The left-side bias is not unique to own-race face processing

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Abstract
Humans show a clear left-side bias in face processing. A chimeric face constructed with the left side (from the viewer's perspective) of a face and its mirror image is usually rated as more resemblant to the original face than a chimeric face constructed with the right side of the same face. Previous studies have characterized the left-side bias mainly with own-race faces, but it remains unclear whether this effect is race specific or if it reflects an universal visual expertise. One hundred and five Chinese students completed two versions of a chimeric face-identification task. The results revealed a significant left-side bias for both own-race (Chinese) and other-race (Caucasian) faces, suggesting that the left-side bias reflects an universal visual expertise in face processing.

Introduction

Faces convey information critical for social interactions. When viewing chimeric faces created from one side of a real face and its mirror image, humans tend to report that a chimeric face created from the left half is more resemblant to the real face (e.g., Brady et al., 2005; Gilbert & Bakan, 1973; Li & Cao, 2017; Proietti et al., 2015). This behavioural effect is frequently referred to as the "left-side bias." First discovered by Wolff (1933) with a facial expression judgment task, the left-side bias is a robust behavioral effect that has been observed in a variety of face tasks. For instance, Gilbert and Bakan (1973) reported a stable left-side bias in a facial identity task, and similar effects have been reported in other face tasks, like emotion recognition (e.g., Bourne, 2008, 2011; Coolican et al., 2008; David, 1993; Ferber & Murray, 2005), gender judgment (e.g., Butler & Harvey, 2005, 2008; Luh et al.,

1991), and age estimation and attractiveness rating (e.g., Burt & Perrett, 1997; Heath et al., 2005). Eye-tracking studies have also shown that the first fixation is more likely to land on the left side of faces during visual exploration of both static and dynamic faces (e.g., Everdell et al., 2007; Guo et al., 2012; Hsiao et al., 2008; Leonards & Scott-Samuel, 2005; Samson et al., 2014). Developmental studies have shown that the left-side bias exists in children and young adults (Failla et al., 2003). The development trajectory of this perceptual bias varies across tasks; overall, it emerges early in life (around 5 years old) and reaches adult level by about 11 years old (e.g., Aljuhanay et al., 2010; Balas & Moulson, 2011; Proietti et al., 2015). In line with these behavioral findings, the left-side bias in face processing has also been reported in neuroimaging studies. For instance, Yovel et al. (2003) found the latency of a face-sensitive event-related potential component (N170) is shorter when viewing the left side of a face than when viewing the right side. The asymmetric activation of the fusiform face area has also been linked to the left-side bias in face recognition (Yovel et al., 2008). Based on these behavioral, developmental, and neuroimaging findings, researchers have suggested that the left-side bias is a behavioral manifestation of perceptual expertise (e.g., Hsiao & Cottrell, 2009; Li & Cao, 2017; Proietti et al., 2015; for a review, see Yovel, 2016).

Face recognition is affected by the racial information of faces. One good example is the other-race effect (i.e., human adults show a significant behavioral impairment in processing other-race faces compared with own-race faces; the accuracy in identifying other-race faces is typically lower). Malpass and

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Kravitz (1969) were the first to discover the other-race effect in a face recognition task, and two theories have been proposed to explain the other-race effect. The experience-based "contact hypothesis" states that people process own-race faces more efficiently because frequent and intense social contacts lead to a higher level of perceptual skills in processing own-race facial traits. Rossion and Michel (2011) proposed this theory to explain the reduced holistic (or configural) processing of other-race faces (Michel, Caldara, et al., 2006; Michel, Rossion, et al., 2006; Tanaka et al., 2004) and the reduced sensitivity to face properties and the relative distances between face features (Hayward et al., 2008; Rhodes et al., 2006). This theory is in line with the notion that faces are encoded in a multidimensional space. The face dimensions are tuned to quickly discriminate between faces we frequently meet in our daily life (i.e., own-race faces), but are inappropriate for distinguishing the details of other-race faces (Valentine, 1991; Valentine et al., 2016). The sociocognitive account, or the "attentional hypothesis," claims that humans categorize faces as ingroup and outgroup from a social cognition perspective. Outgroup (other-race) faces are only processed at a categorical level, but ingroup (own-race) faces are processed in depth and details, resulting in an advantage in own-race face processing (Rodin, 1987; Sporer, 2001). Hugenberg and colleagues integrated this proposal into a "categorization-individuation model" by suggesting that perceiver motivation can modulate the own-race and other-race face processing (Hugenberg & Corneille, 2009; Hugenberg et al., 2013). In particular, perceiver motivation can affect the distribution of attention to own-race and other-race faces. For example, eye-tracking studies provided converging evidence that own-race faces capture attention more easily than do other-race faces (Cao et al., 2013; Palermo & Rhodes, 2007).

