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Brief article

An own-race advantage for components as well as configurations in face recognition

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Abstract

The own-race advantage in face recognition has been hypothesized as being due to a superiority in the processing of configural information for own-race faces. Here we examined the contributions of both configural and component processing to the own-race advantage. We recruited 48 Caucasian participants in Australia and 48 Chinese participants in Hong Kong, and had them study Caucasian and Chinese faces. After study, they were shown old faces (along with distractors) that were either *blurred* (isolating configural processing), in which high spatial frequencies were removed from the intact faces, or *scrambled* (isolating component processing), in which the locations of all face components were rearranged. Participants performed better on the memory test for own-race faces in both the blurred (configural) and scrambled (component) conditions, showing an own-race advantage for both configural and component processing. These results suggest that the own-race advantage in face recognition is due to a general facilitation in different forms of face processing.

Keywords: Face recognition; Face processing; Configural processing; Component processing; Own-race advantage; Other-race effect

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1. Introduction

People are generally better at recognizing faces from their own race than from other races. This *own-race advantage* (*ORA*) occurs across a large number of studies (see Meissner & Brigham, 2001, for a review), and is perceptual rather than physiognomic (Goldstein, 1979). It is robust across differences in race (of both the observers and the observed; Bothwell, Brigham, & Malpass, 1989) and task (e.g., Doty, 1998), and can lead to difficulties with the reliability of eyewitness identification (Meissner & Brigham, 2001). One of its most interesting aspects is that it is an expertise effect within an expertise effect; while we are more expert with own-race than other-race faces, we in turn are more expert at recognizing faces in general than at recognizing most other objects.

What drives our general expertise with faces? Many studies have examined the possible sources of information for face recognition, and have compared information about individual components with information about the face as a whole. This latter type of information is typically described as *configural*, on the basis that it represents the relative positions of features across the face as a whole.[1] Considerable evidence has accumulated for the use of configural processing in face recognition (e.g., Diamond & Carey, 1986; Gauthier & Tarr, 2002; see Schwaninger, Carbon, & Leder, 2003, for a review).

Given an assumption of face processing based on configural information, could the ORA be due to better utilization of this information for own-race faces? Early studies tested recognition of upright and inverted own-race and other-race faces to examine whether configural coding of other-race faces was impaired, and found mixed results (Rhodes, Tan, Brake, & Taylor, 1989; Valentine & Bruce, 1986). However, more recent studies provide evidence for a greater use of configural processing with own-race faces. Both Michel, Caldara, and Rossion (2006a) and Tanaka, Kiefer, and Bukach (2004) tested configural processing of Caucasian and Asian participants in countries where Caucasians are the most numerous race. The task in both studies was adapted from the part/whole task of Tanaka and Farah (1993), in which participants studied a whole face and then discriminated between either individual face components or whole faces differing in only one component. Both studies found that Caucasians showed a larger whole-face advantage (better recognition of whole faces than individual parts) for own-race faces than other-race faces, whereas Asians showed an equally large whole-face advantage for both races. These results were explained as being due to experience; Asians living in Caucasian-dominated countries generally have experience with both races of face, whereas Caucasians tend to have differentially more experience with Caucasian faces. In another study, Michel, Rossion, Han, Chung, and Caldara (2006b) showed

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[1] As it is coded from the face as a whole, this type of information is also sometimes referred to as “holistic”, on the basis that it cannot be decomposed into smaller units. For simplicity, we will use the term “configural” with the intention of referring to facial information that is both configural and holistic (see Maurer, Le Grand, & Mondloch, 2002).

greater interference from one half of a face on processing of the other half (the composite-face effect) for own-race faces than other-race faces; in this study, the effect was found for both Caucasian and Asian participants (unlike the Michel et al., 2006a; Tanaka et al., 2004, studies, the Asian participants here were Koreans living in South Korea who would be expected to have more expertise with Asian than Caucasian faces).

