Cognitive Process Differences Between Moral Beauty Judgments and Moral Goodness Judgments

Yanhui Xiang[1], Xue Wen[2], Jiaxu Zhao[1], Wenrui Zhang[1], and Yiqi Jiang[2]

[1] Cognition and Human Behavior Key Laboratory of Hunan, Department of Psychology, Hunan Normal University, Changsha, China

[2] School of Psychology, Hainan Normal University, Hainan, China

ABSTRACT

Goodness and beauty have always been important topics of debate in the field of philosophy and aesthetics. The present study used behavior and event-related potentials (ERPs) to investigate whether moral beauty judgments and moral goodness judgments involve different cognitive processes or the same cognitive process under different language labels for the same human act. Behavioral results showed that individuals gave significantly higher scores for a beautiful face than an ugly face when making moral beauty judgments, but there were no significant differences between the two conditions when making moral goodness judgments. The ERP experiment displayed larger P2 amplitudes and the late positive potential (LPP) amplitude was elicited when displaying beautiful faces but not ugly faces during moral beauty judgments. However, during moral goodness judgments, the P2 and LPP showed no significant differences under the two conditions. In general, we conclude that moral beauty judgments and moral goodness judgments involve different cognitive processes, although they objectively refer to the same human act. One of the most important differences between moral beauty judgments and moral goodness judgments was that the former process involved an image, whereas the latter did not. The present conclusion provides important insights into the research in aesthetic perception and moral sense.

KEYWORDS

moral beauty
moral goodness
perceived images

INTRODUCTION.

In a scenario where an old man falls down and a young man helps him up, is the young man's behavior beautiful or is it good? The former refers to *moral beauty*, and the latter to *moral goodness*. However, both linguistic labels refer to the same human act. Therefore, this leads to a significant problem of whether moral beauty judgments and moral goodness judgments involve the same cognitive processes or different cognitive processes with different linguistic labels.

In the field of philosophy, this problem has been argued since Antiquity. Some philosophers insisted on combining beauty and goodness together, while others proposed that beauty and goodness were different (Ross et al., 1974). To solve this significant problem, we should not only depend on philosophical speculations, but also on more direct evidence from empirical research. However, due to methodological limitations, it was difficult to investigate moral beauty and moral goodness effectively in the past. Only with this century's technological progress, especially in cognitive neuroscience, this topic has been investigated empirically. Recently, researchers in psychology performed a number of studies on the internal processes and neural mechanisms of moral judgments, moral sense, moral aesthetic judgments, and aesthetic sense, achieving many worthwhile results (e.g., Greene, 2003; Winston et al., 2007).

Corresponding author:Yanhui Xiang. Department of Psychology, Hunan Normal University, Changsha, 410081, China

E-mail: xiangyh@hunnu.edu.cn

First, previous studies concerned the process of moral goodness judgments. Moral judgment refers to the action of giving moral value to a certain behavior or event based on moral principles or a value criterion (Greene, 2003). There are two viewpoints explaining the process of moral goodness judgments, namely, the *cognitive reasoning* viewpoint and the *emotional intuitive* viewpoint. The former emphasizes that moral goodness judgments are the cognitive and reasoning processes influenced by social rules and that cognition and reasoning play a crucial role in the moral process (Kohlberg, 1981), while the latter suggests that moral goodness judgments are processes driven by emotions and that emotional processing directly determines the result of moral goodness judgments (Haidt, 2001). Moreover, in recent years, some researchers proposed the dual-process theory to explain moral processing. It posits that both cognitive reasoning and emotion are involved in moral judgments but that the former's function is related to the abstract moral principle while the latter's function is associated with social adaption. This viewpoint was confirmed by many previous studies using neuroimaging and event-related potentials (ERPs; Greene et al., 2001, 2004, 2008; Pochon et al., 2008). Previous studies have found that ERPs of the temporo-parietal area and the prefrontal area are significantly activated in experiments related to moral judgments (Gan et al., 2015; Leuthold et al., 2015; Peng et al., 2017). Furthermore, in their meta-analysis, Greene and Haidt (2002) identified several important brain areas which are closely related to moral judgment processing, such as the ventromedial prefrontal cortex (VMPFC), the posterior cingulate gyrus, and the dorsolateral prefrontal cortex (DLPFC), and confirmed that these brain areas were closely related to emotional processing and cognitive processing, suggesting that the "moral brain" is a complex overlap of the "emotional brain" and the "cognitive brain". Haidt (2007, 2008) has further illustrated the functional mechanism of cognition and emotion in the process of moral goodness judgments. He showed that emotion played an important role in moral processing and that the subsequent cognition was affected by emotion. In turn, cognitive processes can also drive the emotional process in moral goodness judgments. Taken together, the process of moral goodness judgments is the result of emotion combined with cognition.

Researchers have also conducted a series of studies on the process of beauty and the sense of beauty. According to aesthetic theories, beauty includes natural beauty, artistic beauty, and moral beauty (Berlyne, 1971; Cupchik, 2002; Haidt & Joseph, 2004); the first two belong to *external* beauty, and the latter to *inner* beauty. Researchers previously explored the brain mechanisms of processing various external beauty using neuroimaging. The results showed that the brain areas involved in external beauty judgments are the ventral pathways related to visual processing (V1, V2, V4, and the inferior temporal gyrus), superior frontal gyrus, which is related to cognitive processing, and orbital frontal cortex and anterior cingulate cortex, which are related to emotional processing (Winston et al., 2007; Jacobsen et al., 2006). The evidence from neuroimaging on external beauty judgments further verifies the assumption of aesthetic theory that beauty judgments consist of perceptual, cognitive, and emotional processes (Berlyne, 1971; Cupchik, 2002), of which perceiving the object image is the primary step. Moreover, the two-stage processing model of Höfel and Jacobsen (2007a, 2007b) points out that aesthetic judgments include image integration and classified evaluation, with image integration coming first. In recent years, some researchers have studied the process of inner beauty-moral beauty judgments. Haidt et al. (2003a, 2003b) described moral beauty as the expression of humanity, virtue, and talents independent of perceivable physical forms, which is based on the understanding of social rules and is highly related to social emotions and social cognition. Wang et al. (2015) studied the process of moral beauty judgments using functional magnetic resonance imaging (fMRI) and found that moral beauty judgments activated the orbital frontal cortex (OFC), inferior temporal gyrus (ITG), and superior frontal gyrus (SFG). The OFC is related to emotional processing (Camille et al., 2004; Kringelbach, 2005); the IFG is related to visual processing (Ungerleider & Mishkin, 1982; Nobre et al., 1994; Vandenberghe et al., 1996); the SFG is related to cognitive appraisal processing (Moll et al., 2002; Greene et al., 2004; Heekeren et al., 2005; Jacobsen et al., 2006; Moll & de Oliveira-Souza, 2007). These studies showed that common processing occurred between moral beauty judgments and general beauty judgments, that is, among the perceived image, emotional evaluation, and cognitive reasoning.

