, & Newman, 2017) and the motivation to maintain a

⁵²⁸ moral self-view influences how we perceive (e.g., Ma & Han, 2010) and remember (e.g.,

⁵²⁹ Carlson, Maréchal, Oud, Fehr, & Crockett, 2020; Stanley, Henne, & De Brigard, 2019).

⁵³⁰   Although the results here revealed the prioritization of good character in perceptual

⁵³¹ decision-making, we did not claim that the motivation of a moral self-view *penetrates*

⁵³² perception. The perceptual decision-making process involves processes more than just

⁵³³ encoding the sensory inputs. To fully account for the nuance of behavioral data and/or

⁵³⁴ related data collected from other modules (e.g., Sui, He, Golubickis, Svensson, & Neil

⁵³⁵ Macrae, 2023), we need computational models and an integrative experimental approach

⁵³⁶ (Almaatouq et al., 2022). For example, sequential sampling models suggest that, when

⁵³⁷ making a perceptual decision, the agent continuously accumulates evidence until the

⁵³⁸ amount of evidence passed a threshold, then a decision is made (Chuan-Peng et al., 2022;

⁵³⁹ Forstmann, Ratcliff, & Wagenmakers, 2016; Ratcliff, Smith, Brown, & McKoon, 2016). In

⁵⁴⁰ these models, the evidence, or decision variable, can accumulate from both sensory

information but also memory (Shadlen & Shohamy, 2016). Recently, applications of

sequential sample models to perceptual matching tasks also suggest that different processes

may contribute to the prioritization effect of self (Golubickis et al., 2017) or good self (Hu

et al., 2020). Similarly, reinforcement learning models also revealed that the key difference

between self- and other-referential learning lies in the learning rate (Lockwood et al., 2018).

These studies suggest that computational models are needed to disentangle the cognitive

processes underlying the prioritization of good character.

References

Almaatouq, A., Griffiths, T. L., Suchow, J. W., Whiting, M. E., Evans, J., & Watts,
D. J. (2022). *Beyond Playing 20 Questions with Nature: Integrative Experiment
Design in the Social and Behavioral Sciences.* 1–55.
https://doi.org/10.1017/S0140525X22002874

Anderson, B. A., Laurent, P. A., & Yantis, S. (2011). Value-driven attentional
capture. *Proceedings of the National Academy of Sciences*, *108*(25),
10367–10371. https://doi.org/10.1073/pnas.1104047108

Anderson, E., Siegel, E. H., Bliss-Moreau, E., & Barrett, L. F. (2011). The visual
impact of gossip. *Science*, *332*(6036), 1446–1448.
https://doi.org/10.1126/science.1201574

Atlas, L. Y., Dildine, T. C., Palacios-Barrios, E. E., Yu, Q., Reynolds, R. C.,
Banker, L. A., … Pine, D. S. (2022). Instructions and experiential learning have
similar impacts on pain and pain-related brain responses but produce
dissociations in value-based reversal learning. *eLife*, *11*, e73353.
https://doi.org/10.7554/eLife.73353

Bürkner, P.-C. (2017). Brms: An r package for bayesian multilevel models using
stan [Journal Article]. *Journal of Statistical Software; Vol 1, Issue 1 (2017).*
Retrieved from https://www.jstatsoft.org/v080/i01

567   http://dx.doi.org/10.18637/jss.v080.i01

568   Carlson, R. W., Maréchal, M. A., Oud, B., Fehr, E., & Crockett, M. J. (2020).

569   Motivated misremembering of selfish decisions. *Nature Communications*, *11*(1),

570   2100. https://doi.org/10.1038/s41467-020-15602-4

571   Carpenter, B., Gelman, A., Hoffman, M. D., Lee, D., Goodrich, B., Betancourt, M.,

572   ... Riddell, A. (2017). Stan: A probabilistic programming language [Journal

573   Article]. *Journal of Statistical Software*, *76*(1).

574   https://doi.org/10.18637/jss.v076.i01

575   Chuan-Peng, H., Geng, H., Zhang, L., Fengler, A., Frank, M., & Zhang, R.-Y.

576   (2022). *A Hitchhiker's Guide to Bayesian Hierarchical Drift-Diffusion Modeling*

577   *with dockerHDDM*. PsyArXiv. https://doi.org/10.31234/osf.io/6uzga

578   Deltomme, B., Mertens, G., Tibboel, H., & Braem, S. (2018). Instructed fear

579   stimuli bias visual attention. *Acta Psychologica*, *184*, 31–38.