These three studies provide evidence for more configural processing of own-race than other-race faces. However, none of these studies are directly aimed at investigating the role, if any, of the processing of facial components in supporting the own-race advantage. Although components seem less able to support face recognition than configural information, there is a growing body of evidence that they provide an alternative route to recognition (e.g., Bartlett, Searcy, & Abdi, 2003; Bruyer & Coget, 1987; Collishaw & Hole, 2000). This is often thought to be distinct from "face specific" recognition processes as, for example, component processing seems only mildly affected by face inversion (Collishaw & Hole, 2000; Leder & Bruce, 2000; Searcy & Bartlett, 1996; Sergent, 1984; Tanaka & Farah, 1993). One major aim of the current study was to investigate whether processing of facial components, as well as configurations, would be more efficient for own-race than other-race faces.

An additional aim of the current study was to investigate configural and component processing within the context of a recognition memory task. Most previous studies (e.g., Michel et al., 2006a, 2006b; Tanaka et al., 2004) have used tasks that required only short-term retention (up to about 1 s) of facial information. In contrast, we had participants study a set of normal faces, and then perform a recognition test for stimuli in which we isolated configural or component information. Such a test is more similar to a standard test of the own-race advantage, and allows us to investigate whether configural and component information are utilized in a task that requires retention of facial information over a moderate time period.

To isolate configural and component processing in the present study, we used a method first reported by Schwaninger, Lobmaier, and Collishaw (2002). They had participants study intact faces, and then gave them a recognition test for one of three versions of the original faces; *scrambled*, in which all components were cut out and then re-arranged; *blurred*, in which the intact faces were blurred with a low-pass filter; and *scrambled-blurred*, in which the same low-pass filter was applied to the scrambled components. The level of blur had been determined in previous testing to take performance in the scrambled-blurred condition to chance. The logic of the manipulation was that in the scrambled condition, all configural (and holistic) information was disrupted so that faces could only be recognized on the basis of individual components. When these rearranged components were blurred, participants were simply guessing, meaning that all discriminative information from the components was removed. When applied to the intact faces, this level of blur therefore removes information about fine detail required for component processing[2] but retains the first- and, especially, second-order relational information (Diamond & Carey, 1986) thought to be the basis for configural face processing (Collishaw & Hole, 2000; Sergent, 1984). Schwaninger, et al. showed that recognition of both scrambled (component-based) and blurred (configural-based) faces was above chance, adding to previous evidence that routes to recognition exist for both types of information. In addition, both yielded better performance for familiar than unfamiliar faces.

In this study, we used the scrambled/blurred paradigm to test recognition of own- and other-race faces among Australian Caucasian and Hong Kong Chinese participants. If the ORA is at least partially due to better recruitment of configural information in own- than other-race faces, it should be found for blurred images. In addition, if component information is also partially responsible for the ORA, it should also be found for scrambled faces.

2. Method

2.1. Participants

Ninety-six participants were recruited from two different sites: 48 (15 males) from the University of Western Australia (UWA) and 48 (17 males) from the Chinese University of Hong Kong (CUHK). All participants from UWA were Caucasian and had lived most of their lives in Australia or other Caucasian-dominated countries. All participants from CUHK were Chinese and had lived most of their lives in Hong Kong.

2.2. Stimulus materials

Photographs of unfamiliar Caucasian ($N = 20$) and Chinese ($N = 20$) male students formed the basis of the stimulus materials, which are illustrated in Fig. 1. Each face was standardized to have an inter-pupil distance of 80 pixels, and was placed within a 320×420 pixel frame on a black background. Faces were also converted to 8-bit grayscale. Each participant viewed ten study faces for each race, which were intact faces within the outline (excluding hair). There were three types of test stimulus. Scrambled faces were created by cutting each face into ten components: two eyes, two eyebrows, two cheeks, nose, mouth, chin, and fore-

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[2] As noted by a reviewer, this procedure may not remove *all* component information. To the extent that components are encoded holistically, presenting them in the original configuration will allow component information to be extracted more efficiently than in the scrambled configuration, and so some component information may also be available in the blurred image. In addition, the blurred image also contains information from the outline shape of the head, which differs between images and could be used as a cue to recognition. Note, however, that outline information also exists within the scrambled-blurred images, albeit in componential form, and recognition of these stimuli was at chance. If outline information was used for blurred images, then, it was used as an overall configuration, consistent with information from the rest of the image.