In conclusion, though there are no studies directly investigating the differences or similarities between the processes of moral beauty and moral goodness have been published yet, previous studies in these two areas have achieved impressive results. Previous research found that the processing of moral goodness judgments (good and evil) primarily included cognitive and emotional processing (Haidt, 2008), while moral beauty judgments (beauty and ugliness) primarily included perceptual, cognitive, and emotional processing (Wang et al., 2015). Obviously, moral beauty judgments, but not moral goodness judgments, have the extra processing of the perceived image. Moral beauty judgments may start with image perception, while moral goodness judgments may start directly with cognition or emotion, which may be the most important difference between them. Based on these speculations, we mainly investigated whether image affects moral beauty judgments but not moral goodness judgments. In the present study, the basic experimental design was as follows: the participants completed moral beauty and moral goodness judgment tasks for the same positive social behavior of the same person. If the moral beauty judgment processing was affected by the person's image (attractive or unattractive), which was not manipulated in the moral goodness judgment condition, then we would obtain empirical evidence that the processes of moral beauty judgments and moral goodness judgments are different. Specifically, we used ERPs to explore the influence of image changes on moral beauty and moral goodness judgments. Event-related potentials is a direct measure of neural activity in response to a specific event. With its high temporal resolution and moderate capability for spatial localization, ERP analysis is useful to examine time-locked differences in the field of social cognition.

The current study focused on P2 and LPP. The P2 is a typical brain electrical component which reflects the stimulus materials for bottom-up perceptual processing, especially in the areas at the back of the brain and the parietal-occipital area. This perceptual processing not only involves the discrimination of a simple stimulus, but also integration of multiple characteristics (Luck & Hillyard, 1994a; Potts et al., 2006), reflecting high-level perceptual processing (Kranczioch et al., 2003). In the current study, we explored the separation condition of P2 in moral goodness judgments and moral beauty judgments with different face images (beautiful and ugly). We hypothesized that the process of moral beauty judgments starts with image perception, followed by cognitive and emotional processing, whereas the process of moral goodness judgments starts directly with cognitive and emotional processing. Hence, the separation tendency of P2 should be observed with beautiful and ugly faces in moral beauty judgments but not in moral goodness judgments. The LPP reflects the long slow wave in higher-order cognitive processes (Schupp et al., 2007), which includes cognitive evaluation, inference, and recall (Cacioppo et al., 1993, 1996; Crites & Cacioppo, 1996; Ito & Cacioppo, 2000). Because the perceived image is included in the process of moral beauty judgments, it may trigger the separation of the LPP. On the other hand, this separation will not happen in the process of moral goodness judgments.

MATERIALS AND METHODS

Participants

Forty-six (range: 18-23 years) right-handed college students were recruited as participants from South China Normal University. All participants had normal or corrected-to-normal vision. Participants were divided into two groups: 26 (14 women) participants for behavior experiments and 20 (10 women) participants for the electroencephalograph (EEG) experiments. The present study was approved by the Academic Committee of the School of Psychology of South China Normal University. Informed consent was obtained from all participants before the experiment and payment was made after the experiments.

Stimuli

Experimental materials consisted of 80 behavior scenarios (positive behaviors and negative behaviors, 40 each), 80 beautiful faces (male and female, 40 each), and 80 ugly faces (male and female, 40 each).

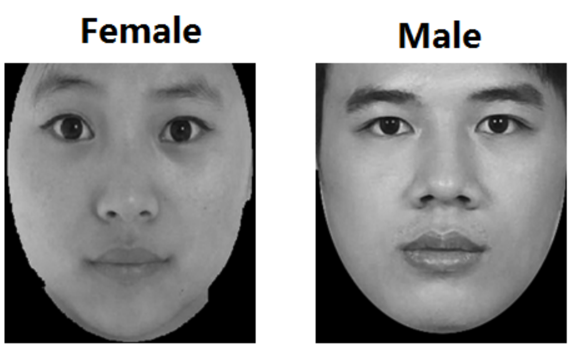

FIGURE 1.
Examples of face images.

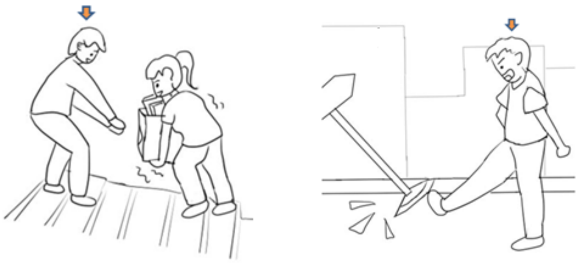

FIGURE 2.
Examples of scene materials.

METHODS OF SELECTING FACIAL IMAGE MATERIALS

Three hundred photographs of nonfamous human faces were selected from Chinese photographs. All were full-face pictures, gazing straight with only neutral facial expressions. We used Photoshop software to unify the standard of image processing, by removing the external characteristics of ears, hair, and neck, keeping only the characteristics of eyes, nose, and cheeks (see Figure 1). The photographs were digitized to grayscale and cropped to fit in an oval window of 202 × 225 px (visual angle = 2 °).