In addition to the left-side bias, the inversion effect (e.g., Haxby et al., 1999; Yin, 1969) and the composite effect (e.g., Young et al., 1987; for a review, see Richler & Gauthier, 2014) are also well-known behavioral markers for visual expertise. Previous studies have reported the inversion effect (e.g., Hancock & Rhodes, 2008; Rhodes et al., 1989; Valentine, 1991) and the composite effect (e.g., Harrison et al., 2014; Horry et al., 2015; Hugenberg & Corneille, 2009; Michel, Caldara, et al., 2006; Michel, Rossion, et al., 2006) for both own-race and other-race faces. There is empirical evidence that the inversion effect is stronger for own-race than for other-race faces (e.g., Hancock & Rhodes, 2008; Rhodes et al., 1989; Sangrigoli & De Schonen, 2004). However, relevant findings in the literatures were inconclusive, with some studies revealing exactly the opposite pattern of results (Valentine, 1991; Valentine & Bruce, 1986). Inconsistent findings of racial information processing have also been reported for the composite effect. For instance, the composite effect for own-race faces is stronger than that of other-race faces in partial paradigms (Hugenberg & Corneille,

2009; Michel, Caldara, et al., 2006; Michel, Rossion, et al., 2006); the magnitude of this effect however, is similar for other-race and own-race faces in complete paradigms (e.g., Bukach et al., 2012; Harrison et al., 2014; Horry et al., 2015). Although the influence of racial information to other face expertise effects (inversion and composite effect) was inconsistent, it is clear that both the inversion and composite effects are modulated by the race of faces, and importantly, neither effect is specific to own-race faces.

To the best of our knowledge, few studies have examined the influence of racial information on the left-side bias in face processing. It remains unclear whether the left-side bias is an own-race specific effect. The present study set out to clear up this issue with the classic facial identity task (e.g., Brady et al., 2005; Coolican et al., 2008). Two experiments were carried out to examine the left bias in Chinese adults, with both Chinese and Caucasian faces. Based on previous findings on the inversion and composite effects, we expect to observe the left-side bias for both own-race and other-race faces. If the left-side bias is observed for own-race faces only, it would suggest that the left-side bias represents a face processing expertise that is specific to own-race faces.

Method

The research protocols reported here were approved by an ethics committee at Zhejiang Normal University, and written informed consent was obtained from all participants.

Two experiments were carried out to examine the left-side bias with a facial identification task, in which left-chimeric
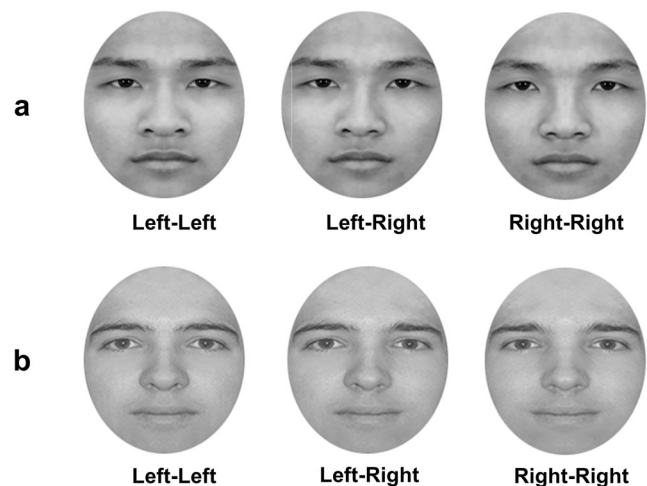
Fig. 1 Sample Chinese (**a**) and Caucasian (**b**) face images used in the chimeric face judgment task. The label "Left-Right" denotes the original face image, whereas the labels "Left-Left" and "Right-Right" denote chimeric face images constructed from the left and right side of the original face, respectively. The individuals in these example face images have all given us permission to use their photos in academic publications

and right-chimeric faces were presented on the screen, together with the original face, and the participant reported which chimeric face was more resemblant to the original face (see Fig. 1). The original face was the same size as the left-chimeric and right-chimeric faces in Experiment 1. The size of the original face was increased by 10% in Experiment 2 to rule out the possibility that the participants may have adopted a feature-comparison or pixel-wise matching strategy when comparing the chimeric faces with the original face (Kaiser et al., 2013; Towler & Eimer, 2016). Other than that, the design and task procedures were the same for both experiments. In both experiments, two separate groups of participants were tested with upright and inverted chimeric faces, respectively.