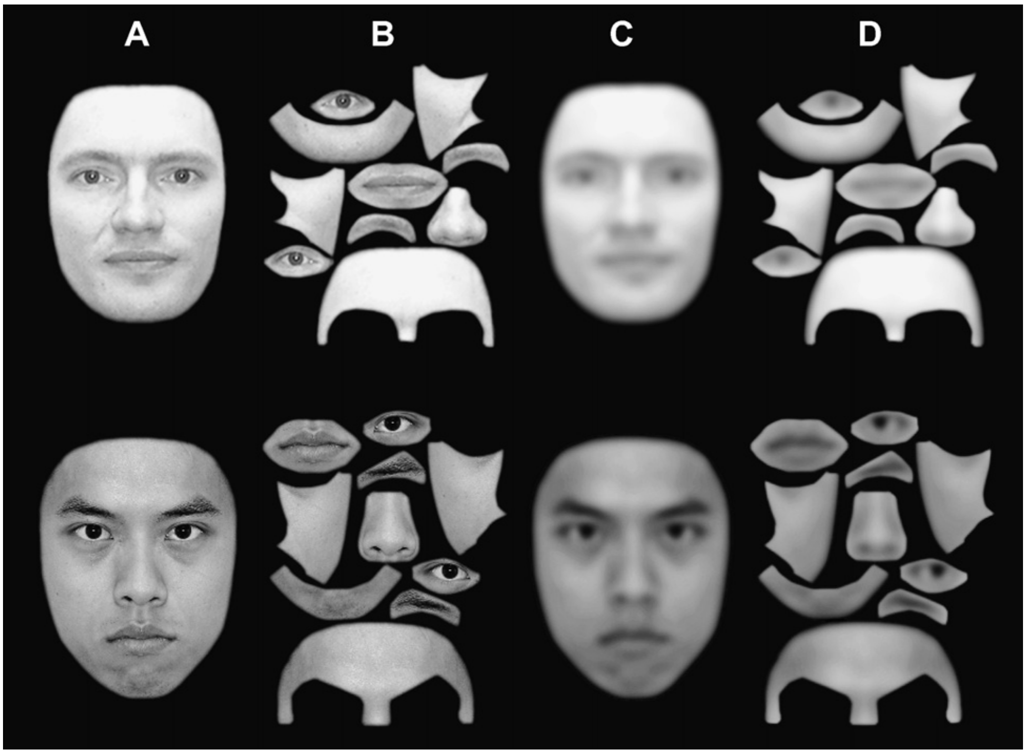

Fig. 1. One Caucasian and one Chinese face shown in (A) the study phase, (B) scrambled condition, (C) blurred condition, and (D) scrambled-blurred condition.

head (these components were chosen by at least 80% of participants when asked by Schwaninger et al. (2002) to list the parts of a face). These components were then rearranged into a new, unface-like configuration. Scrambled configurations for each face were different. Blurred faces were created by taking intact faces and repeatedly applying a Gaussian filter; the filter had a radius of three pixels and a standard deviation of three pixels, and was applied four times. Using the stimulus dimensions (on average, the width of the faces on the screen was 5.5 cm) and a viewing distance of 45 cm (although this was not fixed), the blurring resulted in cutting off spatial frequencies above 20 cycles per face width or 3.5 cycles per degree of visual angle. Scrambled-blurred stimuli were made in the same way as scrambled faces, but were based upon the blurred faces rather than the original faces; the spatial arrangement of each scrambled-blurred face was matched to its scrambled complement.