Eighty college students (range, 19–25 years) conducted a 9-point standardized assessment (1 = *very ugly*; 9 = *very beautiful*) of the photographs. According to the assessment results, we selected 80 beautiful faces (6.652 ± 0.038; male and female, 40 each) and 80 ugly faces (3.046 ± 0.013; male and female, 40 each, see Figure 1).

METHOD OF SELECTING BEHAVIOR SCENARIO MATERIALS

Referring to the previous study by Wang et al. (2015), we used sentences to describe individual positive and negative behaviors in daily life, for example, the boy helped the girl lift heavy weights, the girl refused to give way to the old man. Then, we drew the corresponding scenes using stick figures in black and white. We created 40 scenes reflecting positive behaviors (20 characters were women) and 40 scenes of negative behaviors (20 characters were women; see Figure 2). The stick figures were 598 × 500 px in size. In the preliminary experiments, we selected 18 college students to evaluate the scenarios' positive character on a 7-point scale and confirmed that the positive behavior scenes (5.278 ± 0.148) had higher positivity scores than the negative behavior scenes (2.383 ± 0.112).

The experiment consisted of 40 positive behavior scenes, 40 negative behavior scenes, 80 beautiful faces (male and female, 40 each), and 80 ugly faces (male and female, 40 each). We divided 40 positive behavior scenes into two groups (A and B). Every scene matched with a beautiful or ugly face to form four groups (first group: A scene + beautiful faces, 20; second group: A scenes + ugly faces, 20; third group: B scene + beautiful faces 20; fourth group: B scenes + ugly faces, 20). The matching process used a random method which yielded an equal number of men and women under various conditions. We put the first and fourth groups into Series 1, the second and third groups into Series 2, and the two series included 80 items as experimental materials. We put 40 negative behavior scenes into Series 3 and Series 4 in the same way, and these two series of materials included 80 items as filler materials.

Experimental Design and Procedure

We used a 2 × 2 two-factor within-subjects design; the first independent variable was judgment tasks, including moral beauty and moral goodness judgments. The second independent variable was face images, including beautiful faces and ugly faces.

The study was divided into Experiment 1 and 2. Experiment 1 was the behavior experiment. Twenty-six participants completed the tasks, then behavioral response data were collected. Experiment 2 was the EEG experiment. Twenty participants completed the tasks, similar to Experiment 1, and we collected brain electrical activity data and behavioral response data to compare with Experiment 1. The experiments were conducted individually, and each participant made moral goodness judgments or moral beauty judgments for both experiments. The participants were randomly divided into two sequential groups; participants in the first group were instructed to make moral goodness judgments for Series 1 (experimental materials) and Series 3 (filler materials) firstly (the series were randomly presented), and then make moral beauty judgments of Series 2 (experimental materials) and Series 4 (filler materials); participants in the second group were instructed to make moral beauty judgments of Series 2 (experimental materials) and Series 4 (filler materials) firstly and then make moral goodness judgments of Series 1 (experimental materials) and Series 3 (filler materials). The two tasks had the same experimental procedure but different instructions. That is, the order in which the two groups made moral beauty judgments and moral goodness judgments was reversed to balance the effects of material presentation order on the participants' ratings. The moral goodness judgment task required the participants to judge how good the character in the scenario's behavior was and the moral beauty judgment task required them to judge how beautiful the character in the scenario's behavior was.

The procedure was as follows: Before the experiment started officially, participants were informed of the task requirements and the entire procedure, emphasizing that the face image showed the character in the subsequent behavioral scene, which was marked by a red arrow. When the experiment started, participants sat in a soundproof room and focused on the center of the screen from about 100 cm away. Experiment 1 and 2 had the same procedure. As shown in Figure 3, each trial began with a 500 ms fixation followed by a 100–300 ms blank screen. Then, the face image was presented for 2 s, followed by randomly rendered 500–800 ms blank. After that, the scene drawing was presented for 2 s and the participants were prompted to respond as soon as possible. Afterwards, an empty screen was showed for 1 s. Experiment 1 was a behavior experiment, and we only collected behavioral response data. In Experiment 2, we also collected behavioral response data, but primarily focused on brain electrical activity data.

Event-Related Potential Recording and Analysis

The EEG data were recorded from 64 electrode sites (according to the International 10-20 system) using a NeuroScan system. The left mastoid was used as the online reference. The average of the right and left mastoids was used as the offline reference. The reference electrode was at the nasal tip. To monitor the eye movements, bipolar horizontal and vertical electrooculograms were recorded. All electrode impedances were kept below 5 kΩ. The sampling rate was 1000 Hz. The data were filtered online with a 0.05–100 Hz band pass and refiltered offline with a 0.01–30 Hz band pass. A Neuroscan 4.5 was used for offline analyses of EEG data and a regression procedure was performed to remove ocular artifacts. Based on the average reaction time, we selected 1000 ms as the epoch after the display of behavior scenario stimuli, and 100 ms prior to the onset of the stimuli (behavior scenarios) was used as the baseline.

