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Two faces of the other-race effect:

Recognition and categorization of Caucasian and Chinese faces

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Abstract

The other-race effect is a collection of phenomena whereby individuals process faces of their own race differently from those of other races. Previous studies have revealed a paradoxical mirror pattern of an own-race advantage in face recognition and an other-race advantage in race-based categorization. With a well controlled design, we compared recognition and categorization of own- and other-race faces in both Caucasian and Chinese participants. Compared with own-race faces, other-race faces were less accurately and more slowly recognized, whereas they were more rapidly classified by race. This mirror pattern was confirmed by a unique negative correlation between the two effects with a hierarchical regression analysis, indicating an interaction between processing of face identity and category and a common underlying processing mechanism.

Two faces of the other-race effect:

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The other-race effect is a collection of phenomena whereby faces from one's own race are processed differently from those from other races. One such phenomenon is the own-race recognition advantage whereby own-race faces are recognized more accurately and faster than other-race faces (Bothwell, Brigham, & Malpass, 1989; Brigham & Malpass, 1985; Chiroro & Valentine, 1995; Valentine, 1991). The effect of race on face recognition is robust in that it occurs across different racial groups (Bothwell et al., 1989; Rhodes, Brake, Taylor, & Tan, 1989; Shepherd & Deregowski, 1981), age groups (Chance, Turner, & Goldstein, 1982; Pezdek, Blandon-Gitlin, & Moore, 2003; Sangrigoli & de Schonen, 2004a, 2004b), and in both laboratory and field settings (Brigham, Maass, Snyder, & Spaulding, 1982; Cross, Cross, & Daly, 1971). It has also been confirmed by several meta-analytic studies (Bothwell et al., 1989; Meissner & Brigham, 2001).

Overshadowed by the vast literature on the own-race recognition advantage, is a paradoxical other-race categorization advantage. That is, when participants are asked to categorize faces by their race, they respond faster and more accurately to other-race faces than to own-race faces (Caldara, Rossion, Bovet, & Hauert, 2004; Levin, 1996, 2000; Valentine & Endo, 1992). This other-race categorization advantage has been demonstrated also to be robust with various face stimuli across different racial groups, using either a race-based categorization task or just a simple visual search task.

Notwithstanding this apparent mirror pattern for own-race and other-race faces processed in different tasks, most studies have investigated the two effects separately, with little concurrent examination of the paradoxical phenomena. According to the classic face recognition model (Bruce & Young, 1986; Burton, Bruce, & Johnston, 1990), the two effects are unrelated and the apparent mirror pattern may be coincidental as the two tasks are served by separate parallel processing routes. In the recognition task, one is required to extract from a face an *identity-specific semantic code*, whereas in the categorization task one must rely on a *category-specific semantic code* (Bruce & Young, 1986). The identification and categorization codes are believed to be based on different information and accessed by distinct processing mechanisms.

However, recent evidence has come to support the single route hypothesis that identity and category specific codes are processed by a common route and may interact with each other (Bruyer, Leclere, & Quinet, 2004; Ganel & Goshen-Gottstein, 2002, 2004). Following the single route view, the mirror pattern of the two cross-race effects may reflect trade-off and competition between processing individual identity and categorical facial information.

To date, this possibility has been examined only by two studies with mixed results. In one study, Levin (1996) divided Caucasian participants into two groups: Group 1 showing the own-race recognition advantage and Group 2 not showing the effect. Both groups categorized computer-distorted faces as Caucasian or Black, but showed no significant difference in terms of the other-race categorization advantage. In contrast, Levin (2000) again divided participants into two groups and asked them to search for a Caucasian or black face among other-race face distractors. This time, Group 1 showed a greater other-race categorization advantage relative to Group 2. Nevertheless, no significant differences were found in the same study between the two groups in terms of the other-race categorization advantage when a go-no-go task was used (i.e., participants were asked to respond to a target face category but not to a non-target face category).