Participants

In a recent study by Li and Cao (2017), the reported effect size for the left-side was $d = 0.4$. To reproduce a similar effect, 32 participants were required to achieve a power of 0.8, at an alpha level of 0.05 (G*Power 3; Faul et al., 2007). In Experiment 1, the participants were 54 healthy Chinese students from Zhejiang Normal University (age range 18–26 years; $M = 20.5$ years, $SD = 1.77$; 38 females). Twenty-seven participants were allocated to the upright chimeric face task and the rest to the inverted chimeric face task. In Experiment 2, another 51 healthy university students were tested. Twenty-five of these participants were allocated to the upright chimeric face task and the rest to the inverted chimeric face task. Three participants did not complete the task in Experiment 2. Twenty-four participants from the upright chimeric face task ($M = 19.6$ years, $SD = 1.35$; 17 females) and 24 participants from the inverted chimeric face task ($M = 19.7$ years, $SD = 1.57$; 17 females) were included in the statistical analysis. All participants were right-handed and reported normal or corrected-to-normal visual acuity; they received monetary compensation for their participation.

As noted, two experiments were conducted in this study, with the only methodological difference being that the reference face was 10% larger in Experiment 2. When an omnibus analysis of variance (ANOVA) revealed no main effect or interaction involving experiment (Experiment 1 vs. 2), the data from both experiments were combined to increase power.

The combined data set had 51 participants for each of the face inversion conditions (upright vs. inverted). This gave this study more than enough power to detect the left-side bias reported in previous findings (e.g., Li & Cao, 2017).

Stimuli

Forty grayscale images of Chinese faces (20 female faces) were selected from the face images used in Li and Cao (2017), and 40 grayscale images of Caucasian faces (20 female faces) were selected from the face images from another laboratory (Fu et al., 2012). All face images displayed a neutral facial expression. These face images were cropped to fit a unitary oval frame to remove external features (e.g., hair, ears, jawline). To investigate the left-side bias in face processing, the chimeric face images were created with the same procedure as Li and Cao (2017). The original face images were bisected along the vertical midline into left and right halves, and each half was then combined with its mirror image to create a chimeric face. Thus, each original face yielded one left and one right chimeric face. The final set of images included 80 original faces and 160 chimeric faces. In the inverted face tasks, all images were the same, but flipped upside down (see Fig. 1, for example, with written permission from the persons in the photos). All face images subtended 6° × 7° from a viewing distance of 55 cm. The size of the original face was increased by 10% in Experiment 2 to discourage the participants from adopting a feature-comparison or pixel-wise matching strategy.

Task procedure

Participants sat in a comfortable chair at a distance of 55 cm from a 17-inch CRT monitor (resolution: 1,024 × 768-pixel; refresh rate: 60 Hz) in a dimly lit room. All stimuli were presented against a light-gray background. E-Prime 2.0 (Psychology Software Tools, Pittsburgh, PA) was used for stimulus presentation and behavioral response registration. In both experiments, two groups of participants were randomly assigned to the upright and inverted chimeric face tasks. In both tasks, the participants completed two runs of trials, for the Chinese and Caucasian faces, respectively. These two runs of trials were counterbalanced across participants.