Grand average ERPs were averaged for the four conditions beautiful faces + moral goodness judgments, ugly faces + moral goodness judgments, beautiful faces + moral beauty judgments, and ugly faces + moral beauty judgments. As is shown in the average map of the ERPs (see Figure 4), each condition elicited the N1 and P2 in the parietal-occipital area. Therefore, the average amplitudes of N1 (130-160ms) and P2 (180-250ms) were measured and analyzed. The following nine electrode sites were selected for the analyses of the P2 and N2 components: paretial (Pz, P3, and P4), parieto-occipital (PO3, POz, and PO4), and occipital (Oz, O3, and O4). After the N1 and P2, a LPP was elicited in the centro-parietal site. Therefore, the nine electrode sites from the central to the parietal were selected for the analyses, which included the central (C3, Cz, and C4), the centro-parietal (CPz, CP3, and CP4), and parietal (Pz, P3, and P4) sites (Abdel, 2011). A 2 × 2 (Image [beautiful, ugly] × Task [moral beauty, moral goodness]) repeated-measures analysis of variance (ANOVA) was performed on

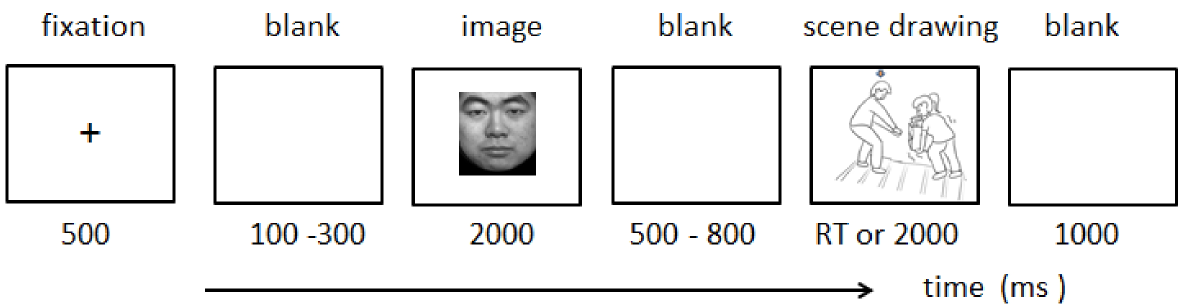

FIGURE 3.

Illustration of one experimental trial.

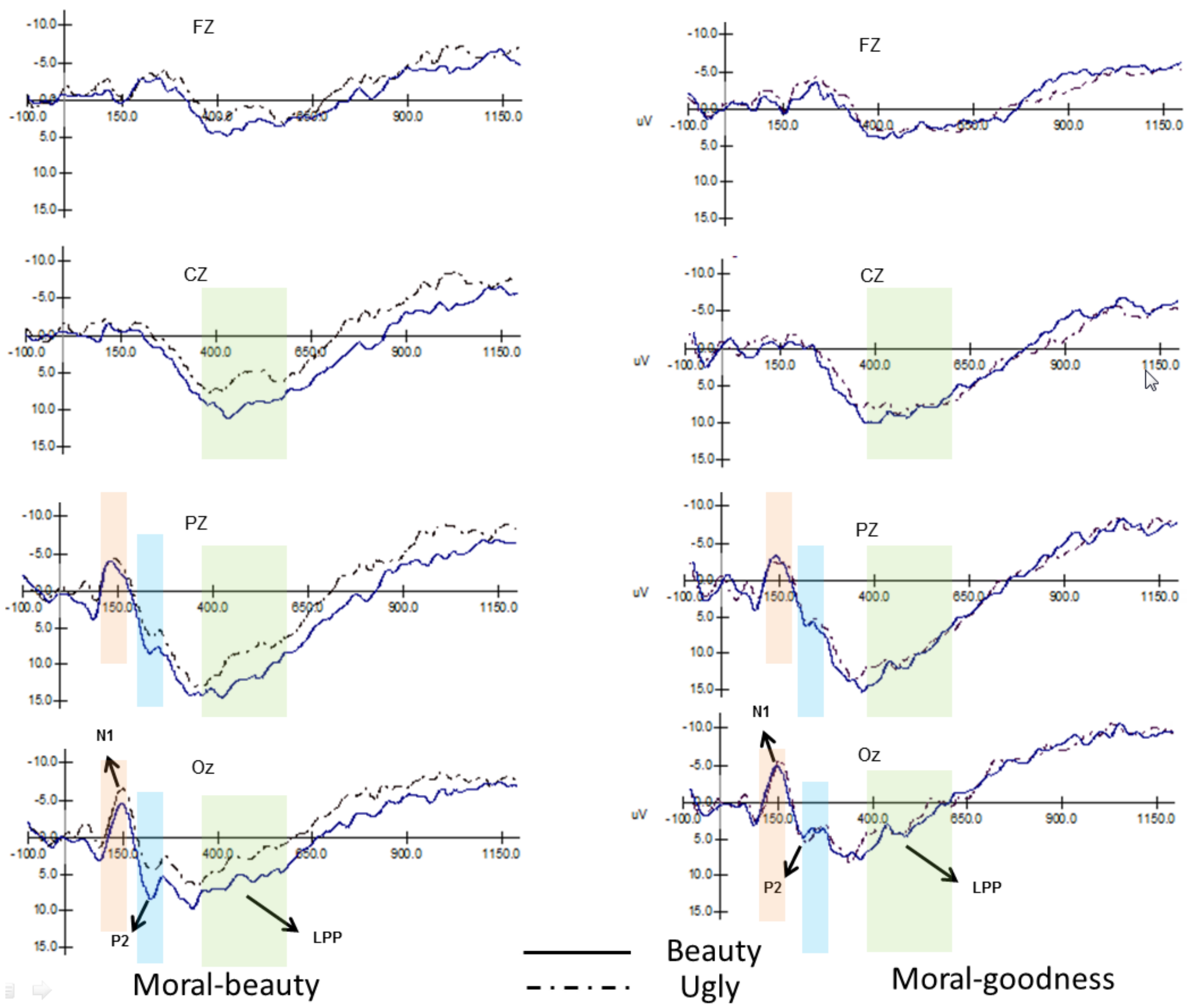

FIGURE 4.

The grand mean ERP waveforms induced by image (beautiful/ugly face) in the moral beauty and moral goodness judgment tasks at the Fz, Cz, Pz, and Oz electrode sites.

the mean amplitude of the N1, P2, and LPP using SPSS 17.0 software package (SPSS Inc., Chicago, Illinois, USA). For significant interactions, we further analyzed the simple effect of image (beautiful/ugly) in the two task conditions (moral beauty/moral goodness). All results used the Greenhouse-Geisser parameters to revise the *p* value and the Bonferroni-Holm method to correct for multiple testing.

