The good person is me: Spontaneous self-referential process prioritizes the good character

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

[1] Nanjing Normal University, 210024 Nanjing, China

[2] Tsinghua University, 100084 Beijing, China

[3] University of Aberdeen, Aberdeen, Scotland

Author Note

Hu Chuan-Peng, School of Psychology, Nanjing Normal University, 210024 Nanjing, China. Kaiping Peng, Department of Psychology, Tsinghua University, 100084 Beijing, China. Jie Sui, School of Psychology, University of Aberdeen, Aberdeen, Scotland. Authors contriubtion: HCP, JS, & KP design the study, HCP collected the data, HCP analyzed the data and drafted the manuscript. All authors read and agreed upon the current version of the manuscripts.

Correspondence concerning this article should be addressed to Hu Chuan-Peng, School of Psychology, Nanjing Normal University, Ninghai Road 122, Gulou District, 210024 Nanjing, China. E-mail: hcp4715@hotmail.com

Abstract

Moral character is central to social evaluation and moral judgment. As such, information related to moral character is prioritized in human cognition. This effect is usually explained as a valence effect. Here we report 9 experiments (data from 404 unique participants) which reveal (1) there is a robust good character prioritization effect in a perceptual matching task, i.e., when neutral geometric shapes were associated with good character, they were prioritized as compared to shapes associated with neutral or bad characters; (2) the prioritization of good character was robust only when the good character referred to the self but weak or non-exist when it referred to others, suggesting a binding effect of the self; (3) the binding between the self and good character exist even when one of them was task-irrelevant. Together, these results provided evidence for spontaneous self-referential processing, i.e., binding the good character with self, as a novel mechanism of the prioritization effect of good character.

Keywords: Perceptual decision-making, Self positivity bias, moral character

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Introduction

[quotes about moral character]

[Morality is central to social life, moral character is the central of morality] **People experience a substantial amount of moral events in everyday life (e.g., Hofmann, Wisneski, Brandt, & Skitka, 2014) and judging the moral character of people is indispensable part of these events**. Whether we are the agent, target, or a third party of a moral event, we always judge moral behaviors as "right" or "wrong", and by doing so, we judge people as "good" or "bad" (Uhlmann, Pizarro, & Diermeier, 2015). Moral character is so important in social life that it is a basic dimension in our social evaluation (Goodwin, 2015; Goodwin, Piazza, & Rozin, 2014) and that a substantial part of people's conversation are gossiping others' moral character (or, reputation) (e.g., Dunbar, 2004). These moral character information may help us to evaluate our in-group members and distinguish out-group members (Ellemers, 2018).

[Two possible effect of moral character prioritization] Given the importance of moral character and limited cognitive resources to process all the information in a social world, will people prioritize information with certain moral character? Focus on the valence of moral character, previous studies explore both negativity effect and positivity effect. The negativity effect, i.e., 'bad' character are prioritized, is consistent with early studies in impression formation which found that negative traits are weighted more in overall impression (N. H. Anderson, 1965; Fiske, 1980; Skowronski & Carlston, 1987). This idea also seemed to consistent with the more general idea that "bad is stronger than good" (Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001; Pratto & John, 1991). A few studies provided evidence for this possibility. For example, E. Anderson, Siegel, Bliss-Moreau, and Barrett (2011) asked participants to associate faces with different behaviors (e.g., negative and neutral behaviors from both social and nonsocial domains) and then perform a binocular rivalry task, where a face and a building were presented to each eye. Participants were required report the content of their visual awareness by pressing buttons. The results revealed that faces associated negative social behaviors dominated participants' visual awareness longer than faces associated with other types of behaviors (but see Stein, Grubb, Bertrand, Suh, & Verosky, 2017). Similarly, Eiserbeck and Abdel Rahman (2020) combined associative learning with attention blink paradigm, where neutral faces were associated with sentences about neutral or negative trust behaviors. They also found that neutral faces associated with negative behavior were processed preferentially.

The positivity effect, i.e., good moral characters are prioritized, is also plausible (see recent reviews, Pool, Brosch, Delplanque, & Sander, 2016; Unkelbach, Alves, & Koch, 2020). Unkelbach et al. (2020) pointed out that bad is not necessarily stronger than good in all aspects of information processing. Sometimes, good is stronger than bad. For example, when participants are asked to classify words as good or bad, positive trait words are classified faster than negative words (Bargh, Chaiken, Govender, & Pratto, 1992). Similarly, in a lexical decision task, participants judge positive words faster than negative words (Unkelbach et al., 2010). Also, Anisfeld and Lambert (1966) found that positive words are easier to associate with nonsense word-like strings, and this advantage in associative potential also appeared in implicit association test (IAT) (Anselmi, Vianello, & Robusto, 2011). Direct evidence for positivity effect of moral character also exist: Shore and Heerey (2013) found that faces with positive interaction in a trust game were prioritized in pre-attentive process.