580   https://doi.org/10.1016/j.actpsy.2017.08.010

581   Dunbar, R. I. M. (2004). Gossip in evolutionary perspective. *Review of General*

582   *Psychology*, *8*(2), 100–110. https://doi.org/10.1037/1089-2680.8.2.100

583   Eiserbeck, A., & Abdel Rahman, R. (2020). Visual consciousness of faces in the

584   attentional blink: Knowledge-based effects of trustworthiness dominate over

585   appearance-based impressions. *Consciousness and Cognition*, *83*, 102977.

586   https://doi.org/10.1016/j.concog.2020.102977

587   Ellemers, N. (2018). Morality and social identity. In M. van Zomeren & J. F.

588   Dovidio (Eds.), *The oxford handbook of the human essence* (pp. 147–158). New

589   York, NY, US: Oxford University Press.

590   Firestone, C., & Scholl, B. J. (2015). Enhanced visual awareness for morality and

591   pajamas? Perception vs. Memory in "top-down" effects. *Cognition*, *136*,

592   409–416. https://doi.org/10.1016/j.cognition.2014.10.014

593   Firestone, C., & Scholl, B. J. (2016a). Cognition does not affect perception:

Evaluating the evidence for "top-down" effects. *Behavioral and Brain Sciences*, *39*, e229. https://doi.org/10.1017/S0140525X15000965

Firestone, C., & Scholl, B. J. (2016b). "Moral Perception" Reflects Neither Morality Nor Perception. *Trends in Cognitive Sciences*, *20*(2), 75–76. https://doi.org/10.1016/j.tics.2015.10.006

Forstmann, B. U., Ratcliff, R., & Wagenmakers, E.-J. (2016). Sequential Sampling Models in Cognitive Neuroscience: Advantages, Applications, and Extensions. *Annual Review of Psychology*, *67*(1). https://doi.org/10.1146/annurev-psych-122414-033645

Freeman, J. B., Stolier, R. M., & Brooks, J. A. (2020). Chapter five - dynamic interactive theory as a domain-general account of social perception. In B. Gawronski (Ed.), *Advances in experimental social psychology* (Vol. 61, pp. 237–287). Academic Press. https://doi.org/10.1016/bs.aesp.2019.09.005

Freitas, J. D., Cikara, M., Grossmann, I., & Schlegel, R. (2017). Origins of the belief in good true selves. *Trends in Cognitive Sciences*, *21*(9), 634–636. https://doi.org/10.1016/j.tics.2017.05.009

Gantman, A. P., & Bavel, J. J. V. (2015). Moral Perception. *Trends in Cognitive Sciences*, *19*(11), 631–633. https://doi.org/10.1016/j.tics.2015.08.004

Gantman, A. P., & Bavel, J. J. V. (2016). See for Yourself: Perception Is Attuned to Morality. *Trends in Cognitive Sciences*, *20*(2), 76–77. https://doi.org/10.1016/j.tics.2015.12.001

Gantman, A. P., & Van Bavel, J. J. (2014). The moral pop-out effect: Enhanced perceptual awareness of morally relevant stimuli. *Cognition*, *132*(1), 22–29. https://doi.org/10.1016/j.cognition.2014.02.007

Goh, J. X., Hall, J. A., & Rosenthal, R. (2016). Mini meta-analysis of your own studies: Some arguments on why and a primer on how. *Social and Personality Psychology Compass*, *10*(10), 535–549. https://doi.org/10.1111/spc3.12267