These different outcomes, however, might be due to different methods used in Levin's studies. For example, the stimuli used for testing the other-race recognition disadvantage were individual faces, but those used to assess the other-race categorization advantage were morphed or average faces. Also, whereas the recognition paradigm remained identical for various experiments, the method for testing categorization varied: in one case with a race-based categorization task (Levin, 1996) and in another with a go-no-go or visual search paradigm (Levin, 2000). And perhaps more importantly, participants were students from a major US university that is ethnically diverse and these participants might have had sufficient exposure to various other-race faces (indeed, although the other-race recognition advantage is highly robust, a significant proportion of participants in both studies did not show it at all). Thus, any close relationship between the other-race recognition disadvantage and the other-race classification advantage might have been obscured by these factors.

To directly examine the interrelation between the paradoxical own- and other-race face effects, in the present study we recruited participants who had near-zero ***direct*** contact with other-race individuals in the UK and China where over

91% and 99% of the population are either Caucasian or Chinese, respectively. The participants completed a recognition task in which they were required to recognize previously seen Chinese and Caucasian faces and a race categorization task in which they were asked to judge the race of Chinese and Caucasian faces. The order of the two tasks was counter-balanced between participants. The two tasks were structured such that the face stimuli were randomly assigned to each task, with the same number of stimuli, the same timing parameters, and the same manual response.

Based on the existing evidence, we expected to observe both the own-race recognition advantage and the other-race categorization advantage among Chinese and Caucasian participants. More importantly, if the dual route hypothesis is true, the two effects should not correlate with each other for both Chinese and Caucasian participants. However, if the single route hypothesis is correct, a significant negative correlation should be observed between the two effects. This is because, in the single route model, identifying own-race faces competes with categorizing them; when processing capacity remains constant, increased proficiency at recognizing own race faces must be compensated with a decrease in categorizing the same faces.

Method

Participants

Thirty-two Han Chinese students (16 females) from Zhejiang Sci-Tech University, P.R. China, and 35 Caucasian students (20 females) from Sheffield University, UK participated in the present study. Participants reported no regular direct contact with other-race individuals. In Sheffield, the population consisted of 91.2% Caucasians and .8% Chinese. In Hangzhou, 99.9% of the population is Han Chinese.

Stimuli

Sixty-four Caucasian and 64 Chinese upright faces were used. All faces were full-color high quality photographic images with the same number of male and female faces taken frontally at a fixed position, digitized in 24-bit colors with a resolution of 640 × 480 pixels.

Design and Procedure

The experiment was a 2 × 2 factorial design, with face race (Caucasian versus Chinese) and task type (recognition by identity, hereafter called the recognition task versus categorization by race, hereafter called the categorization task) as within-subject factors. The 64 faces from either race were divided into 2 lists with the same number of female and male faces. For each participant, the faces from one of the two lists were used for the recognition task and those from the other list were used for the categorization task. In other words, the same participant did not see the same faces in the recognition and categorization tasks. The chance for any face to be used in the recognition task or in the categorization task was equal. The task order was counterbalanced between participants.

For the recognition task, participants first learned 16 Caucasian faces and 16 Chinese faces, repeated for three times with the order of Caucasian and Chinese faces completely randomized. Those faces were then randomly mixed with another 32 unlearned faces (16 from each of the two race categories) for recognition. Participants were asked to press either “1” or “2” on the number pad to indicate whether the face was a previously seen face.

For the categorization task, participants were asked to press the same keys as in the recognition task to indicate whether the face was a Caucasian or Chinese face. The key assignment was counter-balanced between participants.

Participants sat in a dimly lit quiet room and saw the faces from a visual angle of 12.4° in height and 16.4° in width. Faces were presented using E-Prime (Psychology Software Testing, Pittsburgh, PA) with a PC computer. The presentation time of stimuli was 2 seconds per face for the learning phase, and 5 seconds until key press for the recognition phases of both the recognition task and the categorization task. Participants were asked to respond as fast as possible and as accurate as possible. Before each face, participants were asked to look at a centrally located fixation cross-hair with a random variable inter-stimulus interval between 500 to 1000 ms.

Results

Preliminary analyses showed that the effects of participant gender and face gender were not significant. Thus, the two factors were excluded from further analyses. We first examined the two other-race effects (for recognition and categorization) separately in the two participant groups (Caucasian and Chinese) to evaluate their size and direction. Then a hierarchical regression analysis was conducted to evaluate the relationship between the two face-race effects.