These two possibilities, however, ignore the agency of participants who is perceiving the information and making perceptual decisions. The external stimuli only contain subjective value if they are relevant to the self of the decision-maker []. When it comes to moral character, there are long-history of studies showing that moral character is central for people's self-concept and identity. A positive moral character is viewed as the core feature of identity (e.g., Strohminger, Knobe, & Newman, 2017). A lot of studies revealed that people distort their perception, memory, and change their actions to maintain a positive view of their moral self-view. Given this strong motivation, it is possible that participant has spontaneous self-referential for the perception tasks where no self-referential process were not explicitly excluded [citation related to spontaneous self-referential].

Here, we report nine experiments where we found (1) there is a robust good character prioritization effect in social associative learning task, i.e., when neutral geometric shapes were associated with good character, they were prioritized as compared to shapes associated with neutral or bad characters; (2) prioritization of good character was robust only when it is relevant to the self but weak or non-exist when it referred to a non-self label; (3) the binding between good character and self exist even when one of the label became task-irrelevant. Together, these results provided evidence for spontaneous self-referential processing as a novel mechanism of the prioritization effect of good character. In all experiments, a social associative learning task in which th effect of physical features are minimized — participants performed a perceptual matching task after associated different moral characters (good, neutral, and bad) with different geometric shapes.

Disclosures

We reported all the measurements, analyses, and results in all the experiments in the current study. Participants whose overall accuracy lower than 60% were excluded from analysis. Also, the accurate responses with less than 200ms reaction times were excluded from the analysis. These 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 in Tsinghua University, Beijing, China. Participants in these experiments were recruited in the local community. To increase the sample size of experiments to 50 or more (Simmons, Nelson, & Simonsohn, 2013), we recruited additional participants in Wenzhou University, Wenzhou, China in 2017 for experiment 1a, 1b, 4a, and 4b. Experiment 3b was finished in Wenzhou University in 2017 (See Table S1 for overview of these experiments).

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

General methods

Design and Procedure

This series of experiments used the social associative learning paradigm (or tagging paradigm, see Sui, He, and Humphreys (2012)), in which participants first learned the associations between geometric shapes and labels of person with different moral character (e.g., in first three studies, the triangle, square, and circle and good person, neutral person, and bad person, respectively). The associations of the shapes and label were counterbalanced across participants. After remembered the associations, participants finished a practice phase to familiar with the task, in which they viewed one of the shapes upon the fixation while one of the labels below the fixation and judged whether the shape and the label matched the association they learned. When the overall accuracy reached 60% or higher at the end of the practicing session, participants proceeded to the experimental task, which was the same as in the practice phase. Otherwise, they will finish another practices session.

Experiment 1a, 1b, 1c, 2, 5, and 6a were design to explore and validate the effect of moral character on perceptual matching. These experiments shared a 2 (matching: match vs. nonmatch) by 3 (moral character: good vs. neutral vs. bad person) within-subject design. Experiment 1a was the first one of the whole series studies, which revealed a prioritization of good character. Experiment 1b, 1c, and 2 followed to confirm that it is the moral character that caused the effect. More specifically, experiment 1b used different Chinese words as labels to test whether the effect only occurred with certain words. Experiment 1c manipulated the moral valence indirectly: participants first learned to associate different moral behaviors with different Chinese names, after remembered the association, they then performed the perceptual matching task by associating names with different shapes. Experiment 2 further tested whether the way we presented the stimuli influence the effect of valence, by sequentially presenting labels and shapes instead of simultaneously. Note that a few participants in experiment 2 also participated experiment 1a because we originally planned a cross task comparison. Experiment 5 was designed to compare the effect size of moral character and other importance social evaluative dimensions (aesthetics and emotion). Different social evaluative dimensions were implemented in different blocks, the moral character blocks shared the design of experiment 1a. Experiment 6a, which shared the same design as experiment 2, was an EEG experiment which aimed at exploring the neural correlates of the effect. But we will focus on the behavioral results of experiment 6a in the current manuscript.

Experiment 3a, 3b, and 6b were designed to test whether the prioritization of good person reflect a valence effect or a self-referential effect. To do so, we included self-reference as another within-subject variable. For example, the experiment 3a directly extend the design of 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). The 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), experiment 6b were conducted in two days: the first day participants finished perceptual matching task as a practice, and 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 separate the self-referential trials and other-referential trials. That is, participants finished two different types of block: in the self-referential blocks, they only responded to good-self, neutral-self, and bad-self, with half match trials and half nonmatch trials; in the other-reference blocks, they only responded to good-other, neutral-other, and bad-other.

Experiment 4a and 4b were design to further test the self-referential process in the prioritization of good-person. In 4a, we only used two labels (self vs. other) and two shapes (circle, square). To manipulate the moral character, we presented moral-related words within shapes and instructed participants to ignore the words in shapes during the task. In 4b, we reversed the role of self-reference and moral character: participant learned three labels (good-person, neutral-person, and bad-person) and three shapes (circle, square, and triangle), and the words related to identity, "self" or "other", were presented in shapes. As in 4a, participants were told to ignore the words inside the shape during the task.