Golubickis, M., Falben, J. K., Sahraie, A., Visokomogilski, A., Cunningham, W. A., Sui, J., & Macrae, C. N. (2017). Self-prioritization and perceptual matching: The effects of temporal construal. *Memory & Cognition*, *45*(7), 1223–1239. https://doi.org/10.3758/s13421-017-0722-3

Goodwin, G. P., Piazza, J., & Rozin, P. (2014). Moral character predominates in person perception and evaluation. *Journal of Personality and Social Psychology*, *106*(1), 148–168. https://doi.org/10.1037/a0034726

Hu, C.-P., Lan, Y., Macrae, C. N., & Sui, J. (2020). Good me bad me: Does valence influence self-prioritization during perceptual decision-making? *Collabra: Psychology*, *6*(1), 20. https://doi.org/10.1525/collabra.301

Juechems, K., & Summerfield, C. (2019). Where does value come from? *Trends in Cognitive Sciences*, *23*(10), 836–850. https://doi.org/10.1016/j.tics.2019.07.012

Jussim, L., Crawford, J. T., Anglin, S. M., Stevens, S. T., & Duarte, J. L. (2016). Interpretations and methods: Towards a more effectively self-correcting social psychology. *Journal of Experimental Social Psychology*, *66*, 116–133. https://doi.org/10.1016/j.jesp.2015.10.003

Liu, Q., Wang, F., Yan, W., Peng, K., Sui, J., & Hu, C.-P. (2020). Questionnaire data from the revision of a chinese version of free will and determinism plus scale. *Journal of Open Psychology Data*, *8*(1), 1. https://doi.org/10.5334/jopd.49/

Lockwood, P. L., Wittmann, M. K., Apps, M. A. J., Klein-FlÃŒgge, M. C., Crockett, M. J., Humphreys, G. W., & Rushworth, M. F. S. (2018). Neural mechanisms for learning self and other ownership. https://doi.org/10.1038/s41467-018-07231-9

Ma, Y., & Han, S. (2010). Why we respond faster to the self than to others? An implicit positive association theory of self-advantage during implicit face recognition. *Journal of Experimental Psychology: Human Perception and Performance*, *36*, 619–633. https://doi.org/10.1037/a0015797

648   Makowski, D., Ben-Shachar, M. S., Chen, S. H. A., & Lüdecke, D. (2019). Indices of

649   Effect Existence and Significance in the Bayesian Framework. *Frontiers in*

650   *Psychology, 10.* https://doi.org/10.3389/fpsyg.2019.02767

651   Makowski, D., Ben-Shachar, M. S., & Lüdecke, D. (2019). bayestestR: Describing

652   Effects and their Uncertainty, Existence and Significance within the Bayesian

653   Framework. *Journal of Open Source Software*, *4*(40), 1541.

654   https://doi.org/10.21105/joss.01541

655   Ohman, A., Lundqvist, D., & Esteves, F. (2001). The face in the crowd revisited: A

656   threat advantage with schematic stimuli. *Journal of Personality and Social*

657   *Psychology*, *80*(3), 381–396. https://doi.org/10.1037/0022-3514.80.3.381

658   Pool, E., Brosch, T., Delplanque, S., & Sander, D. (2016). Attentional bias for

659   positive emotional stimuli: A meta-analytic investigation.

660   https://doi.org/10.1037/bul0000026

661   Ratcliff, R., Smith, P. L., Brown, S. D., & McKoon, G. (2016). Diffusion Decision

662   Model: Current Issues and History. *Trends in Cognitive Sciences*, *20*(4),

663   260–281. https://doi.org/10.1016/j.tics.2016.01.007

664   Rouder, J. N., & Lu, J. (2005). An introduction to bayesian hierarchical models

665   with an application in the theory of signal detection [Journal Article].

666   *Psychonomic Bulletin & Review*, *12*(4), 573–604.