1000 ms　　**500 ms**　　**response**　　**1000 ms**
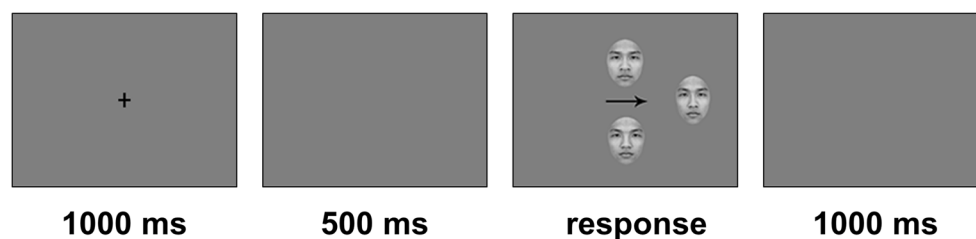
Fig. 2 The sequence of events in a sample trial. Upright-chimeric faces are shown in this illustration. The trial event sequence was the same for the inverted-chimeric face task

The task procedure was the same as Li and Cao (2017), and an example trial with upright chimeric faces is illustrated in Fig. 2. The original face, the left-chimeric and right-chimeric faces are simultaneously presented on the screen, and the participant was required to report which chimeric face was more resemblant to the original face. The original face could appear on the left or right side of the screen, while the left-chimeric and right-chimeric faces were equally likely to appear above or below the screen center. So, there were four possible screen configurations: original face (on the left or right side) × chimeric faces (with the left-chimeric face above and the right-chimeric face below screen center, or vice versa). Each screen configuration was tested for 40 trials, giving us a total of 160 trials. These 160 trials were randomly allocated to four blocks of 40 trials.

On each trial, a central fixation cross was first presented for 1,000 ms, followed by a blank screen of 500 ms and a face screen with the original face and the corresponding left-chimeric and right-chimeric faces. In the face screen, the original face randomly appeared on the left or right side of the screen, 7.5° from the screen center; the two chimeric faces appeared above and below a central arrow, which pointed towards the original image. The edge-to-edge distance between the chimeric faces was 6° (see Fig. 2). The face screen persisted until the participant pressed the "u" or "v" key on the keyboard to indicate the upper or lower chimeric face was more resemblant to the original face.

Design and analysis

Experiments 1 and 2 both adopted a three-factor mixed design. The within-subjects variables were the race of the face stimuli (Chinese vs. Caucasian) and the location of the original faces (in left or right visual field), and the between-subjects variable was the orientation of the face (upright vs. inverted). The dependent measure of interest was the left/right (L/R) asymmetry score. For each trial, the response was designated as left-biased if the participant chose the left chimeric face and right-biased if the participant chose the right chimeric face. The left/right (L/R) asymmetry score was calculated as the number of trials in which the participants chose the left chimeric face minus that of trials in which the participants chose the right chimeric face, divided by the total number of trials (cf. Coolican et al., 2008). Thus, the left/right (L/R) asymmetry score ranged from −1 to +1. A score of 0 indicates no bias, and a score that is significantly greater or less than 0 indicates left-side and right-side bias, respectively. There is no time pressure in the chimeric face identity task, but for completeness, we also report the analysis of response times in Supplemental Materials.

To avoid accidentally rejecting the null hypothesis, Bayesian statistics were also reported in the present paper. Here, we report inclusion Bayes factors (BF), which quantify the evidence in the data for including a predictor in a model (van den Bergh et al., 2020). For a straightforward

interpretation of the main effects and interactions in a multi-factor design. We compared only "matched" models. This model comparison approach was suggested by Sebastiaan Mathôdand it is now available in JASP (JASP Team, 2020). With this approach, the inclusion of Bayes factor for an interaction effect is the ratio between models with an interaction effect against models with the same predictors, except for the interaction effect. To present the results in a concise format, inclusion BFs are presented alongside the ANOVA and t-test results.

Results

As noted above, both experiments adopted a 2 (race: Chinese vs. Caucasian) × 2 (original face location: left vs. right visual field) × 2 (face orientation: upright vs. inverted) mixed design. To examine if the size of the original face (10% larger in Experiment 2) had any impact on different tasks, experiment (Experiment 1 vs. Experiment 2) was included as a factor in the omnibus ANOVA on the L/R asymmetry score.