E-prime 2.0 was used for presenting stimuli and collecting behavioral responses. For participants recruited in Tsinghua University, they finished the experiment individually in a dim-lighted chamber, stimuli were presented on 22-inch CRT monitors and their head were fixed by a chin-rest brace. The distance between participants' eyes and the screen was about 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 the shape or the word and the fixation cross was $3.5°$ of visual angle. For participants recruited in Wenzhou University, they finished the experiment in a group consisted of $3 \sim 12$ participants in a dim-lighted testing room. Participants were required to finished the whole experiment independently. Also, they were instructed to start the experiment at the same time, so that the distraction between participants were minimized. The stimuli were presented on 19-inch CRT monitor. The visual angles are could not be exactly controlled because participants' chin were not fixed.

In most of these experiments, participant were also asked to fill a battery of questionnaire after they finish the behavioral tasks. All the questionnaire data were open (see, dataset 4 in Liu et al., 2020). See Table S1 for a summary information about all the experiments.

Data analysis

We used the `tidyverse` of r (see script `Load_save_data.r`) to preprocess the data. Results of 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 provided 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 normal distribution for all data. Using appropriate distributions for the data will avoid misleading results and provide better fitting of the data. For example, Reaction times are not normally distributed but right skewed, and the linear assumption in ANOVAs is not satisfied (Rousselet & Wilcox, 2019). Third, BHM provides an unified framework to analyze data from different levels and different sources, avoid the information loss when we need to combine data from different levels.

We used the `r` package `BRMs` (**Bürkner_2017?**), which used Stan (Carpenter et al., 2017) for the BHM analyses. We estimated the over-all effect across experiments with similar experimental design, instead of using a two-step approach where we first estimate parameters, e.g., d' for each participant, and then use a random effect model meta-analysis to synthesize the effect (e.g., Goh, Hall, & Rosenthal, 2016).

Accuracy. We followed previous studies (Hu, Lan, Macrae, & Sui, 2020; Sui et al., 2012) and used signal detection theory approach to analyze the accuracy data. More specifically, the match trials are treated as signal and the non-match trials are noise. The sensitivity and criterion of signal detection theory by BHM (Rouder & Lu, 2005). Because the BHM can model different level's data using a single unified model, we used a three-level HBM to model prioritization effect of good-person, which include data from five experiments: 1a, 1b, 1c, 2, 5, and 6a. Similarly, we modeled experiments with both self-referential and moral character with a three-level HBM model, which includes 3a, 3b, and 6b. For experiment 4a and 4b, we used two-level models for each separately. However, we could compare the posterior of parameters directly because we have full posterior distribution of parameters.

We used the Bernoulli distribution to model the accuracy data. For a single participant, we assume that the accuracy of ith trial is Bernoulli distributed (binomial with 1 trial), with probability p_i that $y_i = 1$.

$$y_i \sim Bernoulli(p_i)$$

and the probability of choosing "match" p_i at the ith trial is a function of the trial type:

$$\Phi(p_i) = \beta_0 + \beta_1 IsMatch_i$$

therefore, the outcomes y_i are 0 if the participant responded "nonmatch" on the ith trial, 1 if they responded "match". We then write the generalized linear model on the probits (z-scores; Φ, "Phi") of ps. Φ is the cumulative normal density function and maps z scores to probabilities. In this way, the intercept of the model (β_0) is the standardized false alarm rate (probability of saying 1 when predictor is 0), which we take as our criterion c. The slope of the model (β_1) is the increased probability of responding "match" when the trial type is “match”, in z-scores, which is another expression of d'. Therefore, c = -zHR = $-\beta_0$, and $d' = \beta_1$.

In our experimental design, there are three conditions for both match and non-match trials, we can estimate the d' and c separately for each condition. In this case, the criterion c is modeled as the main effect of valence, and the d' can be modeled as the interaction between valence and match:

$$\Phi(p_i) = 0 + \beta_0 Valence_i + \beta_1 IsMatch_i * Valence_i$$

In each experiment, we had multiple participants. We can estimate the group-level parameters by extending the above model into a two-level model, where we can estimate parameters on individual level (varying effect) and the group level parameter simultaneously (fixed effect). The probability that the jth subject responded “match” ($y_{ij} = 1$) at the ith trial p_{ij}. In the same vein, we have

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

The the generalized linear model can be re-written to include two levels:

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

We again can write the generalized linear model on the probits (z-scores; Φ, “Phi”) of ps.

The subjective-specific intercepts ($\beta_0 = -zFAR$) and slopes ($\beta_1 = d'$) are describe by multivariate normal with means and a covariance matrix for the parameters.