667   https://doi.org/10.3758/bf03196750

668   Rousselet, G. A., & Wilcox, R. R. (2020). Reaction times and other skewed

669   distributions: Problems with the mean and the median. *Meta-Psychology*, *4*.

670   https://doi.org/10.15626/MP.2019.1630

671   Shadlen, M. N., & Shohamy, D. (2016). Decision Making and Sequential Sampling

672   from Memory. *Neuron*, *90*(5), 927–939.

673   https://doi.org/10.1016/j.neuron.2016.04.036

674   Shore, D. M., & Heerey, E. A. (2013). Do social utility judgments influence

attental processing? *Cognition*, *129*(1), 114–122.

https://doi.org/10.1016/j.cognition.2013.06.011

Simmons, J. P., Nelson, L. D., & Simonsohn, U. (2013). *Life after p-hacking*
[Conference Proceedings]. https://doi.org/10.2139/ssrn.2205186

Stanley, M. L., Henne, P., & De Brigard, F. (2019). Remembering moral and
immoral actions in constructing the self. *Memory & Cognition*, *47*(3), 441–454.
https://doi.org/10.3758/s13421-018-0880-y

Stein, T., Grubb, C., Bertrand, M., Suh, S. M., & Verosky, S. C. (2017). No impact
of affective person knowledge on visual awareness: Evidence from binocular
rivalry and continuous flash suppression. *Emotion*, *17*(8), 1199–1207.
https://doi.org/10.1037/emo0000305

Strohminger, N., Knobe, J., & Newman, G. (2017). The true self: A psychological
concept distinct from the self: *Perspectives on Psychological Science*.
https://doi.org/10.1177/1745691616689495

Sui, J., He, X., Golubickis, M., Svensson, S. L., & Neil Macrae, C. (2023).
Electrophysiological correlates of self-prioritization. *Consciousness and
Cognition*, *108*, 103475. https://doi.org/10.1016/j.concog.2023.103475

Sui, J., He, X., & Humphreys, G. W. (2012). Perceptual effects of social salience:
Evidence from self-prioritization effects on perceptual matching. *Journal of
Experimental Psychology: Human Perception and Performance*, *38*(5),
1105–1117. https://doi.org/10.1037/a0029792

Sui, J., & Humphreys, G. W. (2015). The Integrative Self: How Self-Reference
Integrates Perception and Memory. *Trends in Cognitive Sciences*, *19*(12),
719–728. https://doi.org/10.1016/j.tics.2015.08.015

Sui, J., & Rotshtein, P. (2019). Self-prioritization and the attentional systems.
Current Opinion in Psychology, *29*, 148–152.
https://doi.org/10.1016/j.copsyc.2019.02.010

Unkelbach, C., Alves, H., & Koch, A. (2020). Chapter three - negativity bias, positivity bias, and valence asymmetries: Explaining the differential processing of positive and negative information. In B. Gawronski (Ed.), *Advances in experimental social psychology* (Vol. 62, pp. 115–187). Academic Press. https://doi.org/10.1016/bs.aesp.2020.04.005

Willis, J., & Todorov, A. (2006). First impressions: Making up your mind after a 100-ms exposure to a face. *Psychological Science*, *17*(7), 592–598. https://doi.org/10.1111/j.1467-9280.2006.01750.x

Xiao, Y. J., Coppin, G., & Bavel, J. J. V. (2016). Perceiving the world through group-colored glasses: A perceptual model of intergroup relations. *Psychological Inquiry*, *27*(4), 255–274. https://doi.org/10.1080/1047840X.2016.1199221

Table 1

Information about all experiments.