The results revealed a significant main effect of race (Chinese vs. Caucasian), $F(1, 98) = 10.166$, $p = .002$, $\eta_p^2 = 0.094$, $BF_{10} = 112.996$, with more positive L/R asymmetry scores observed for Caucasian ($M = 0.04$, $SD = 0.18$) than for Chinese faces ($M = −0.01$, $SD = 0.18$). There was a significant main effect of orientation (upright vs. inverted), $F(1, 98) = 4.794$, $p = .031$, $\eta_p^2 = 0.047$, $BF_{10} = 1.996$, reflecting the fact that the L/R asymmetry score was more positive for upright ($M = 0.05$, $SD = 0.17$) than for inverted ($M = −0.02$, $SD = 0.17$) faces. There was a significant main effect of the location of original face (left vs. right visual field), $F(1, 98) = 11.182$, $p = .001$, $\eta_p^2 = 0.102$, $BF_{10} = 16.908$; with higher L/R asymmetry scores observed when the original faces were presented in the left ($M = 0.04$, $SD = 0.18$) than in the right visual field ($M = 0.00$, $SD = 0.17$). The two-way interaction between race and orientation was significant, $F(1, 98) = 5.493$, $p = .021$, $\eta_p^2 = 0.053$, $BF_{10} = 6.288$. Post hoc contrasts revealed that, in the upright face task, the L/R asymmetry score was largely the same for Chinese faces ($M = 0.05$, $SD = 0.19$) and Caucasian faces ($M = 0.06$, $SD = 0.19$), $t(50) = 0.706$, $p = .552$, Cohen's $d = 0.10$, $BF_{10} = 0.193$. In the inverted face task, however, the L/R asymmetry score was more positive for Caucasian faces ($M = 0.02$, $SD = 0.19$) than for Chinese faces ($M = −0.06$, $SD = 0.19$) faces, $t(50) = 3.498$, $p < .001$, Cohen's $d = 0.35$, $BF_{10} = 28.428$. No main effect or interaction involving experiment (Experiment 1 vs. 2) was significant, all Fs < 1.418, all ps > .237, suggesting that the size of the original face had negligible impact on the L/R asymmetry score and it was quite unlikely
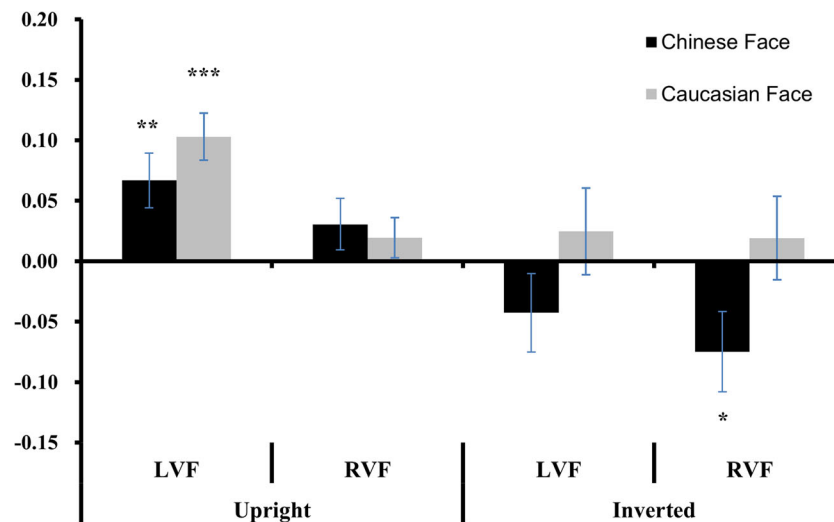
Fig. 3 The L/R asymmetry scores from all conditions (Experiments 1 and 2 combined). Error bars represent standard errors of the mean. *p < 0.05, **p < 0.01, ***p < 0.001

that the participant had adopted a feature comparison strategy in the task.

To examine whether a left-side bias was present in any experimental conditions (see Fig. 3), one-sample t tests were performed to compare the L/R asymmetry score against the no-bias threshold (0). As noted, there was no main effect or interaction involving experiment (Experiment 1 vs. 2), so data from Experiments 1 and 2 were combined to enhance the statistical power of these t tests. In the upright face tasks, when the original faces were presented in the left visual field, there was a reliable left-side bias in processing both Chinese (M = 0.07, SD = 0.16), $t(50)$ = 2.969, p = .005, Cohen's d = 0.42, BF_{10} = 7.355, and Caucasian faces (M = 0.10, SD = 0.14), $t(50)$ = 5.277, p < .001, Cohen's d = 0.75, BF_{10} > 150. When the original faces were presented in the right visual field, no significant left-side bias was observed both for Chinese faces (M = 0.03, SD = 0.15), $t(50)$ = 1.443, p = .155, Cohen's d = 0.20, BF_{10} = 0.403, and Caucasian faces (M = 0.02, SD = 0.12), $t(50)$ = 1.175, p = .246, Cohen's d = 0.17, BF_{10} = 0.292. In the inverted face tasks, when the original faces were presented in the left visual field, there was no reliable left-side bias for Chinese faces (M = −0.04, SD = 0.23), $t(50)$ = 1.309, p = .196, Cohen's d = 0.19, BF_{10} = 0.340, and Caucasian faces (M = 0.02, SD = 0.26), $t(50)$ = 0.694, p = .491, Cohen's d = 0.10, BF_{10} = 0.192. When the original faces were presented in the right visual field, there was no left-side bias for Caucasian faces (M = 0.02, SD = 0.25), $t(50)$ = 0.552, p = .584, Cohen's d = 0.08, BF_{10} = 0.176; for Chinese faces, the L/R asymmetry score even suggested a right-side bias (M = −0.07, SD = 0.24), $t(50)$ = 2.257, p = .028, Cohen's d = 0.32, BF_{10} = 1.540.