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

For experiments that had 2 (matching: match vs. non-match) by 3 (moral character: good vs. neutral vs. bad), i.e., experiment 1a, 1b, 1c, 2, 5, and 6a, the formula for accuracy in `BRMs` is as follow:

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

For experiments that had two by two by three design, we used the follow formula for the BGLM:

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

In the same vein, we can estimate the posterior of parameters across different experiments. We can use a nested hierarchical model to model all the experiment with similar design:

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

the generalized linear model is then

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

The outcomes y_{ijk} are 0 if participant j in experiment k responded "nonmatch" on trial i, 1 if they responded "match".

$$\begin{bmatrix} \beta_{0jk} \\ \beta_{1jk} \end{bmatrix} \sim N(\begin{bmatrix} \theta_{0k} \\ \theta_{1k} \end{bmatrix}, \sum)$$

and the experiment level parameter mu_{0k} and mu_{1k} is from a higher order distribution:

$$\begin{bmatrix} \theta_{0k} \\ \theta_{1k} \end{bmatrix} \sim N(\begin{bmatrix} \mu_{0} \\ \mu_{1} \end{bmatrix}, \sum)$$

in which mu_0 and mu_1 means the population level parameter.

Reaction times. For the reaction time, we used the log normal distribution (https://lindeloev.github.io/shiny-rt/#34_(shifted)_log-normal) to model the data. This means that we need to estimate the posterior of two parameters: μ, σ. μ is the mean of the `logNormal` distribution, and σ is the disperse of the distribution. Although the log normal distribution can be extended to shifted log normal distribution, with one more parameter: shift, which is the earliest possible response, we found that the additional parameter didnt' improved the model fitting and therefore used the log nomral in our final analysis.

The reaction time of the jth subject on ith trial is a linear function of trial type:

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

while the log of the reaction time is log-normal distributed:

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

y_{ij} is the RT of the ith trial of the jth participants.

$$\mu_j = \beta_{0j} + \beta_{1j} * IsMatch_{ij} * Valence_{ij}$$
$$\begin{bmatrix}\beta_{0j}\\ \beta_{1j}\end{bmatrix} \sim N(\begin{bmatrix}\theta_0\\ \theta_1\end{bmatrix}, \sum)$$

$$\sigma_j \sim HalfCauchy()$$

Formula used for modeling the data as follow:

```
RT_sec ~ Valence*ismatch + (Valence*ismatch | Subject), family =
lognormal()
```

or

```
RT_sec ~ ID*Valence*ismatch + (ID*Valence*ismatch | Subject), family =
lognormal()
```

we expanded the RT model three-level model in which participants and experiments are two group level variable and participants were nested in the experiments.

$$log(y_{ijk}) \sim N(\mu_{jk}, \sigma_{jk})$$

y_{ijk} is the RT of the ith trial of the jth participants in the kth experiment.

$$\log(y_{ijk}) \sim N(\mu_{jk}, \sigma_{jk})$$

$$\sigma_{jk} \sim HalfCauchy()$$

$$\mu_{jk} = \beta_{0jk} + \beta_{1jk} * IsMatch_{ijk} * Valence_{ijk}$$

$$\beta_{jk} \sim N(\mu_j, \sigma_j)$$

$$\mu_j \sim N(\mu, \sigma)$$

$$\sigma_j \sim HN(\sigma_\sigma)$$

Prioritization of good person. We estimated the effect size of d' and RT from experiment 1a, 1b, 1c, 2, 5, and 6a for the prioritization of good person. We reported fixed effect of three-level BHM that included all experiments that tested the valence effect.

Prioritization of good person is modulated by self-referential. We also estimated the interaction between moral character and self-referential process, which included results from experiment 3a, 3b, and 6b. Using three-level models, we tested two possible explanations for the prioritization of good character: valence effect or self-referential based prioritization.

Spontaenous binding between self and good person. In the third part, we focused on experiment 4a and 4b, which were designed to examine two more nuanced explanation concerning the good-self. The design of experiment 4a and 4b are complementary. Together, they can test whether participants are more sensitive to the moral character of the Self (4a), or the identity of the good character (4b).

We only reported the subjective distance between different persons, and did not analyze other questionnaire data, which were described in (Liu et al., 2020).

Results

Prioritization of good character related information

In this part, we report results from five experiments that tested whether an associative learning task, including 192 participants. Note that for both experiment 1a and 1b, there were two independent samples with different equipment, trials numbers and testing situations. Therefore, we modeled them as independent samples. These five experiments revealed a robust effect of moral character on perceptual matching task.

For the d prime, we found robust effect of moral character. Shapes associated with good character ("good person", "kind person" or a name associated with morally good behavioral history) has higher sensitivity (median = 2.49, 95% HDI = [2.19 2.75]) than shapes associated with neutral character (median = 2.18, 95% HDI = [1.90 2.48]), $median_{diff}$ = 0.31, 95% HDI [0.02 0.63] , but we did not find differences between shapes associated with bad character (median = 2.23, 95% HDI = [1.94 2.53]) and neutral character, $median_{diff}$ = 0.05, 95% HDI [-0.29 0.37].

For the reaction times, we also found 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 character has faster responses (median = 578.64 ms, 95% HDI = [508.15 661.14]) than shapes associated with neutral character (median = 623.45 ms, 95% HDI = [547.98 708.24]), $median_{diff}$ = -44.05, 95% HDI [-59.96 -30.43]. We also found that the responses to shapes associated with bad character (median = 640.41 ms, 95% HDI = [559.94 719.63]) were slower as compared to the neutral character, $median_{diff}$ = 17.04, 95% HDI [4.02 29.92]. See Figure 1.