RESULTS

Behavioral Results

We analyzed the behavioral data of 26 participants from Experiment 1. A 2 × 2 (Image [beautiful, ugly] × Task [moral beauty, moral goodness]) analysis on the score data demonstrated that the interaction between image and task was significant, $F(1, 25) = 9.629$, $p = .005$, $\eta^2 = 0.278$. Further analysis showed that for moral beauty judgments, the scores (5.97 ± 0.64) for beautiful faces were significantly higher (5.30 ± 0.61) than for ugly faces, $F(1, 25) = 15.742$, $p = .001$, $\eta^2 = 0.386$. However, we did not observe significant differences in scores between beautiful faces (5.68 ± 0.84) and ugly faces (5.61 ± 0.84) in the moral goodness judgments task, $F(1, 25) = 1.174$, $p = .289$, $\eta^2 = 0.045$.

Similarly, in the two-way ANOVA of the score data from the EEG experiment (behavior data of Experiment 2), we also found a significant interaction between image and task, $F(1, 19) = 7.285$, $p = .014$, $\eta^2 = 0.277$. Further analysis showed that the scores for beautiful faces (5.71 ± 0.67) were significantly higher than the scores for ugly faces (5.17 ± 0.65) in the moral beauty judgments task, $F(1, 19) = 41.294$, $p < .001$, $\eta^2 = 0.685$. Similar to Experiment 1, we also observed no significant differences in scores between beautiful faces (5.76 ± 0.58) and ugly faces (5.63 ± 0.82) in the moral goodness judgments task, $F(1, 19) = 0.940$, $p = .344$, $\eta^2 = 0.047$.

Event-Related Potential Data

N1

A three-factor repeated-measures ANOVA of task (moral beauty judgments, moral goodness judgments) × image (beautiful faces, ugly faces) × location (parietal, parietal-occipital, occipital) on N1 (130-

160ms) was performed. The results showed no significant interactions between task, image, and location, $F(2, 38) = 0.016$, $p = .927$, $\eta^2 = 0.001$, as well as between task and image, $F(1, 19) = 0.711$, $p = .410$, $\eta^2 = 0.036$. In addition, there was no main effect observed for either factor.

P2

A three-factor repeated-measures ANOVA of task (moral beauty judgments, moral goodness judgments) × image (beautiful faces, ugly faces) × location (parietal, parietal-occipital, occipital) on P2 (180-250ms) was performed. We found a significant interaction among the three factors, $F(2, 38) = 4.368$, $p = .031$, $\eta^2 = 0.187$. We further investigated the amplitude difference of face image on the P2 in the different brain areas in the two tasks. In moral beauty judgments, we found that beautiful faces induced more significant positive waves than ugly faces in the parietal, $F(1, 19) = 4.838$, $p = .040$, $\eta^2 = 0.203$, parieto-occipital, $F(1, 19) = 7.322$, $p = .014$, $\eta^2 = 0.278$, and occipital, $F(2, 38) = 7.310$, $p = .010$, $\eta^2 = 0.278$ areas. The closer to the occipital lobe, the greater the difference in the wave induced by beautiful and ugly faces. In the moral goodness judgments task, we observed no significant difference between beautiful and ugly face conditions in the parietal, $F(1, 19) = 0.124$, $p = .728$, $\eta^2 = 0.006$, parieto-occipital, $F(1, 19) = 0.002$, $p = .965$, $\eta^2 > 0.000$, and occipital, $F(2, 38) = 0.042$, $p = .840$, $\eta^2 = 0.002$.

LATE POSITIVE POTENTIAL

Similar to the P2 analyses, a three-way repeated-measures ANOVA (task × image × location) on LPP amplitudes was conducted. We only found a significant interaction between task and face, $F(1, 19) = 4.982$, $p = .038$, $\eta^2 = 0.208$. Further testing showed that in moral beauty judgments, beautiful faces induced more significant positive waves than ugly faces, $F(1, 19) = 10.618$, $p = .004$, $\eta^2 = 0.358$. However, for moral goodness judgments, we did not observe significant differences in LPP amplitudes between beautiful and ugly faces, $F(1, 19) = 0.454$, $p = .509$, $\eta^2 = 0.023$.

DISCUSSION

The behavioral results from Experiment 1 showed that participants tended to report significantly higher scores for beautiful than for ugly faces when performing moral beauty judgments. On the other hand, we did not observe score differences between beautiful and ugly face images during moral goodness judgments. This suggests that a beautiful face could improve moral beauty judgments relative to an ugly face, but a beautiful face cannot significantly improve moral goodness judgments relative to an ugly. The results of Experiment 1 thus confirmed that images of beautiful and ugly faces significantly affect moral beauty but not moral goodness judgments. Thus, the perceived image might affect moral beauty judgments but not moral goodness judgments. It is especially significant that the results of Experiment 1 were highly consistent with behavioral data from Experiment 2, which demonstrates that this result is very reliable and stable.