2.3. Procedure

The experiment was conducted on a Macintosh eMac with a 17-inch CRT, using RSVP software (www.tarrlab.org). The race of face to be tested was blocked, with order counterbalanced across participants. Within each block, participants initially viewed the 10 intact study faces, one at a time, for 10 s each. Faces were separated by a 1 s blank interval. Faces were viewed twice in this series. Participants were instructed to remember the faces in order to take a memory test at a later time. After all faces had been viewed twice, participants had a short break, and then received the memory test. Each participant received one of the three types of test stimulus; scrambled (18 participants at each testing location), blurred (18 participants), or scrambled-blurred (12 participants). Twenty images were shown in the test, 10 of which corresponded to the old faces and 10 of which were new. Each stimulus was presented on the CRT until participants responded, with a 1 s blank interval between faces. For the purposes of counterbalancing whether faces appeared during study (and were therefore targets in the later test) or as foils at test, participants were considered in pairs. For one participant in each pair, ten faces were randomly selected from the set of 20 to act as study faces. For the other member of the pair, these ten faces became foils in the test. Faces were displayed in different random orders for each participant.

Participants were informed that they would see altered versions of the faces they had studied, along with altered versions of new faces, and they should press one key on the keyboard for "old" faces and another for "new" faces. They were informed that accuracy, rather than response speed, was important. After the recognition test for one race of face, they were given a short break and then performed the same task with the other race of face. Participants saw the same type of altered images for both races. The experiment took about 30 min to complete.

3. Results

3.1. Signal detection analysis

We used signal detection theory to measure recognition performance. Hits and false alarms were determined for each participant, and then used to calculate d' (Green & Swets, 1966) for both own- and other-race face recognition for each participant. The results are summarized in Fig. 2. Note first that d's for the scrambled-blurred condition were all around 0, indicating that there was no difference between hits and false alarms, and therefore participants were guessing. Planned *t*-tests showed that none of the four scrambled-blurred conditions were significantly different from 0 (chance), all t's <1.14. These results suggest that the level of blurring was sufficient to eliminate component processing of the face images.

Having determined that the blurring manipulation was strong enough, we can turn to the two conditions of interest. As noted previously, the scrambled condition tests component processing, and the blurred condition tests primarily configural processing. For each, we tested Caucasian and Chinese participants on own- and other-race faces. If the ORA is due to specifically configural processing, we should observe better own-race than other-race recognition for the blurred condition, but not for the

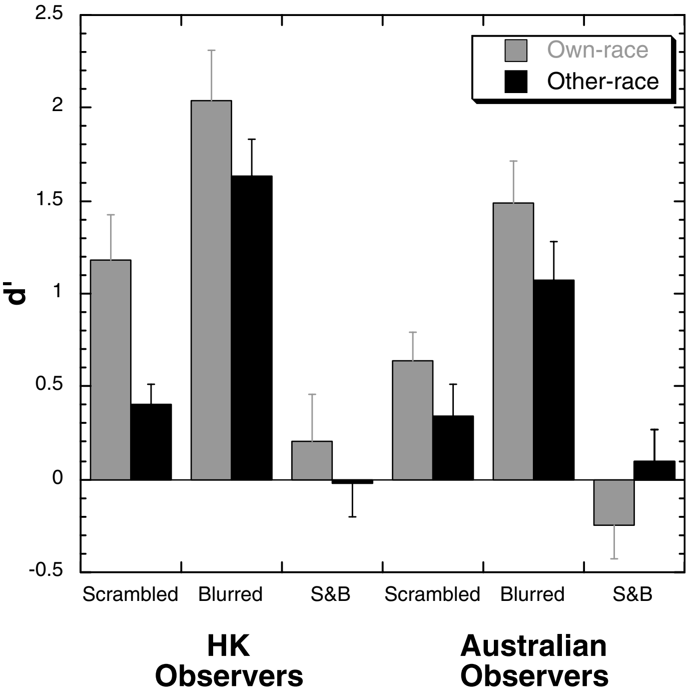

Fig. 2. d′ as a function of race of face, race of participant and test stimulus alteration. Error bars show standard error of the mean (between participants).