For the nonmatch trials, we also found the advantage of good character: Shapes associated with good character (median = 653.21 ms, 95% HDI = [574.65 739.57]) are faster than shapes associated with neutral (median = 671.14 ms, 95% HDI = [591.71 760.09]), $median_{diff}$ = -17.65 ms, 95% HDI [-23.85 -10.36]. Similarly, the shapes associated with bad character (median = 676.35 ms, 95% HDI = [599.13 767.76]) was responded slower than shapes associated with neutral character, $median_{diff}$ = 17.04 ms, 95% HDI [4.02 29.92], but the effect size was smaller, (**see supplementary materials**).

Self-referential process modulates prioritization of good character

In this part, we report results from three experiments (3a, 3b, and 6b) that aimed at testing whether the moral valence effect found in the previous experiments is modulated by self-referential processes. These three experiments included data from 108 participants.

Because we have found that a facilitation effect of good character and slow-down effect of bad character in the first part, in this part, we will focus on the whether such effect interact with self-referential factor. In others words, we not only reported differences between good/bad character with neutral character for self-referential and other-referential separately, but also compare the differences between the difference. For details of individual studies, please see supplementary materials.

For the *d* prime, we found that an interaction between moral character effect and self-referential, the self- and other-referential difference was greater than zero for good vs. neutral character differences ($median_{diff}$ = 0.51; 95% HDI = [-1.48 2.61]) but not for bad vs. neutral differences ($median_{diff}$ = -0.02; 95% HDI = [-1.85 2.17]). Further analyses revealed that the good vs. neutral character effect only appeared for self-referential conditions but not other-referential conditions. The estimated *d* prime for good-self was greater than neutral-self ($median_{diff}$ = 0.56; 95% HDI = [-1.05 2.15]), *d* prime for good-self was also greater than good-other condition ($median_{diff}$ = ; 95% HDI = [ ]). The differences between bad-self and neutral-self, good-other and neutral-other, bad-other and neutral-other are all centered around zero (see Figure 2, B, D).

For the RTs part, we also found the interaction between moral character and self-referential, the self- and other-referential differences was below zero for the good vs. neutral differences ($median_{diff}$ = -105.39; 95% HDI = [-533.16 281.69]) but not for the bad vs. neutral differences ($median_{diff}$ = -9.46; 95% HDI = [-290.72 251.38]). Further analyses revealed a robust good-self prioritization effect as compared to neutral-self ($median_{diff}$ = -47.58; 95% HDI = [-202.88 16.83]) and good-other ($median_{diff}$ = -57.14; 95% HDI = [-991.89 621.29]) conditions. Also, we found that both good character and bad character were responded slower than neutral character when it was other-referential. See Figure 2.

These results suggested that the prioritization of good character is modulated by the self-referential processing: when the good character was prioritized when it was self-referential, but it was slowed down when it was other-referential.

Spontaneous binding between the good character and the self

Two studies further tested whether the binding between self and good character happen even when two aspect of information are separated and only one of them is task-relevant. We are interested in testing whether the task-relevance modulated the effect observed in previous experiment.

In experiment 4a, where self- and other-referential were task-relevant and moral character are task-irrelevant. We found self-related conditions were performed better than other-related conditions, on both *d* prime and reaction times. This pattern is consistent with previous studies (e.g., Sui et al. (2012)).

More importantly, we found evidence, albeit weak, that task-irrelevant moral character also played an role. For shapes associated with self, *d'* was greater when shapes had a good character inside the shape (median = 2.83, 95% HDI [2.63 3.01]) than shapes that have neutral character (median = 2.74, 95% HDI [2.58 2.95], BF = 4.4) or bad character (median = 2.76, 95% HDI [2.56 2.95], 3.1), but we did not found difference between shapes with bad character and neutral character inside for the self-referential shapes. For shapes associated with other, the results of *d'* revealed a reversed pattern to the self-referential condition: *d* prime was smaller when shapes had a good character inside (median = 1.87, 95% HDI [1.71 2.04]) than had neutral (median = 1.96, 95% HDI [1.80 2.14]) or bad character (median = 1.98, 95% HDI [1.79 2.17]) inside. See Figure 3.

The same pattern was found for RTs. For self-referential condition, when good character was presented as a task-irrelevant stimuli, the responds (median = 641, 95% HDI [623 662]) were faster than when neutral character (median = 649, 95% HDI [631 668]) or bad character (median = 648, 95% HDI [628 667]) were inside. This effect was reversed for other-referential condition: shapes associated with other with good character inside (median = 733, 95% HDI [711 754]) were slower than with neutral character (median = 721, 95% HDI [702 741]) or bad character (median = 718, 95% HDI [696 740]) inside.

In experiment 4b, moral character was the task-relevant factor, and we found that there were main effect of moral character: shapes associated with good character were performed better than other-related conditions, on both *d'* and reaction times.