The ERP results from Experiment 2 showed that there were no significant interactions or main effects between the task, image, and location factors on N1. Previous studies have indicated that the combination of N1 and P2 usually reflects the visual encoding process of stimulation in the early stage (Näätänen, 1988; Kounios & Holcomb, 1992; Kutas & Hillyard, 1980), but they may play different roles in identifying the stimulus. Therefore, the present N1 result may simply reflect the fact that images have no effect on moral beauty judgments or moral goodness judgments in the early stage of identifying the stimuli. However, the P2 result, which may be regarded as the later stage of identifying the stimuli, shows significant interactions with task, image, and location factors. Especially in moral beauty judgments, the beautiful faces induced more positive significant P2 amplitudes than the ugly faces in the parietal and occipital areas. The closer to the occipital lobe, the greater the difference in the wave induced by beautiful and ugly faces, while there was no significant difference of P2 amplitude between beautiful faces and ugly faces in moral goodness judgments. Previous research showed that the P2 is a typical component reflecting bottom-up stimulus processing (Amodio, 2009; Hillyard & Kutas, 1983). It is worth noting that stimulus processing is not confined to stimulus recognition, but is based on a variety of stimulus features, indicating higher-level perceptual processing (Luck & Hillyard, 1994b; Potts et al., 2006; Kranczioch et al., 2003). Therefore, at this stage, the face images only affect the processing of moral beauty judgments within the time window of the P2, but they do not affect the processing of moral goodness judgments. This is probably because participants might conduct different perceptual integrations during the processing of the scenarios according to the different judgment tasks. That is, in the moral goodness judgment task, the participants only needed to form a kind of "outline" of the judged situation, which was exacted from the scenario and reflected the basic relationship describing ownership and event. They did not need to integrate image information. Therefore, the images (beautiful or ugly faces) had almost no effect during the moral goodness judgments. In the moral beauty judgment task, the participants were required to evaluate the degree of moral beauty and form a kind of "situation" (not only know that a person did this, but also to process the image of this person), which not only included the information of the basic relationship describing ownership and event, but also included the image information. Therefore, the processing of moral beauty judgments was affected by different images. This explanation is also supported by previous research on aesthetic theory, which has indicated that the processing of beauty involves perceiving the images (Berlyne, 1971; Cupchik, 2002; Winston et al., 2007). As a kind of beauty, moral beauty judgment processing also needs to integrate images, and was this affected by the images in the present study. More importantly, our viewpoint of forming the "situation" with image information at the beginning of the perception process in the moral beauty judgment task was also supported by the aesthetic processing two-stage theory (Höfel & Jacobsen, 2007a, 2007b; Jacobsen & Höfel, 2003). This theory suggests that aesthetic judgments can be divided into two stages, image integration and classified evaluation. In the present study, the difference in P2 between the moral beauty judgment task demonstrated that moral beauty judgments need to integrate images, which is consistent with this theory. That is to say, the individual needs face-based intention integration in the judgment of moral beauty, but there is no such integration process in the judgment of moral goodness. As a result, the P2, which reflects integrated processing, is separated during the moral beauty judgment due to the difference between beautiful and ugly faces.

Within the 350–600 ms time window of moral beauty judgments, we also found that beautiful faces induced more positive significant LPP amplitudes in the central-parietal areas than ugly faces , but we observed no significant differences in the LPP amplitudes between beautiful and ugly faces in moral goodness judgments. The LPP is the late positive slow wave, which generally reflects higher-level cognitive processing such as reasoning, decision-making, and recall (Schupp et al., 2006, 2007; Ito & Cacioppo, 2000; Qin & Han, 2009). In addition, previous studies have proved that moral goodness and moral beauty judgments should both have the common stage of cognitive reasoning. For example, Greene and Haidt (2002) carried out a meta-analysis of fMRI research on moral goodness judgments and found that the DLPFC was one of the important brain areas of moral goodness judgments, and this area was mainly responsible for central cognition. In addition, Wang et al. (2015) found that the SFG was activated during moral beauty judgments, and it overlapped with DLPFC. Thus, the LPP mainly reflects cognitive reasoning in moral goodness or moral beauty judgments. That is, the LPP reflects the cognitive inference processing based on scene information formed in the perceptual stage. In the moral beauty judgment task, as the individual forms a "situation" including image information (beautiful or ugly face) in the perceptual stage, it produces a separation of the LPP in the cognitive reference stage. In the moral goodness judgment task, as the individual forms an "outline" in the perceptual stage, the entity image was already "filtered" in the outline and thus does not affect moral goodness judgments in the perceptual stage. Hence, no image information participates in the cognitive processing. Therefore, it does not produce a separation of the LPP under the different conditions of beautiful and ugly faces. In this part, according to the analyses of amplitude differences of the LPP under different conditions, we further confirmed the basic assumption that moral beauty judgments involve images but moral goodness judgments do not.

In summary, based on the results of the P2 and LPP analyses, we further propose the following for the processing of moral beauty judgments. The first stage is the perceptual formation, which involves forming a situation including the image information of the stimulus. Then, this situation is involved in cognitive reasoning. Therefore, the image is involved in cognitive inference. However, although moral goodness judgments had the same process as moral beauty judgments, they involve forming a kind of outline which reflects the relationship of ownership and event in the perceptual stage. This outline is then processed in the cognitive inference stage. Therefore, the stimulus images are not involved in moral cognitive inference in moral goodness judgments. Therefore, one of the important differences between moral beauty and moral goodness judgments is whether images are involved in the entire process.

CONCLUSION

In conclusion, to our best knowledge, this is the first study exploring whether moral beauty and moral goodness judgments involve the same or different processing. The current study suggests that when participants are required to separately evaluate the same behavior materials for moral goodness or moral beauty judgments, beautiful or ugly faces have a different impact on cognitive processing in the two tasks. Specifically, image is involved in moral beauty but not moral goodness judgments. Therefore, we can conclude that moral beauty and moral goodness judgments involve different cognitive processes with different linguistic labels, although they usually refer to the same human act. In addition, the biggest difference is in the involvement of image information in the entire process. However, the results of this study are not enough to resolve this significant problem and more future research studies are required before definite conclusions can be drawn.

ACKNOWLEDGEMENTS

Conflict of interest. The authors declare no conflict of interest

Ethical approval. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The current study was approved by Research Ethics Committee of the Institute of Psychology of The John Paul II Catholic University of Lublin.

Informed consent. Written informed consent was obtained from all individual participants included in the study prior to data collection.

The authors would like to thank Lei Mo, Tingting Wang, and Qiulin Luo for their extremely helpful comments on earlier drafts of this manuscript.

FUNDING

This work was supported by grants from the project by Humanities and Social Sciences of Ministry of Education Foundation of China (18YJC190025, Project Name: Neural Correlation Mechanism between Beauty and Goodnesspt.