Accuracy

Two-way ANOVAs were performed on both participant groups with task type (Categorization vs. Recognition) and face race (Caucasian vs. Chinese) as within-subject factors.

Caucasian participants. Both main effects were significant, for task type, $F(1, 34) = 74.56$, *prep* = .99, $\eta^2 = .69$, and for face race, $F(1, 34) = 12.27$, *prep* = .98, $\eta^2 = .27$. Participants were more accurate in the categorization task than in the identification task and in processing Caucasian faces than Chinese faces. The interaction was significant, $F(1, 34) = 12.229$, *prep* = .98, $\eta^2 = .27$. Paired *t* tests showed Caucasian faces were more accurately recognized than Chinese faces, showing the own-race recognition advantage, $t(34) = 3.69$, *prep* = .98, but both face races were categorized equally well. The lack of difference in accuracy between face races in the categorization task was likely due to the ceiling-level performance (see Table 1 and Figure 1).

Chinese participants. Only the effect of task type was significant, $F(1, 31) = 5.52$, *prep* = .99, $\eta^2 = .62$. Participants were more accurate in the categorization task. The interaction was marginally significant, $F(1, 31) = 4.06$, *prep* = .87, $\eta^2 = .12$. Paired *t* tests showed a significant face-race effect favoring Chinese faces in the recognition task, $t(31) = -2.31$, *prep* = .91, but not in the categorization task, replicating the results in Caucasian participants, perhaps also due to a ceiling effect in accuracy in the categorization task.

Reaction Time

The same two-way ANOVAs were performed on the reaction time data as in the accuracy data.

Caucasian participants. Both main effects of task type and face-race were significant, $F(1, 34) = 50.43$, *prep* = .99, $\eta^2 = .60$, and $F(1, 34) = 5.35$, *prep* = .91, $\eta^2 = .14$, respectively. Participants were slower in the recognition tasks than in the categorization tasks and were faster overall in processing Caucasian faces than Chinese faces. This effect was further moderated by a significant interaction between task type and face-race, $F(1, 34) = 26.06$, *prep* = .99, $\eta^2 = .43$. Paired *t* tests showed a significant face-race effect in both the recognition task, $t(34) = -4.99$, *prep* = .99, and the categorization task, $t(34) = 2.68$, *prep* = .95. Participants recognized Caucasian faces faster but categorized Chinese faces more quickly, an expected mirror pattern of the two face-race effects (see Table 1 and Figure 1).

Chinese participants. The main face-race effect was significant, $F(1, 31) = 4.20$, *prep* = .88, $\eta^2 = .12$, with a longer reaction time overall for Chinese faces. The interaction was significant as well, $F(1, 31) = 12.46$, *prep* = .98, $\eta^2 = .29$. Paired *t* tests showed that the participants recognized Chinese faces faster, $t(31) = 2.25$, *prep* = .90, and categorized Caucasian faces more quickly, $t(31) = -3.32$, *prep* = .98. These results again showed the expected mirror pattern of the two face-race effects and replicated the findings of the Caucasian participants.

Comparing the Sizes of the Two Face-Race Effects Between the Two Race Groups

The sizes of the own-race recognition advantage and other-race categorization advantage were compared using the difference between own-race and other-race faces in reaction time. Accuracy data were not analyzed similarly due to the ceiling level performance. Independent-samples *t* tests showed that there was no difference between sizes of the own-race recognition advantage across the two groups. However, Chinese participants showed a significantly larger other-race categorization advantage than did Caucasian participants, *t*(65) = -2.46, *prep* = .93 (see Table 1 and Figure 1).

Relation Between the Two Face-Race Effects

The above results revealed the anticipated mirror pattern between the two other-race effects. However, this relationship could be due to the fact that both effects originate from some general cognitive or task factors such as processing speed or task difficulty. To rule out these possibilities, a hierarchical regression analysis was used to examine whether there existed a relation between the two face-race effects above and beyond other major extraneous factors.