Most importantly, we found evidence that task-irrelevant self-referential process also played an role. For shapes associated with good person, the *d* prime was greater when shapes had an "self" inside than with "other" inside ($mean_{diff}$ = 0.14, 95% credible intervals [-0.02, 0.31], BF = 12.07), but this effect did not happen when the target shape where associated with "neutral" ($mean_{diff}$ = 0.04, 95% HDI [-.11, .18]) or "bad" person ($mean_{diff}$ = -.05, 95% HDI[-.18, .09]).

The same trend appeared for the RT data. For shapes associated with good person, with a "self" inside the shape reduced the reaction times as compared with when a "other" inside the shape ($mean_{diff}$ = -55 ms, 95% HDI [-75, -35]), but this effect did not occur when the shapes were associated neutral ($mean_{diff}$ = 10, 95% HDI [1, 20]) or bad ($mean_{diff}$ = 5, 95% HDI [-16, 27]) person. See Figure 3.

Discussion

[Summary of results] 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. We found robust effect that good character was prioritized in the shape-label matching task, regardless how good character was represented (single word or behavioral description). Moreover, the prioritization of good character was not driven by valence itself, i.e., "good" vs "bad". Instead, this effect was modulated by a self-referential processing: prioritization only occurred when moral characters are self-referential (experiments …). Finally, the prioritization of good character was modulated by self-referential information even when either the self- or character- related information was irrelevant to experimental task (experiment 4a and 4b). In contrast, when good character became other-referential, even implicitly, the performance was worse thant other-referential neutral character. Together, these findings highlight the importance of the self in perceiving more character information, contribute to a growing literature on the social nature of perception (Freeman, Stolier, & Brooks, 2020; Xiao, Coppin, & Bavel, 2016) by supporting the idea that people prioritize socially salient stimuli.

[Effect of good character] The robust effect of the prioritization of good character provide solid evidence for the effect of moral character on perceptual decision-making. Previous research reported the effect of morality on perception but the results and the mechanisms were disputed. For example, (E. Anderson et al., 2011) reported that faces associated with bad social behavior capture attention more rapidly, however, independent team failed to replicate the effect (Stein et al., 2017). Another studies 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 caused by semantic priming instead of morality (Firestone & Scholl, 2015; Jussim, Crawford, Anglin, Stevens, & Duarte, 2016). In the current study, we used associative learning task which allow us to eliminate the semantic priming: (1) we only use a few pairs of stimuli; (2) the stimuli that used to represent moral character are neutral stimuli. Moreover, the moral character information can be learned by typical moral behavioral instead of moral character label. The effect was replicated in all five different samples further confirmed that the prioritization effect of good character found in our paradigm is robust.

The prioritization of good character, however, is different previous moral perception studies which reported a negativity effect, i.e., information related to bad moral character are processed better (E. Anderson et al., 2011; Eiserbeck & Abdel Rahman, 2020). For instance, E. Anderson et al. (2011) reported the faces associated with negative social behaviors dominated the awareness for longer time than those associated with neutral or positive behaviors. This difference may resulted from the differences in the task, while in many previous moral perception studies, the participants were asked to detect the existence of a stimuli, while the current task participants need to recognize the stimuli and perform the matching task. That said, previous studies targeted the early stage of perception while the current task focus more on the decision-making at relative later stage of information processing. The positivity occur at later stage while the negativity effect occur at early stage of information process had been reported in affective stimuli as well (Pool et al., 2016).

[Self-binding as a novel explanation and consistent with broader theory about morality] We further tested whether prioritization effect of moral character was due to purely valence or because of spontaneous self-referential processing. Our results revealed that prioritization of good character is modulated by self-relatedness of the character information: when the good character was prioritized when it was related to self, even when the self-relatedness was task irrelevant. By contrast, when good character information was no longer prioritized when it was associated with non-self. These results echo prior research on moral-self view (Freitas, Cikara, Grossmann, & Schlegel, 2017; Strohminger et al., 2017), suggesting that the central role of moral-self to our participants is not only at self-report level but also at perceptual level.

[Beyond the debate about penetration of perception] Instead of claiming the moral-self motivation *penetrates* perception, we argue that perceptual decision-making process include more processes than just encoding the sensory inputs. In other words, we are not against or for one side of the cognition-penetration debate (Firestone & Scholl, 2016). Instead, we suggest to further develop computational models better account the nuance of behavioral data and/or related data collected from other modules. For example, sequential sampling models suggest that, when making a perceptual decision, the agent is continuously accumulate evidence until the amount of evidence passed a threshold, then a decision is made (Forstmann, Ratcliff, & Wagenmakers, 2016; Ratcliff, Smith, Brown, & McKoon, 2016). In these models, the evidence, or decision variable, can accumulate from both sensory information but also memory []. Recently applications of sequential sample model to perceptual matching tasks also suggest that different processes may contributed 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 more specified computational models are need to disentangle the cognitive processes underlying the prioritization of good character.

