Vision Research xxx (2011) xxx–xxx

Contents lists available at SciVerse ScienceDirect

Vision Research

journal homepage: www.elsevier.com/locate/visres

The role of features and configural processing in face-race classification

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ARTICLE INFO

Article history:
Received 17 May 2011
Received in revised form 29 September 2011
Available online xxxx

Keywords:
Face perception
Other-race faces
Configural processing
Featural processing

ABSTRACT

We explored perceptual factors that might account for the other-race classification advantage (ORCA) in classifying faces by race. Testing Chinese participants in China and Israeli participants in Israel we show that: (a) The distinction between Chinese and Israeli faces is highly accurate even on the basis of isolated eyes or faces with eyes concealed, but full faces are categorized faster. (b) The ORCA is similarly robust for full faces and for face parts. (c) The ORCA was larger when the configuration of the inner-face components was distorted, reflecting delayed categorization of own-race distorted faces relative to own-race normally configured faces but no conspicuous distortion effect on other-race faces. These data demonstrate that perceptual factors can account for the ORCA independently of social bias. We suggest that one source of the ORCA in race categorization is the configural analysis applied by default while processing own-race but not other-race faces.

1. General Introduction

It is well documented that humans can identify faces of their own race better than of other-race faces, a phenomenon labeled "the other-race effect" (ORE; for reviews see Meissner & Brigham, 2001; Sporer, 2001). On the other hand, it has been shown that the classification of faces by race is faster for other-race than own-race faces a phenomenon labeled "the other-race advantage" (ORA; Caldara et al., 2004; Levin, 1996, 2000; Valentine & Endo, 1992; Zhao & Bentin, 2008).[1] Whereas the ORE has been extensively investigated (e.g., Byatt & Rhodes, 2004; Furl, Phillips, & O'toole, 2002; Tanaka, Kiefer, & Bukach, 2004; Valentine, 1991), the other-race categorization advantage (ORCA) received relatively less attention.

Several accounts for ORCA have been proposed in the literature. One of the most pervasive accounts is based on the multidimensional space model of face-encoding and classification proposed by Valentine and colleagues (Valentine, 1991; Valentine and 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. Classification of a face (at any subordinate level) results from summating the total activation of all nearby nodes, and increased total activation of nodes in a given group leads to faster classification. Since the subjective similarity among individual faces is reduced by experience, the descriptive dimensions are better fit to distinguish among faces from own race than from other-races. Consequently, relative to own-race faces other-race faces form a denser neighborhood in which the spreading of activation among near-by nodes is higher. The higher homogeneity of other-race than own-race faces in the representational space might lead to easier spread of activation among other-race faces which may account for the faster and more accurate classification of other-race than own race faces by race (ORCA), as well as a slower and less accurate identification of individual other-race than own-race faces (ORE).

A different account, albeit not mutually exclusive with the n-dimensional representation account, has been suggested from social psychology perspective. According to this account, the race (particularly of minority groups) is a distinctive feature the perception of which is prioritized during face processing (e.g., Levin, 1996, 2000). Such accounts explain ORCA assuming that faces are classified as own-race on the basis of the absence of the race-distinctive feature. Since finding a positive diagnostic feature is usually faster than deciding upon its absence, other-race faces are classified by race faster than own-race faces. Tentatively supporting this account, several authors found that, Caucasian observers detected a black face among Caucasian faces faster than a white face among black faces (Chiao et al., 2006; Levin, 1996, 2000), while neither African national participants nor African American participants showed a similar other-race search advantage for white faces. Whereas such findings support the notion that that ORCA might,

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[1] Note that these acronyms are very misleading. Indeed, ORA has been recently used as acronym for the "own-race advantage", which is the same phenomenon that has been labeled by "the other race effect" (Hayward, Rhodes, & Schwaninger, 2008). To avoid this confusion we used the term "other-race classification advantage" (ORCA; we thank an anonymous reviewer for this suggestion).

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doi:10.1016/j.visres.2011.10.001

indeed, reflect a strategic bias for detecting minority groups (e.g., Hugenberg, Miller, & Claypool, 2007) they do not specify what the race-distinctive features are and how they are perceived.