DECLARATION OF CONFLICTING INTERESTS

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this manuscript.

REFERENCES

Abdel, R. R. (2011). Facing good and evil: Early brain signatures of affective biographical knowledge in face recognition. *Emotion, 11*, 1397–1405. doi: 10.1037/a0024717

Amodio, D. M. (2009). Intergroup anxiety effects on the control of racial stereotypes: A psychoneuroendocrine analysis. *Journal of Experimental Social Psychology, 45*, 60–67. doi: 10.1016/j.jesp.2008.08.009

Berlyne, D. E. (1971). *Aesthetics and psychology*. Appleton Century Crofts.

Camille, N., Coricelli, G., Sallet, J., Pradat-Diehl, P., Duhamel, J. R., & Sirigu, A. (2004, May). The involvement of the orbitofrontal cortex in the experience of regret. *Science, 304*, 1167–1170. doi: 10.1126/science.1094550

Cacioppo, J. T., Priester, J. R., & Berntson, G. G. (1993). Rudimentary determinants of attitudes: II. Arm flexion and extension have differential effects on attitudes. *Journal of Personality and Social Psychology, 65*, 5–17. doi: 10.1037/0022-3514.65.1.5

Cacioppo, J. T., Petty, R. E., Feinstein, J. A., & Jarvis, W. B. G. (1996). Dispositional differences in cognitive motivation: The life and times of individuals varying in need for cognition. *Psychological Bulletin, 119*, 197–253. doi: 10.1037/0033-2909.119.2.197

Crites, S. L., & Cacioppo, J. T. (1996). Electrocortical differentiation of evaluative and nonevaluative categorizations. *Psychological Science, 7*, 318–321. doi: 10.1111/j.1467-9280.1996.tb00381.x

Cupchik, G. C. (2002). The evolution of psychical distance as an aesthetic concept. *Culture & Psychology, 8*, 155–187. doi: 10.1177/1354067X02008002437

Gan, T., Lu, X., Li, W., Gui, D., Tang, H., & Mai, X., et al. (2015). Temporal dynamics of the integration of intention and outcome in harmful and helpful moral judgment. *Frontiers in Psychology, 6*, 3–40. doi: 10.3389/fpsyg.2015.02022

Greene, J. D., Sommerville, R. B., Nystrom, L. E., Darley, J. M., & Cohen, J. D. (2001, September). An fMRI investigation of emotional engagement in moral judgment. *Science, 293*, 2105–2108. doi: 10.1126/science.1062872

Greene, J., & Haidt, J. (2002). How (and where) does moral judgment work? *Trends in Cognitive Sciences, 6*, 517–523. doi: 10.1016/S1364-6613(02)02011-9

Greene, J. D. (2003). From neural'is' to moral'ought': what are the moral implications of neuroscientific moral psychology? *Nature Reviews Neuroscience, 4*, 846–850. doi: 10.1038/nrn1224

Greene, J. D., Nystrom, L. E., Engell, A. D., Darley, J. M., & Cohen, J. D. (2004). The neural bases of cognitive conflict and control in moral judgment. *Neuron, 44*, 389–400. doi: 10.1016/j.neuron.2004.09.027

Greene, J. D., Morelli, S. A., Lowenberg, K., Nystrom, L. E., & Cohen, J. D. (2008). Cognitive load selectively interferes with utilitarian moral judgment. *Cognition, 107*, 1144–1154. doi: 10.1016/j.cognition.2007.11.004

Haidt, J. (2001). The emotional dog and its rational tail: a social intuitionist approach to moral judgment. *Psychological Review, 108*, 814–834. doi: 10.1037/0033-295X.108.4.814

Haidt, J. (2003a). The moral emotions. In: R. J. Davidson, K. R. Scherer, & H. H. Goldsmith (Eds.), *Handbook of affective sciences* (pp. 852–870). Oxford University Press.

Haidt, J. (2003b). Elevation and the positive psychology of morality. In C. L. M. Keyes & J. Haidt (Eds.), *Flourishing: Positive psychology and the life well-lived* (pp. 275–289). American Psychological Association.

Haidt, J., & Joseph, C. (2004). Intuitive ethics: How innately prepared intuitions generate culturally variable virtues. *Daedalus, 133*, 55-66. doi: 10.1162/0011526042365555

Haidt, J. (2007, May). The new synthesis in moral psychology. *Science, 316*, 998–1002. doi: 10.1126/science.1137651

Haidt, J. (2008). Morality. *Perspectives on Psychological Science, 3*, 65–72. doi: 10.1111/j.1745-6916.2008.00063.x

Heekeren, H. R., Wartenburger, I., Schmidt, H., Prehn, K., Schwintowski, H. P., & Villringer, A. (2005). Influence of bodily harm on neural correlates of semantic and moral decision-making. *Neuroimage, 24*, 887–897. doi: 10.1016/j.neuroimage.2004.09.026

Hillyard, S. A., & Kutas, M. (1983). Electrophysiology of cognitive processing. *Annual Review of Psychology, 34*, 33–61.

Höfel, L., & Jacobsen, T. (2007a). Electrophysiological indices of processing aesthetics: Spontaneous or intentional processes? *International Journal of Psychophysiology, 65*, 20–31. doi: 10.1016/j.ijpsycho.2007.02.007

Höfel, L., & Jacobsen, T. (2007b). Electrophysiological indices of processing symmetry and aesthetics: A result of judgment categorization or judgment report? *Journal of Psychophysiology, 21*, 9–21. doi: 10.1027/0269-8803.21.1.9

Ito, T. A., & Cacioppo, J. T. (2000). Electrophysiological evidence of implicit and explicit categorization processes. *Journal of Experimental Social Psychology, 36*, 660–676. doi: 10.1006/jesp.2000.1430

Jacobsen, T., & Höfel, L. (2003). Descriptive and evaluative judgment processes: behavioral and electrophysiological indices of processing symmetry and aesthetics. *Cognitive, Affective, & Behavioral Neuroscience, 3*, 289–299. doi: 10.3758/CABN.3.4.289

Jacobsen, T., Schubotz, R. I., Höfel, L., & Cramon, D. Y. V. (2006). Brain correlates of aesthetic judgment of beauty. *Neuroimage, 29*, 276–285. doi: 10.1016/j.neuroimage.2005.07.010

Kutas, M., & Hillyard, S. A. (1980, January). Reading senseless sentences: Brain potentials reflect semantic incongruity. *Science, 207*, 203–205. doi: 10.1126/science.7350657

Kohlberg, L. (1981). *The philosophy of moral development moral stages and the idea of justice*. Harper & Row.