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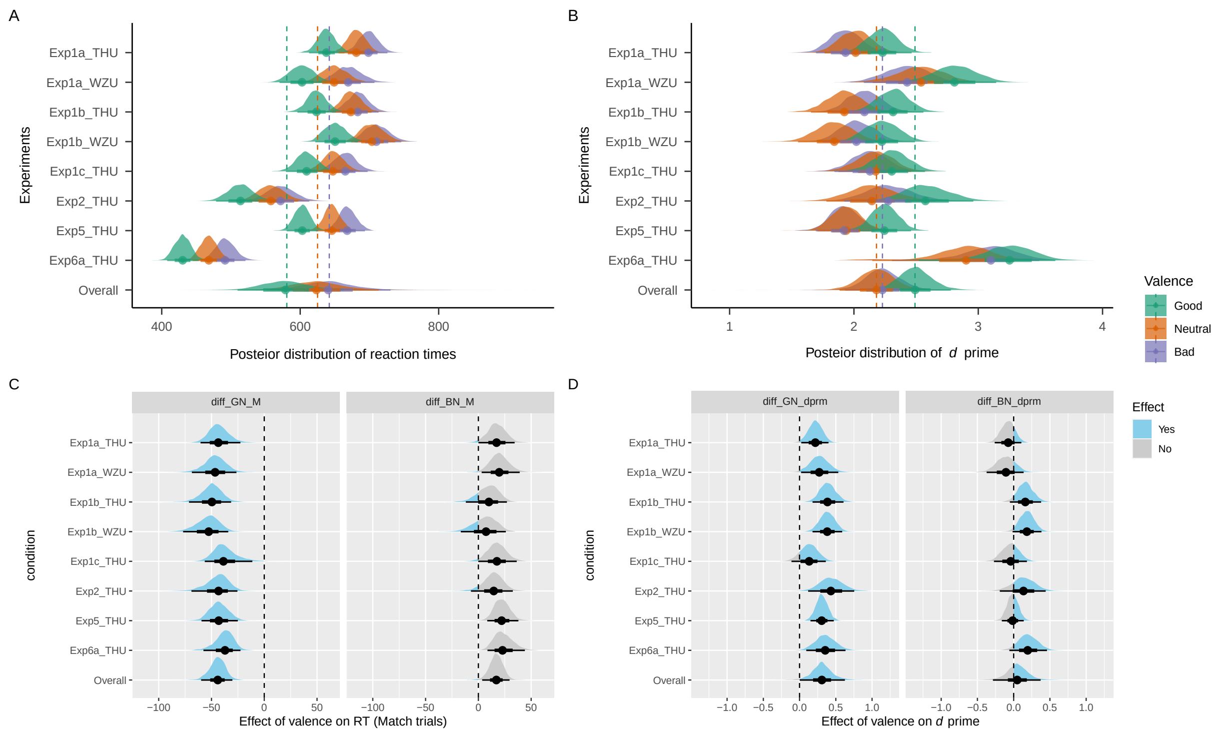

Figure 1. Effect of moral character on RT and d’