scrambled condition.[3] As can be observed from Fig. 2, however, participants showed strong own-race effects in both the blurred and scrambled conditions. To analyze the results we computed a three-way mixed ANOVA, with race of face (own-race, other-race) varying within subjects, and race of participant (Caucasian, Chinese) and test stimulus alteration (blurred, scrambled) varying between subjects. Note that in the ANOVA we did not include the scrambled-blurred (control) condition as no own-race effect was predicted for this condition (since performance was expected to be at chance).

All three main effects were statistically significant. First, we observed an own-race effect, with better performance for own-race than other-race stimuli overall, $F(1,68) = 17.33$, $p < .001$. Second, we replicated Schwaninger et al. (2002) in finding better performance for the blurred than scrambled condition, $F(1,68) = 30.37$, $p < .001$. Third, we found better performance by Hong Kong participants than by Australian participants, $F(1,68) = 6.6$, $p < .05$. Despite the significant main effects, we found no significant interactions. The most important of these theoretically was the test stimulus alteration by race of face interaction. A significant interaction might show a larger own-race effect for the blurred (configural) condition than the

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[3] We replicated Schwaninger et al. (2002) in finding that all scrambled conditions and all blurred conditions were significantly above chance as measured by planned t-tests; the smallest t-value occurred for Australian participants viewing scrambled other-race faces, $t(17) = 2.003$, $p = .03$, and all other tests were significant at $p = .001$.

Table 1
Means (with between-participant standard errors) of response latencies

	Hong Kong observers			Australian observers		
Race of face	Scrambled	Blurred	Scr-Blur	Scrambled	Blurred	Scr-Blur
Own-race	3739 (442)	980 (62)	2715 (318)	3660 (264)	1281 (78)	4069 (503)
Other-race	3685 (510)	1017 (82)	2862 (597)	3979 (293)	1494 (123)	4107 (551)

scrambled (component) condition. However, as can be observed from Fig. 2 this was not the case numerically, and the *F*-value was very low, $F(1,68) = 0.29$, $p = .59$. The main effect for race of participant did not interact with any of the other variables (race of participant × race of face $F(1,68) = 1.04$, $p > .05$; race of participant × alteration, $F < 1$; race of participant × race of face × alteration, $F(1,68) = 1.23$, $p > .05$), and is not theoretically interesting.

3.2. Response latencies

To test for a possible speed-accuracy trade-off, we analysed latencies for correct responses to "old" trials (Table 1). Latencies longer than three standard deviations above the mean (totalling 1.84% of trials) were removed from each condition. For consistency with the analysis of sensitivity, we conducted a mixed ANOVA using blurred and scrambled conditions only.[4] This analysis showed a significant main effect for condition, $F(1,68) = 103.88$, $p < .001$, as responses to blurred stimuli were much faster than to scrambled stimuli. No other main effects or interactions were statistically significant. Thus, we can conclude that the effects observed for sensitivity are not caused by a speed-accuracy trade-off.

4. Discussion

We found better performance for blurred faces than scrambled faces, replicating Schwaninger et al. (2002) and supporting the widely-reported primacy of configural processing in face recognition (Diamond & Carey, 1986; Schwaninger et al., 2003). We also found that both Australian and Hong Kong participants showed an own-race advantage, and most importantly, that the ORA occurred for both configural and component information. The finding of an ORA for configural information is consistent with the findings of Michel et al. (2006a, 2006b) and Tanaka et al. (2004), but here, unlike these earlier studies, it occurred in the context of a recognition memory paradigm. The ORA for memory of component information has not been previously reported and has important implications for both accounts of race expertise in face processing and of face recognition in general.