Kounios, J., & Holcomb, P. J. (1992). Structure and process in semantic memory: Evidence from event-related brain potentials and reaction times. *Journal of Experimental Psychology: General, 121*, 459–479. doi: 10.1037/0096-3445.121.4.459

Kranczioch, C., Debener, S., & Engel, A. K. (2003). Event-related potential correlates of the attentional blink phenomenon. *Cognitive Brain Research, 17*, 177–187. doi: 10.1016/S0926-6410(03)00092-2

Kringelbach, M. L. (2005). The human orbitofrontal cortex: linking reward to hedonic experience. *Nature Reviews Neuroscience, 6*, 691–702. doi: 10.1038/nrn1747

Leuthold, H., Kunkel, A., Mackenzie, I. G., & Filik, R. (2015). Online processing of moral transgressions: erp evidence for spontaneous evaluation. *Social Cognitive & Affective Neuroscience, 10*, 1021–1029. doi: 10.1093/scan/nsu151

Luck, S. J., & Hillyard, S. A. (1994a). Electrophysiological correlates of feature analysis during visual search. *Psychophysiology, 31*, 291–308. doi: 10.1111/j.1469-8986.1994.tb02218.x

Luck, S. J., & Hillyard, S. A. (1994b). Spatial filtering during visual search: evidence from human electrophysiology. *Journal of Experimental Psychology: Human Perception and Performance, 20*, 1000–1014. doi: 10.1037/0096-1523.20.5.1000

Moll, J., & de Oliveira-Souza, R. (2007). Moral judgments, emotions and the utilitarian brain. *Trends in Cognitive Sciences, 11*, 319–321. doi: 10.1016/j.tics.2007.06.001

Moll, J., de Oliveira-Souza, R., Bramati, I. E., & Grafman, J. (2002). Functional networks in emotional moral and nonmoral social judgments. *Neuroimage, 16*, 696–703. doi: 10.1006/nimg.2002.1118

Näätänen, R. K. (1988). Implications of the ERPs data for psychological theories of attention. *Biological Psychology, 26,* 117–163. doi: 10.1016/0301-0511(88)90017-8

Nobre, A. C., Allison, T., & McCarthy, G. (1994). Word recognition in the human inferior temporal lobe. *Nature, 372*, 260–263. doi: 10.1038/372260a0

Peng, X., Jiao, C., Cui, F., Chen, Q., Li, P., & Li, H. (2017). The time course of indirect moral judgment in gossip processing modulated by different agents. Psychophysiology, 54, 1459–1471. doi: 10.1111/psyp.12893

Pochon, J. B., Riis, J., Sanfey, A. G., Nystrom, L. E., & Cohen, J. D. (2008). Functional imaging of decision conflict. *The Journal of Neuroscience, 28*, 3468–3473. doi: 10.1523/JNEUROSCI.4195-07.2008

Potts, G. F., Martin, L. E., Burton, P., & Montague, P. R. (2006). When things are better or worse than expected: The medial frontal cortex and the allocation of processing resources. *Journal of Cognitive Neuroscience, 18*, 1112–1119. doi: 10.1162/jocn.2006.18.7.1112

Qin, J., & Han, S. (2009). Neurocognitive mechanisms underlying identification of environmental risks. *Neuropsychologia, 47*, 397–405. doi: 10.1016/j.neuropsychologia.2008.09.010

Ross, R., Glomset, J., Kariya, B., & Harker, L. (1974). A platelet-dependent serum factor that stimulates the proliferation of arterial smooth muscle cells in vitro. *Proceedings of the National Academy of Sciences, 71*, 1207-1210. doi: 10.1073/pnas.71.4.1207

Schupp, H. T., Flaisch, T., Stockburger, J., & Junghöfer, M. (2006). Emotion and attention: event-related brain potential studies. *Progress in Brain Research, 156*, 31–51. doi: 10.1016/S0079-6123(06)56002-9

Schupp, H. T., Stockburger, J., Codispoti, M., Junghöfer, M., Weike, A. I., & Hamm, A. O. (2007). Selective visual attention to emotion. *The Journal of Neuroscience, 27*, 1082–1089. doi: 10.1523/JNEUROSCI.3223-06.2007

Ungerleider, L. G., & Mishkin, M. (1982). Two cortical visual systems. In D. K. Ingle, M. A. Goodale, & R. J. W. Mansfield (Eds.), *Analysis of visual behavior* (pp. 549–586), MIT Press.

Vandenberghe, R., Price, C., Wise, R., Josephs, O., & Frackowiak, R. S. (1996). Functional anatomy of a common semantic system for words and pictures. *Nature, 383*, 254–256. doi: 10.1038/383254a0

Wang, T., Mo, L., Mo, C., Tan, L. H., Cant, J. S., Zhong, L., & Cupchik, G. (2015). Is moral beauty different from facial beauty? Evidence from an fMRI study. *Social Cognitive and Affective Neuroscience, 10*, 814–823. doi: 10.1093/scan/nsu123

Winston, J. S., O'Doherty, J., Kilner, J. M., Perrett, D. I., & Dolan, R. J. (2007). Brain systems for assessing facial attractiveness. *Neuropsychologia, 45*, 195–206. doi: 10.1016/j.neuropsychologia.2006.05.009

RECEIVED 05.07.2018 | ACCEPTED 25.03.2020