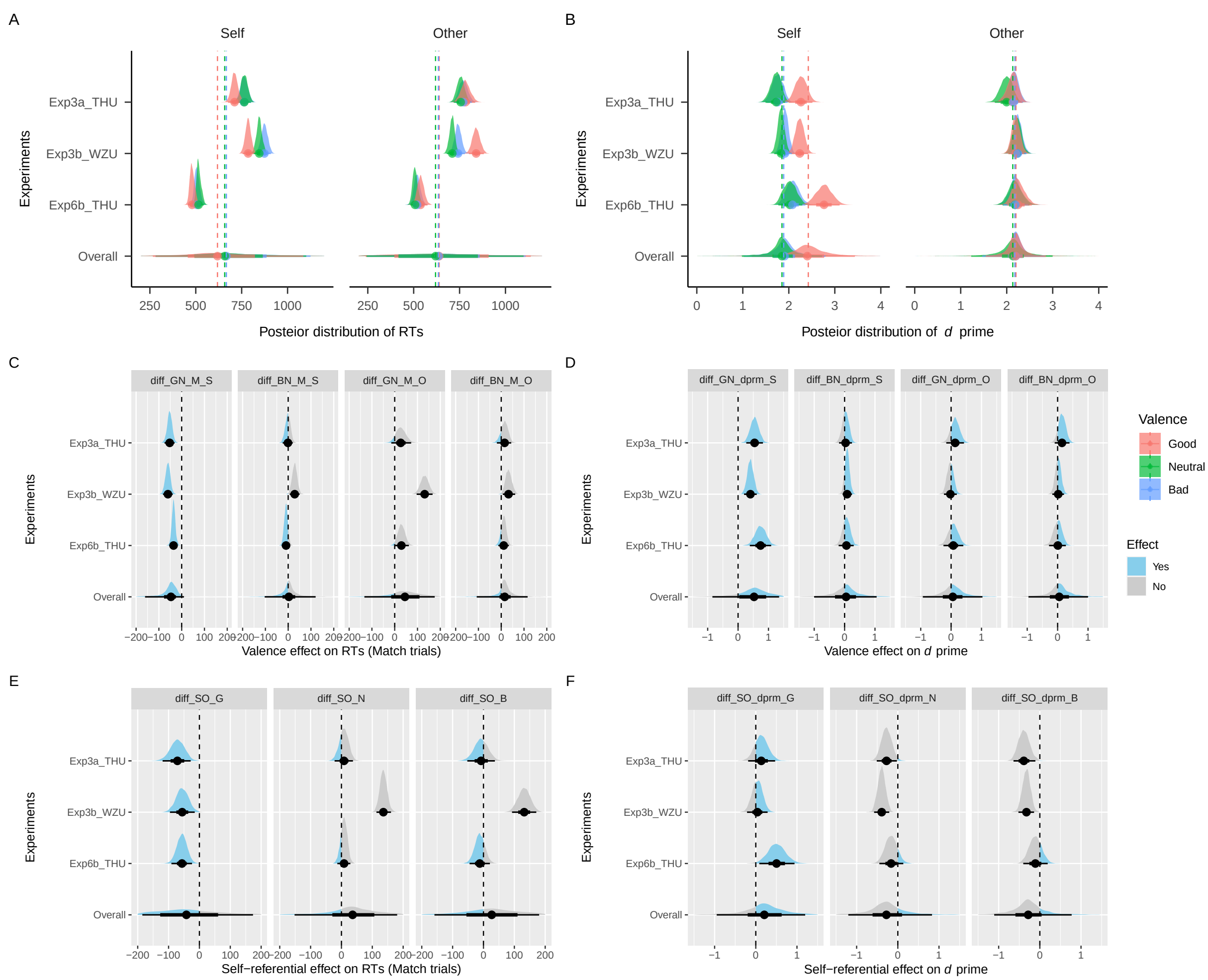

Figure 2. Interaction between moral character and self-referential

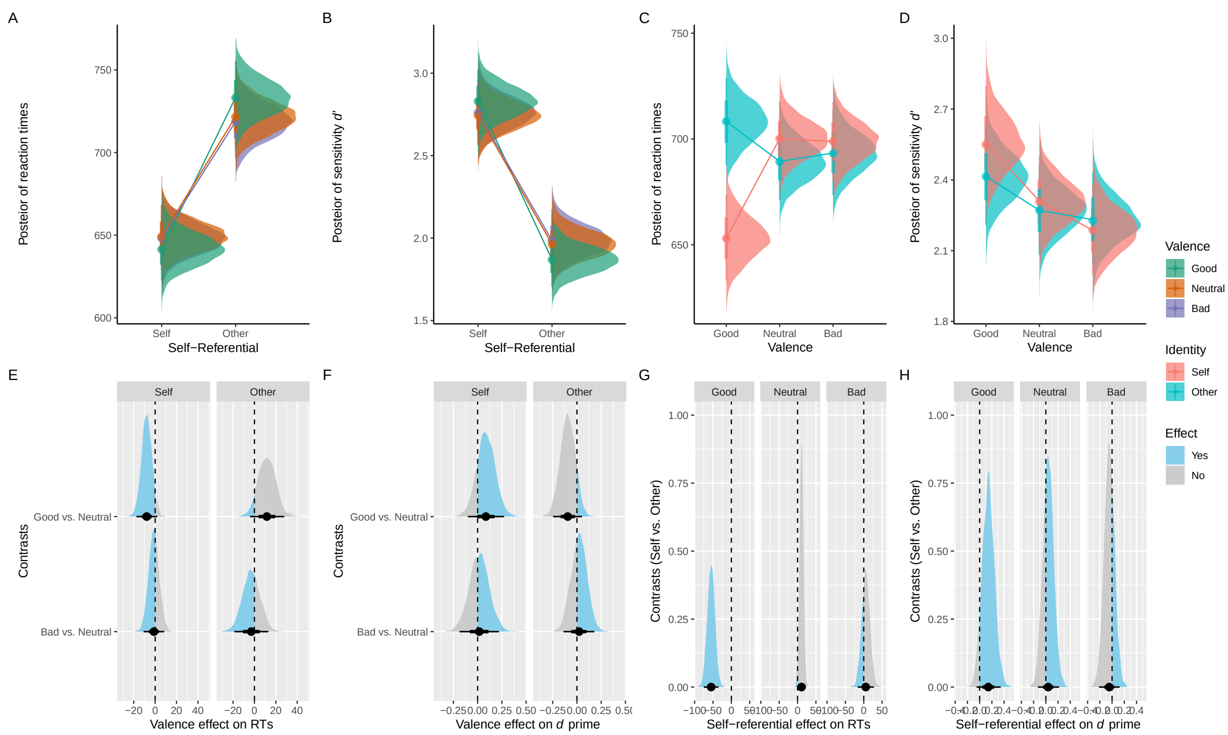

Figure 3. Experiment 4: Implicit binding between good character and the self.