ExpID	Time	Location	N	n.of.trials	Self.ref	Stim.for.Morality	Presenting.order
Exp_1a_1	2014-04	Beijing	38 (35)	60	NA	words	Simultaneously
Exp_1a_2	2017-04	Wenzhou	18 (16)	120	NA	words	Simultaneously
Exp_1b_1	2014-10	Beijing	39 (27)	60	NA	words	Simultaneously
Exp_1b_2	2017-04	Wenzhou	33 (25)	120	NA	words	Simultaneously
Exp_1c	2014-10	Beijing	23 (23)	60	NA	descriptions	Simultaneously
Exp_2	2014-05	Beijing	35 (34)	60	NA	words	Sequentially
Exp_3a	2014-11	Beijing	38 (35)	60	explicit	words	Simultaneously
Exp_3b	2017-04	Wenzhou	61 (56)	60	explicit	words	Simultaneously
Exp_4a_1	2015-06	Beijing	32 (29)	30	implicit	words	Simultaneously
Exp_4a_2	2017-04	Wenzhou	32 (30)	60	implicit	words	Simultaneously
Exp_4b_1	2015-10	Beijing	34 (32)	60	implicit	words	Simultaneously
Exp_4b_2	2017-04	Wenzhou	19 (13)	60	implicit	words	Simultaneously
Exp_5	2016-01	Beijing	43 (38)	60	NA	words	Simultaneously
Exp_6a	2014-12	Beijing	24 (24)	180	NA	words	Sequentially
Exp_6b	2016-01	Beijing	23 (22)	90	explicit	words	Sequentially