We used the size of the own-race recognition advantage as the dependent measure. The overall recognition time and accuracy were entered into the model first to account for a possible association with processing speed and task difficulty. The participant race factor was also entered into this model to account for any difference between Chinese and Caucasian participants in the size of the own-race recognition advantage. The model was significant, R^2 change = .287, *F* change (1, 65) = 26.16, *prep* = .99. This significant effect was mainly due to the significant positive correlation between the overall recognition time and the size of the own-race recognition advantage, β = .285, *t* = -5.11, *prep* = .99. The unique contributions of the other two factors were not significant. This result suggests that the longer one took in recognizing faces in general, the larger advantage he/she might have in recognizing own-race faces relative to other-race faces.

Second, the critical factor, the size of the other-race categorization advantage, was entered into the model. The model was significant, R^2 change = .045, F change (1, 64) = 4.33, *prep* = .89, β = -.138, t = -2.08, prep = .89. After partialling out the effects of the overall reaction time, accuracy, and race, the size of the own-race recognition advantage was significantly related to the size of the other-race categorization advantage. The faster one recognized own-race faces than other-race faces, the slower one categorized own race faces than other-race faces.

At the third step, we further tested the effect of interaction between the overall recognition time and the size of the other-race categorization advantage on the size of the own-race recognition advantage. This interaction term (expressed as the product of the recognition time and size of other-race categorization advantage) was not significant (see Table 2).

Discussion

In the present study, we concurrently examined the mirror pattern of the own-race recognition advantage and the other-race categorization advantage. As predicted, Chinese participants recognized Chinese faces more efficiently than Caucasian faces but categorized Caucasian faces better than Chinese faces. This pattern of results was completely replicated with Caucasian participants who recognized Caucasian faces more efficiently than Chinese faces but categorized Chinese faces better than Caucasian faces.

This finding is the first in the literature to obtain a clear mirror pattern of the own- and other-race face recognition and categorization effects. The fact that Chinese participants' responses were entirely opposite to Caucasian participants' responses when recognizing and categorizing the same face stimuli ruled out the possibility that our finding was due to the specifics of face stimuli used. Further, because our recognition and categorization tasks had highly similar task structure and demand, we can confidently attribute the mirror pattern of the own- and other-race effects to processing differences involved in recognizing and categorizing Chinese and Caucasian faces.

More importantly, our results failed to confirm the hypothesis derived from the dual route model of face processing that the own-race recognition advantage is completely unrelated to the other-race categorization advantage. Our hierarchical regression analysis revealed that the own-race recognition advantage was significantly correlated with the other-race categorization advantage above and beyond such factors as participants' overall reaction time, overall accuracy, and race. More specifically, the more efficiently participants recognized their own-race faces relative to other-race faces, the less efficiently they categorized their own-race faces. This result suggests that the own-race recognition advantage is closely related to the other-race categorization advantage. Moreover, our result suggests that expertise at recognition is not a cost-free accomplishment of one's increased visual processing experience with own-race faces. It is achieved at the cost of categorization of own-race faces.

This finding is in line with the single route hypothesis that the process of recognition and that of categorization share common pathways at a certain level of face processing. Recognizing faces with which one has a high level of expertise interferes with categorizing them. However, the exact nature of this interference and the level at which such interference takes place need to be specified with further research. It is likely that the mirror pattern of the own- and other-race effects observed here is a manifestation of a broader phenomenon. It has been found that people recognize faces of their own age and gender better than faces of other ages or gender (Anastasi & Rhodes, 2005, 2006; Wright & Sladden, 2003). A recent study found that when faces were assigned into arbitrary in-group and out-group categories, participants recognized in-group faces better than the out-group faces, similar to the own-race recognition advantage (Bernstein, Young, & Hugenberg, 2007). Although concurrent categorization studies have yet to be conducted with regard to categorizing own- and other- age, gender or arbitrary in- and out-group faces, it is quite possible that a mirror pattern of the recognition and categorization effects will be observed beyond cross-race face processing.

There have been some suggestions as to why increased experience and expertise with processing one category of faces should affect detrimentally the categorization of faces of this category. One suggestion (Levin, 1996, 2000) is that when processing a category of faces with which individuals have expertise, they automatically encode individuating information first, followed by categorical information. In contrast, when processing of a category of faces with which individuals have limited experience, they encode first categorical information followed by individuating information. This hypothesis predicts that the response latency in recognition of own-race faces should be faster than categorization of the same faces and recognition of other-race faces should be slower than categorization of the same faces. This prediction is, however, not entirely consistent with the present and existing findings. In general, categorizing faces regardless of race types was faster and more accurate than recognizing faces. However, in the present study, when the task demand and structure were held constant, own-race recognition was faster than own-race categorization for Chinese participants, while Caucasian participants categorized both Chinese and Caucasian faces' races significantly faster than recognizing them.

