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Holistic processing, contact, and the other-race effect in face recognition

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ABSTRACT

Face recognition, holistic processing, and processing of configural and featural facial information are known to be influenced by face race, with better performance for own- than other-race faces. However, whether these various other-race effects (OREs) arise from the same underlying mechanisms or from different processes remains unclear. The present study addressed this question by measuring the OREs in a set of face recognition tasks, and testing whether these OREs are correlated with each other. Participants performed different tasks probing (1) face recognition, (2) holistic processing, (3) processing of configural information, and (4) processing of featural information for both own- and other-race faces. Their contact with other-race people was also assessed with a questionnaire. The results show significant OREs in tasks testing face memory and processing of configural information, but not in tasks testing either holistic processing or processing of featural information. Importantly, there was no cross-task correlation between any of the measured OREs. Moreover, the level of other-race contact predicted only the OREs obtained in tasks testing face memory and processing of configural information. These results indicate that these various cross-race differences originate from different aspects of face processing, in contrary to the view that the ORE in face recognition is due to cross-race differences in terms of holistic processing.

1. Introduction

Face race has been shown to influence performance in many face tasks, such as face recognition and identification (Meissner & Brigham, 2001; Sporer, 2001), holistic face processing (Michel, Caldara, & Rossion, 2006; Michel, Rossion, Han, Chung, & Caldara, 2006; Tanaka, Kiefer, & Bukach, 2004), processing of featural and configural facial information (i.e., spacing between face features, Hayward, Rhodes, & Schwaninger, 2008; Rhodes et al., 2009; Rhodes, Hayward, & Winkler, 2006), or categorization of facial gender, age, and expression (Dehon & Brédart, 2001; Elfenbein & Ambady, 2002; O'Toole, Peterson, & Deffenbacher, 1996). Although these various other-race effects (OREs) have been demonstrated in separate studies, it remains unclear whether the influences of face race on these tasks arise from the same underlying mechanisms or from independent processes.

What underlies these OREs remains a matter of debate (Hayward, Crookes, & Rhodes, 2013; Hugenberg et al., 2010; Rhodes et al., 2010). Some propose that the OREs are caused by different level of holistic processing involved in own- and other-race faces (Hancock & Rhodes, 2008; Michel, Caldara, & Rossion, 2006; Michel, Rossion, et al., 2006; Tanaka, Kiefer, & Bukach, 2004). This hypothesis is plausible as holistic processing (i.e., perceiving face as a whole rather than a collection of independent face parts, Maurer, Le Grand, & Mondloch, 2002) is often correlated with face recognition ability (Richler, Cheung, & Gauthier, 2011; Wang et al., 2012; but see Konar, Bennett, & Sekuler, 2010; Zhou et al., 2012). Others assume that the OREs come from an own-race advantage in processing both configural (i.e., relative location and spatial relations among face parts) and featural information (i.e., face parts) (Hayward, Rhodes, & Schwaninger, 2008; Hayward, Crookes, & Rhodes, 2013; Rhodes, Hayward, & Winkler, 2006; Rhodes et al., 2009). Still others hypothesize that the OREs may stem from a general in-group/out-group bias (Sporer, 2001), which drives people to selectively attend to different facial properties for own- and other-race faces (Hugenberg et al., 2010; Levin, 2000). For own-race faces, people selectively attend to identity-diagnostic information, which is critical to discriminate different individuals. In contrast, for other-race faces, people tend to pay attention to race-diagnostic information without individuating them, therefore impairing their late recognition (Hugenberg et al., 2010).

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Although it may be difficult to disentangle different hypotheses for the ORE because they are not mutually exclusive (see also Zhao, Hayward, & Bülthoff, 2014), discerning whether or not these various OREs are supported by the same underlying mechanisms is possible. Irrespective of which hypothesis provides a better account for the various OREs, if those OREs arise from the same underlying mechanisms, then individual differences in ORE observed in one task should show some correlation with those observed in a different task. Alternatively, if the OREs observed in different tasks are mediated by different processes, then these OREs should be independent of each other.

Prior studies that have attempted to link the ORE in face recognition to that in holistic processing have found mixed results. Significant correlation between OREs in face recognition and in holistic processing has been observed in one study (DeGutis et al., 2013) but not others (Michel, Caldara, & Rossion, 2006; Michel, Rossion, et al., 2006). This discrepancy may be due to methodological differences in estimating those OREs. Whereas Michel and colleagues used a subtraction-based method to calculate the ORE (i.e., subtracting performance for other-race faces from performance for own-race faces), DeGutis et al. (2013) used a regression-based analysis (i.e., regressing out performance for other-race faces from performance for own-race faces), which may provide a more sensitive measure of correlations between different OREs. Other studies suggest that the absence of correlation reflects the independent influence of face race on face perception (e.g., holistic processing) and on face memory (Schwaninger, Ryf, & Hofer, 2003; Wilhelm et al., 2010; but see Wiese, Kaufmann, & Schweinberger, 2014).