Note. Stim.for.Morality = How moral character was manipulated; Presenting.order = How shapes & labels were presented. Number in () for N is number of participants are included in the analysis. In the current analysis, we only remain participants' data when they participate the experiment for the first time.
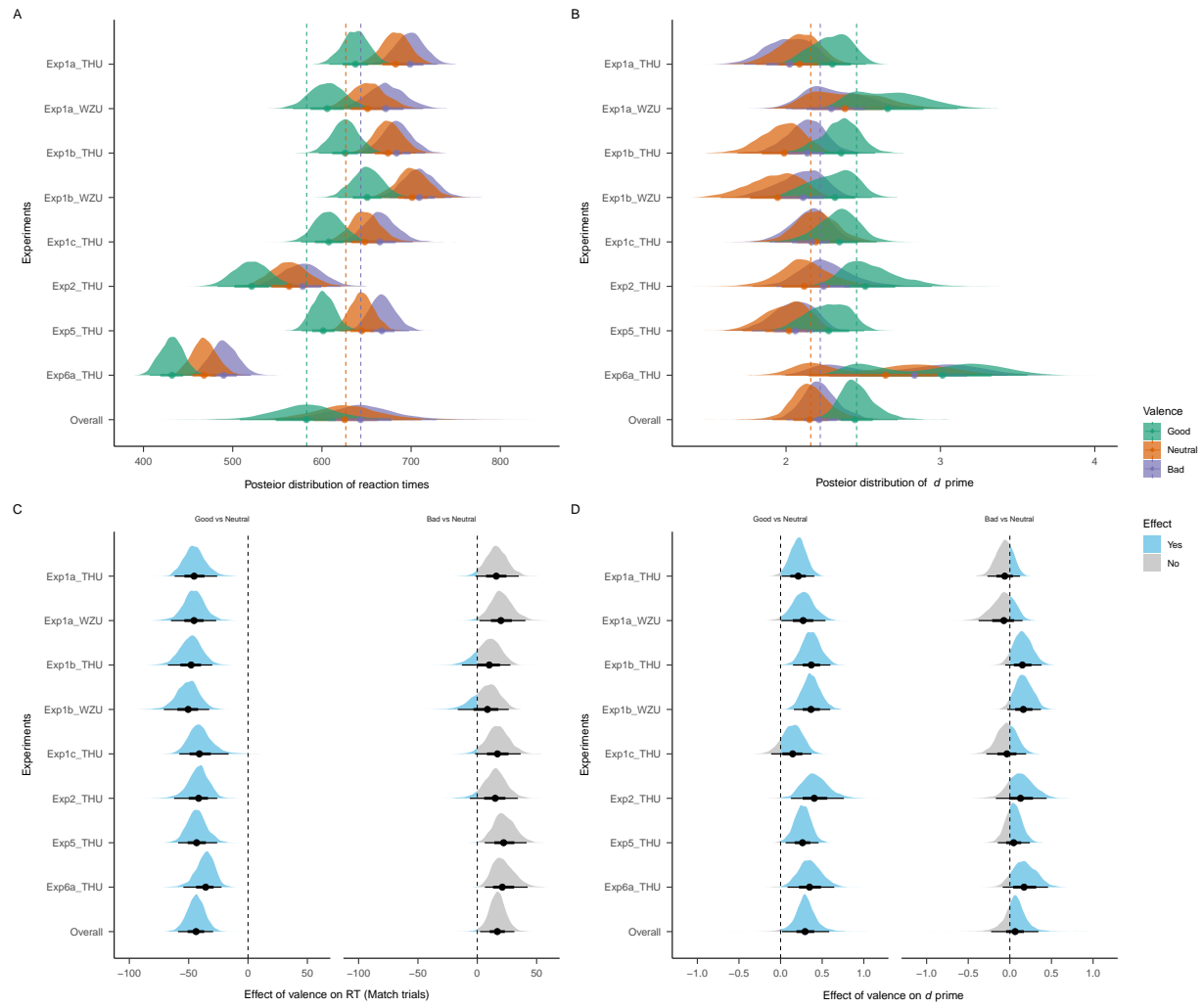
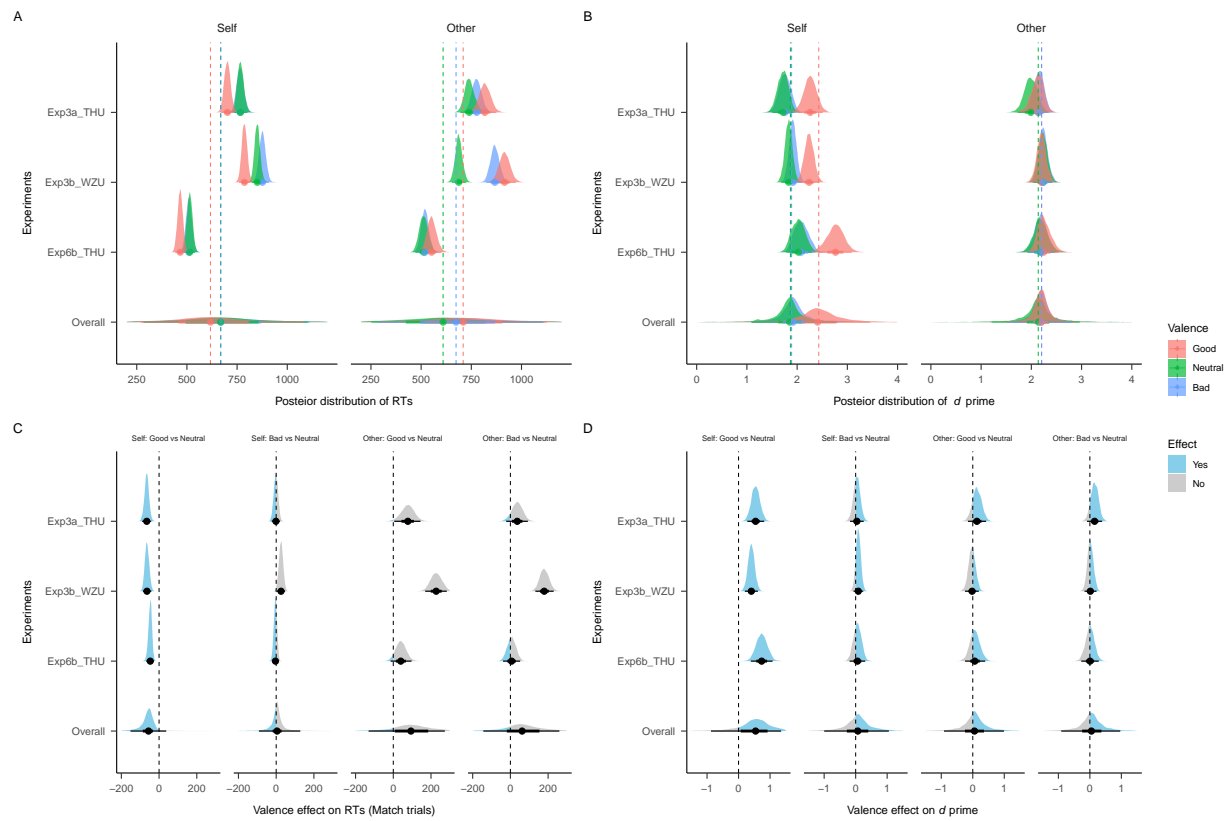*Figure 1.* Effect of moral character on perceptual matching