Another hypothesis alternative to the above serial processing hypothesis is that individuals devote differential processing resources (e.g., attention) to a face's categorical and individuating information depending on whether the face is in-group and familiar versus out-group and unfamiliar (Sporer, 2001). When encountering unfamiliar out-group faces, individuals may devote more resources to categorical information than individuating information. In contrast, when encountering familiar in-group faces, individuals may devote more resources to individuating information. Indeed, recent studies showed that the improvement in recognition of other-race faces can been achieved by directing participants to attend to the individuating information of other-race faces (Hills & Lewis, 2006; Hugenberg, Miller, & Claypool, 2007). This resource allocation hypothesis explains the mirror pattern of the own- and other-race face effects. It is also consistent with the finding that for own-race faces the entry or default level of processing is at the individual level as opposed to the basic level for common objects (Tanaka & Taylor, 1991). Further, training studies have shown that increased expertise at processing a category of visual stimuli leads to a downward shift in entry point or default processing from the basic level to the subordinate category level (Bukach, Gauthier, & Tarr, 2006). The present and existing evidence taken together suggests that the resource allocation hypothesis rather than the serial processing hypothesis may be a likely candidate to best explain the mirror pattern of the own- and other-race face effects.

In summary, the present study used identical face stimuli and task demand and structure and revealed that both Chinese and Caucasian participants showed the same mirror pattern of the own-race recognition advantage and other-race categorization advantage. Further, after partialling out the effects of extraneous factors, categorizing other-race faces as opposed to own-race faces was significantly related to individuating own-race faces as opposed to other-race faces. This significant correlation suggests an antagonistic relationship between face individuating and categorization: Increased efficiency at individuating faces may come at the cost of efficiency at categorizing the same faces. This antagonistic relationship may be a general face processing phenomenon and reflect differential resource allocation at the early stage of face processing when individuals encounter faces with which they have different levels of expertise.

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Table 1

Mean Percentage Accuracy (SD) and Reaction Time in Milliseconds (SD) of Chinese and Caucasian Participants for Chinese and Caucasian Faces in the Recognition and Categorization Tasks

Participants	Face Race	Accuracy (SD)		Reaction time (SD)	
		Recognition	Categorization	Recognition	Categorization
Chinese	*Chinese*	88.2 (6.5)	94.9 (7.3)	973.85 (165.7)	1117.89 (357.6)
	Caucasian	84.6 (8.4)	95.9 (4.2)	1026.99 (237.0)	983.22 (325.5)
Own race – Other-race		3.6	-1.0	-53.14	134.67
Caucasian	*Chinese*	86.1 (9.5)	97.9 (2.2)	1094.60 (242.9)	746.17 (230.9)
	Caucasian	91.1 (7.3)	97.9 (4.3)	1019.41 (195.7)	780.11 (262.8)
Own race – Other-race		5.0	0.0	-75.18	33.94

Table 2

Summary of the Hierarchical Regression Analysis of the Other-Race Recognition Disadvantage

Step	Measures	β at final step	*t*	R^2 change
1				.287**
	Overall recognition time	.285	5.11***	
	Overall recognition accuracy	.056	.53	
	Participant race	-.025	-.24	
2	Other-race categorization advantage	.138	2.08*	.045*
3	Overall recognition time × other-race categorization advantage	.098	.17	
	Overall R^2			.332

Only unstandardized regression coefficients were used because standardized coefficients are inappropriate with interaction term (Aiken & West, 1991). ** denotes that *prep* > .98, and * denotes that *prep* > .88.

Figure Captions

Figure 1. Accuracy (top panel) and reaction time (bottom panel) for Caucasian and Chinese faces in Caucasian (solid line) and Chinese (dotted line) participants in recognition and categorization tasks. Standard error bars are shown.

Fig. 1

a. Accuracy

b. Reaction time