In the present study, we investigated whether OREs observed in different face recognition tasks are mediated by the same underlying mechanisms or supported by different processes. In two experiments reported here, participants performed a set of tasks that have been reported to be sensitive to the race of face and tap into different aspects of face processing. In Experiment 1, we used the whole/part task (Tanaka, Kiefer, & Bukach, 2004), the blurred and scrambled face recognition task (Hayward, Rhodes, & Schwaninger, 2008), and the Cambridge Face Memory Tests (CFMT, Duchaine & Nakayama, 2006; McKone et al., 2012). The whole/part task was used to estimate cross-race differences in holistic processing (i.e., the whole/part advantage, Michel, Caldara, and Rossion, 2006; Tanaka, Kiefer, & Bukach, 2004). As elaborated in Tanaka and Farah (1993), holistic face processing means that "the representation of a face used in face recognition is not composed of representations of the face's parts, but more as a whole face" (p 226). Thus, recognition of face parts should be better when tested within the whole face than as isolated face parts (i.e., whole/part advantage). The blurred and scrambled task measured ORE in configural processing (recognizing faces using configural information preserved in blurred faces) and featural processing (recognizing faces using isolated face features) (Hayward, Rhodes, & Schwaninger, 2008; Mondloch et al., 2010; Rhodes et al., 2009). The original and the Chinese version of CFMTs allowed us to assess the ORE in face recognition (McKone et al., 2012). In Experiment 2, we used the composite face task to measure ORE in holistic processing and the CFMT to measure ORE in face recognition, which allowed us to examine whether our results are specific to the tasks used in Experiment 1. In both experiments, we first examined the OREs in different tasks, and then tested whether these OREs are correlated with each other.

A questionnaire was included in each experiment to measure participants' experience with other-race people. It has been shown that contact with other-race people is correlated with individual difference in OREs observed in face recognition tasks (Meissner & Brigham, 2001). For instance, more frequent other-race contacts tend to elicit a smaller ORE in face recognition (Wiese, Kaufmann, & Schweinberger, 2014), a smaller ORE in terms of face inversion effect (Hancock & Rhodes, 2008), and a smaller ORE in recognition of blurred faces (Rhodes et al., 2009). In addition, more experience in actively individuating other-race faces also leads to a smaller ORE in holistic processing, as measured with a composite face task (Bukach et al., 2012). Nonetheless, these results were observed with different studies using a diversity of questionnaires, leaving it unclear whether other-race contact affects various OREs in a similar way. The inclusion of a questionnaire along with the face recognition tasks allowed us to address this question directly.

The battery of tasks we selected here provides a comprehensive test of whether the OREs manifested in different tasks are linked to each other, and whether they are similarly affected by contact with other-race people. Strong cross-task correlations between observed OREs would suggest that they are rooted in the same underlying mechanisms. In contrast, evidence of independent OREs would suggest that face race affects various types of face processing differently.

2. Experiment 1

2.1. Participants

We tested 34 German participants (17 females, mean age = 30.4, *SD* = 7.5) at the Max Planck Institute for Biological Cybernetics, and 32 Chinese (23 females, mean age = 21.9, *SD* = 3.8) at the University of Hong Kong. In accordance with the Declaration of Helsinki, the procedures were approved by local IRBs and signed consent forms were obtained from individual participants before the experiment.

2.2. Tasks

The experiment consisted of three tasks. Each participant performed the whole/part task first, then the blurred and scrambled tasks, followed by the CFMT task. Each task was performed with both Asian and Caucasian faces. Participants were instructed to respond as accurately as possible in all tasks. The experiment ended with participants filling out a cross-race contact questionnaire.

2.2.1. Whole/part task

Stimuli. Whole and part faces were created using 96 faces (48 Caucasians, 48 Asians, half male, half female faces) from the MPI face database (http://faces.kyb.tuebingen.mpg.de, Blanz & Vetter, 1999). Faces of the same race and gender were randomly paired. For each pair, we swapped key face parts (i.e., eyes, nose, and mouth) between both faces. These feature-swapped faces were used as distractor stimuli for the original faces in the *whole condition* (Fig. 1A). We also isolated these key face parts from each face and arranged them into a non-face like configuration, forming face parts stimuli for the *part condition* (Fig. 1A). Thus, differences between two whole faces in the whole condition were exactly the same as those between two sets of face parts in the part condition. The reason for changing three key face parts at once was to minimize potential attentional bias toward to certain face parts in completing the task (e.g., the eyes, see Crookes, Favelle, & Hayward, 2013; DeGutis et al., 2013). We also introduced a small viewpoint change to avoid the use of an image matching strategy. Target faces were turned either to the left or to the right by 15°, while test faces were always presented from the frontal view.

Procedure. Participants performed a sequential matching task. Each participant had two blocks of 48 trials (2 conditions × 2 genders × 12 identities), one for each race, with block order counterbalanced across participants. In each block, whole and part trials were randomly mixed. Each trial proceeded with a fixation cross (250 ms), a blank screen (250 ms), a target face (1000 ms), the first