To briefly summarize, the L/R asymmetry score revealed that there was a clear left-side bias for both own-race and other-race faces in the upright face task when the original faces were presented in the left visual field.

In the inverted face task, the L/R asymmetry score was more positive for other-race than for own-race faces; however, the L/R asymmetry scores were not greater than 0, suggesting no left-side bias.

Discussion

In two experiments, we adopted the classic facial identity task to examine how racial information impacts the left-side bias in face processing. Consistent with previous findings (e.g., Coolican et al., 2008; Li & Cao, 2017; Proietti et al., 2015), this study revealed a significant left-side bias for own-race (Chinese) faces. Importantly, the present results also extended the left-side bias to other-race (Caucasian) faces, suggesting that the left-side bias is not a perceptual expertise that is unique to own-race faces, at least in the Chinese population. These findings are in line with previous studies examining the inversion effect and composite effect for both own-race and other-race faces (e.g., Hancock & Rhodes, 2008; Rhodes et al., 1989; for a review, see Rossion & Michel, 2011). Taken together, the inversion effect, composite effect, and left-side bias effect all suggest that face processing is a perceptual expertise that is not unique to own-race faces.

One notable finding of the present study was that the left-side bias was seen only when the original faces were presented in the left visual field, replicating the finding reported in an earlier study (Li & Cao, 2017). Researchers have suggested that the left-side bias effect is a behavioral consequence of the right hemisphere dominance for face processing and the left-to-right reading habit (Megreya & Havard, 2011). On one hand, when the original face was presented in the left visual field, there may be a hemisphere advantage of face recognition as it directly reflected to right hemisphere; on the other hand,

the left-to-right reading habit may enhance the right hemisphere advantage. However, when the original face was presented in the right visual field, both hemisphere advantage and left-to-right reading habit cannot give play to left-side bias effect in face processing. The chimeric face identification task in the present study was not a standard divided visual field paradigm, a possible visual field advantage for the left-side bias requires further examination in a divided visual field paradigm. A feature-comparison or pixel-wise matching strategy was ruled out in the present Experiment 2, and previous eye-tracking studies have also shown that the preference for the left side of faces is a stronger process preference, rather than the results of visual strategies (Hsiao & Cottrell, 2008; Hsiao & Liu, 2012). More specifically, the optimum fixation position is located on the left side of the nose (from the observer's perspective), not the midline of the face in neutral face processing. There still could be other strategies in this preference judgment task without time pressure. Therefore, future studies should consider the sequential paradigm to exclude any potential strategy (Li et al., 2018).

The present study has revealed a clear left-side bias in Chinese participants when processing both Chinese and Caucasian faces, but cautions should be taken when interpreting these findings as evidence that the left-side bias effect is a universal effect. Previous studies have shown that holistic or configural face processing is stronger in Asians than in Caucasians (Chua et al., 2005; Lewis et al., 2008; Miyamoto et al., 2011). For example, Miyamoto et al. (2011) recruited Japanese and Americans to explore configural face processing and found that compared with Caucasian Americans, the Japanese showed better performance in configural face processing. Importantly, studies of the own-race effect have also revealed that the ability in processing other-race faces is superior in Eastern than in Western populations (Crookes et al., 2013; Michel, Caldara, et al., 2006; Mondloch et al., 2010). Previous studies have also shown that, although both Caucasian and Asian participants show holistic processing of own-race faces, the holistic processing of other-race faces (i.e., the composite effect) is stronger in Asian than in Caucasian participants (e.g., the inversion task in Rhodes et al., 1989; the composite face task in Michel, Caldara, et al., 2006; and the whole-part task in Tanaka et al., 2004). This study did not test a group of Caucasian participants. While the results show a clear left-side bias in Chinese individuals processing other-race faces, there is no empirical evidence for a similar finding in Caucasians.