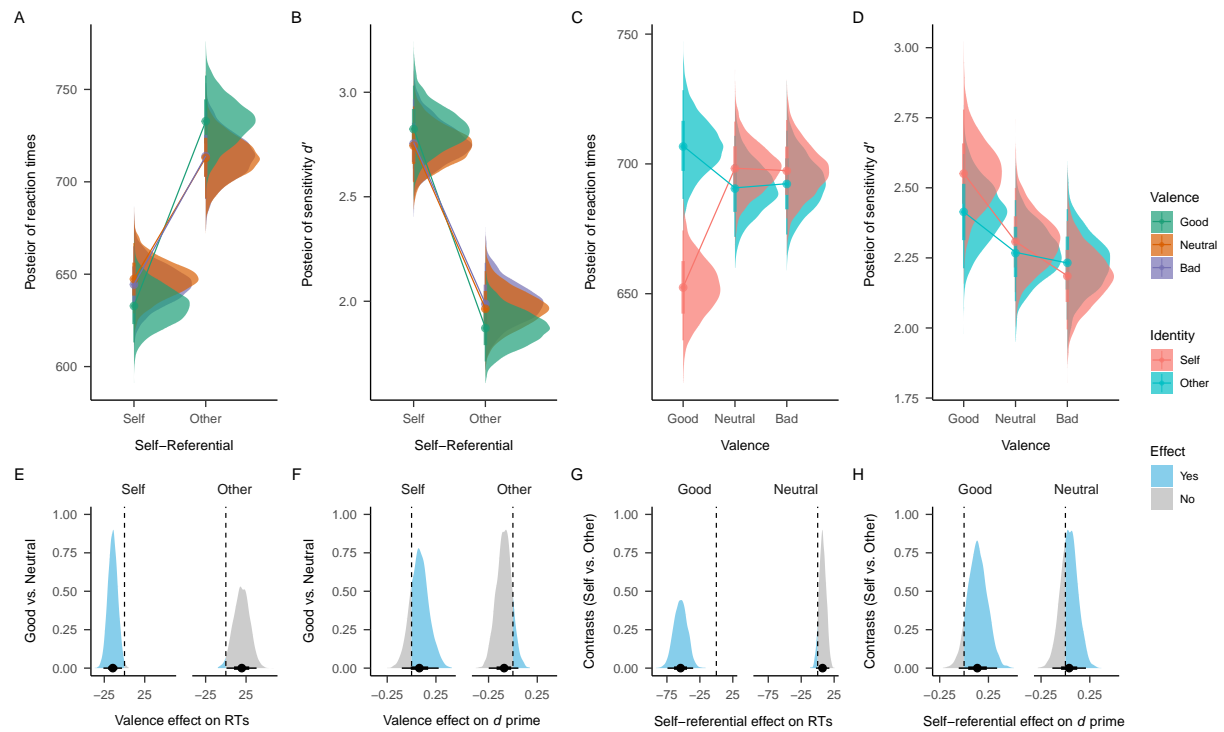*Figure 2.* Interaction between moral character and self-referential

Figure 3. Experiment 4: Implicit binding between good character and the self.