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[4] Note that latencies for scrambled-blurred trials are meaningless as the sensitivity analysis shows that participants were simply guessing.

Our finding of an ORA for component information might be considered surprising given that both Tanaka et al. (2004) and Michel et al. (2006a) required participants to recognize individual face components, and neither found a consistent ORA for component processing (although Michel et al. did find better performance by Asian participants in both the part and whole conditions for Asian faces). There are a number of differences between our task and the two previous studies that might account for this difference in performance. The most important difference is the number of features available for recognition in the two paradigms. Whereas the component condition of our experiment used the entire face, the isolated feature condition in the Tanaka and Farah (1993) task uses just one component. This use of a single part by the latter paradigm is necessary to control for differences with the whole face condition, but it requires deletion of all face components other than the target. Just as configural processing is thought to recruit information from the entire face, any component processing route would likely function best with input from all face parts. Thus, our scrambled component condition may be more sensitive to component processing because it receives input from a broad range of components on each trial, rather than just from a single one.

A second difference between our experiment and the part/whole paradigm is that the encoding and retrieval tasks are very different. In terms of encoding, participants in our experiment had 10 s to encode each face, whereas in the part/whole experiments they had 500/1000 ms on each trial. In addition, as noted above, we used a recognition memory task, whereas the other studies employed an immediate two-alternative-forced-choice task. It is possible that the visual short-term memory mediating performance in the latter task is able to encode part shape relatively accurately, particularly when participants quickly learn that half the trials will give them only an isolated component with which to perform the recognition task. On the other hand, the long-term representations tested by our study may be more susceptible to the effects of expertise.

Given these findings, what do our results mean for the ORA and for face recognition in general? Although other studies have shown better configural processing for own-race than other-race faces (e.g., Michel et al., 2006a, 2006b; Tanaka et al., 2004), our study shows that higher efficiency at using information from own-race faces is not limited to this information channel. The superiority in own-race face recognition may be due to expertise within a range of processing pathways, each one specialized for different aspects of a face. A recently reported own-race advantage for detecting component changes in faces provides converging evidence for this conclusion (Rhodes, Hayward, & Winkler, 2006).

In turn, these results show that the use of component information can be modulated in much the same way that configural information is affected by expertise. Interestingly, Schwaninger et al. (2002) found similar results to those of the present study when comparing familiar to unfamiliar face recognition. Old-new recognition of familiar faces was better than recognition of unfamiliar newly encoded faces both for scrambled and blurred stimuli. Similar to the results reported here, there was no interaction between familiarity and presentation type (scrambled vs. blurred). Thus, both component and configural processing became better when faces were familiar, suggesting that a common underlying process could account for general familiarity with faces and for the ORA effects found in this study.

To isolate configural processing in this study we blurred the images to remove information supporting featural processing, which removed spatial frequencies higher then 20 cycles per face width. This is consistent with a recent study by Goffaux, Hault, Michel, Vuong, and Rossion (2005), in which they found that featural processing of faces was supported by high-spatial frequency filtered faces (although in their experiments the spatial frequency cutoff was 32 cycles per face width). On the other hand, Goffaux et al. found the strongest configural processing occurred with low-spatial frequency filtered faces (<8 cycles per face), which excludes much of the information from a middle band of spatial frequencies included in our blurred stimuli (and found from previous studies to support reliable face recognition; for a review, see Goffaux & Rossion, 2006; Morrison & Schyns, 2001). The extent to which our results would be replicated with faces only containing spatial frequencies lower than 8 cycles per face is not clear and needs to be investigated in future studies.

In conclusion, our results both support and broaden those of earlier studies (e.g., Michel et al., 2006a, 2006b; Tanaka et al., 2004). Whereas those studies showed better configural processing of own-race faces, we have shown (i) better processing of component information for own-race faces and (ii) the advantage for both configural and component information in own-race faces occurring within a memory test. We hope that this study renews interest in the different sources of facial information that might underlie the ORA.

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