In the present study, the left-side bias was observed for upright faces, whereas no left-side bias was observed for inverted faces. This observation is consistent with the finding that inversion can abolish a variety of face processing effects—for instance, in gender chimeric face tasks (Butler & Harvey, 2005) and the emotional chimeric face tasks (Bourne, 2011; Innes et al., 2016). This inversion effect is likely the result of the right hemispheric specialization in face processing (Bourne, 2011; Butler & Harvey, 2005) or attentional deployment (Innes et al., 2016). While face inversion eliminated the left-side bias for other-race (Caucasian) faces, this manipulation led to a trend toward a right-side bias for own-race (Chinese) faces. This differential impact of face inversion on own-race and other-race faces may attribute to the different strategies people use to process own-race and other-race faces. For instance, previous studies have revealed stronger holistic or configural processing for own-race than for other-race faces (e.g., Hancock & Rhodes, 2008; Michel et al., 2007; Tanaka et al., 2004; for a review, see Rossion & Michel, 2011), and there is ample evidence showing that inversion reduces or disrupts mainly holistic or configural processing (e.g., Itier & Taylor, 2004; Rhodes et al., 1989).

Surprisingly, the present results revealed an overall stronger left-side bias for other-race than for own-race faces, indicating an other-race advantage in the left-side bias. To the best of our knowledge, most previous studies on own-race and other-race faces have found that the recognition of other-race faces is impaired compared with that of own-race faces (e.g., Dehon & Brédart, 2001; Elfenbein & Ambady, 2002; O'Toole et al., 1996; Rhodes et al., 2006). Nevertheless, there is also evidence for an "other-race advantage" in face processing—for instance, classification of faces by race is faster for other-race faces than for own-race faces (e.g., Caldara et al., 2004; Levin, 1996, 2000; Valentine & Endo, 1992; Zhao & Bentin, 2008, 2011). One well-received account for this other-race advantage is the multidimensional space model for face encoding and classification, which was proposed by Valentine and colleagues (Valentine, 1991; Valentine & Endo, 1992). According to this model, faces are encoded as nodes in an n-dimensional space where the distance between any two nodes is inversely related to their subjective similarity. Other-race faces are more densely clustered in this space (Byatt & Rhodes, 2004; Valentine, 1991; Valentine & Endo, 1992), making them more difficult to discriminate compared with own-race faces. However, a dense clustering means that the activation of one node is usually supported by nearby nodes (due to short-distance excitation); consequently, the total activation caused by a group of similar faces will reach the decision threshold faster, leading to superior performance in face classification (Zhao & Bentin, 2011). In the present study, the participants were asked to report which chimeric face (left or right chimeric face) was more resemblant to the original face. It is possible that, compared with own-race faces, the chimeric other-race face is closer to the original other-race face in the multidimensional face space, leading to an overall stronger left-side-bias effect. It is also possible that the Chinese participants adopted a more analytical rather than the helictical strategy when processing other-race faces, leading to a stronger left-side bias for other-race faces. Further empirical work is required to verify these

possible explanations. Some previous eye-tracking studies found the different sampling biases were found in scanning own-race and other-race faces (Lee et al., 2017; Liu et al., 2015; Xiao et al., 2014). For example, Liu et al. (2015) found 3-month-old infants fixated more on the left eye region of own-race faces and more on the nose bridge of other-race faces; 6-month-old infants attended more to the right eye region of own-race faces and more to the left eye region of other-race faces. The fixation patterns of 9-month-old infants were more similar to that of 6-month-old infants. Those results suggested that there are different sampling biases to own-race and other-race faces in infants. It could be there are different sampling biases for own-race and other-race faces in adults, leading to a stronger left-side bias for other-race faces. Future studies should examine this hypothesis by using eye-tracking technology.

To briefly summarize, the present study revealed a reliable left-side bias in upright face processing for both own-race and other-race faces. We conclude that the left-side bias reflects a universal perceptual expertise that is not specific to own-race faces.

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