Several perceptual strategies are used by humans while processing a face at different levels. At the basic-level, human faces are distinguished by their characteristic global structure, that comprises of two eyes fairly symmetrically located on both sides of a vertical axis which includes the nose and the mouth, all framed by an oval contour (coined "first-order relations", Maurer, Le Grand, & Mondloch, 2002). This global structure imposes itself during face perception leading to holistic processing, that is, the mutual influence between all face features at least during the initial stages of face processing (e.g., Tanaka & Farah, 1993; Young, Hellawell, & Hay, 1987). Since the first-order relations are shared by all normal human faces, within-category individuation of faces requires a deeper analysis of the face components (such as a particular shape of the nose or the width of the lips, frequently labeled "feature analysis") as well as the computation of spatial-relations between the inner face features within the face contour (coined "second-order relations", Maurer et al., 2002). There is evidence that individual face recognition relies on both individual components (e.g., Cabeza & Kato, 2000) and on configural computations of the second-order relations (e.g., Mckone, Martini, & Nakayama, 2001; Schwaninger, Carbon, & Leder, 2003).

Regardless of the everlasting debate about whether these computations are ear-marked for face processing (Mckone, Kanwisher, & Duchaine, 2007) or represent the hallmark of perceptual expertise (Bukach, Gauthier, & Tarr, 2006), it is evident that both holistic and configural processing are modulated by the amount of visual experience (Le Grand et al., 2002, 2004) and, consequently, by the familiarity with a race (Mckone, Brewer, et al., 2007; Michel, Caldara, & Rossion, 2006). Since the experience people have with own-race faces is normally higher than with other race faces (see discussion in Brigham & Malpass, 1985) it is not surprising that, independent of face identification, all three types of processing (global/holistic, featural and configural) are more efficient when people process own-race than other-race faces (for holistic processing see Michel, Rosssion, et al., 2006; Tanaka, Kiefer, & Bukach, 2004; for configural processing see Hancok & Rhodes, 2008; Fallshore & Schooler, 1995; for features processing see Hayward, Rhodes, & Schwaninger, 2008; Rhodes, Hayward, & Winkler, 2006). Consequently, some authors accounted for the ORE by linking the higher experience with own- than other-race faces with the more effective application of face-characteristic perceptual strategies (e.g., Rhodes et al., 1989; Tanaka, Kiefer, & Bukach, 2004; but see Robins and Perera (2011) for a qualification of this view). Note, however, that such arguments do not necessarily hold for the ORCA in the classification of faces by race, which does not depend on the ability to identify individual faces. Indeed, the contrary could be assumed; the more efficient one would be with face processing the greater would be his expertise in individual face identification and, therefore, the density of the faces' representations neighborhood would be reduced. Whereas this rationale is explicitly expressed in Valentine's *n*-dimensional model, there have been only few attempts to associate the ORCA with particular processing strategies and, with the notable exception of Levin's race feature theory (2000), only a few studies were aimed at investigating the kind of perceptual information used for the identification of face race.

Unlike face individuation, classification of faces by race implies ignoring differences among individual faces while focusing on perceptual information that is common within race and distinguishes best among races. Since second-order relations are presumed to be a major source of diversity among individual faces (Farah et al., 1998; Searcy & Bartlett, 1996), it stands to reason that classification by race does not involve configural processing. Supporting this hypothesis Levin (2000) found that, although inversion slowed down the overall classification time, Caucasian participants still classified Black faces faster than Caucasian faces. Since face inversion is supposed to impede expertise-based configural processing (e.g., Diamond & Carey, 1986; Farah, Tanaka, & Drain, 1995; Rhodes, Brake, & Atkinson, 1993), the similar ORCA found for upright and inverted faces suggests that differential configural processing among races is not a major source for this effect. Alternatively, it is possible that a face's race is best defined by its global structure and/or distinctive features. Addressing the global structure hypothesis, although the first-order relations for faces of different races are similar, it is still possible that races are distinguished by the overall face-contour. Tentative support for this hypothesis was provided by Harel and Bentin (2009) who found that classification of faces as Chinese or Israeli was not impaired when high spatial frequencies were filtered out from the images but was significantly slower and less accurate when the low spatial frequencies were absent. Since low-pass spatial filtering reduces the visibility of fine details but preserves the global shape, these data suggest that global and configural information might be essential for race categorization. However, these data should be interpreted with caution because ORCA was not found in that study at any of the spatial frequency scales investigated. Turning from configural processing to race-diagnostic features, to our knowledge there are no studies that examined directly the importance of different features for race identification. To this end, the goal of the present study was to compare the use of features (eyes), global (face contour) and configural information in race categorization within and across races.

In Experiment 1, full faces, isolated eyes as well as faces with the eyes region masked by black disks were used to investigate the type of information that is used to distinguish between own-race and other-race faces. In Experiment 2, we investigated the influence of configural face distortions on race categorization, assuming that such distortion should interfere with configural computations. Hence if configural computations are applied with predilection to own-race faces, the ORCA should be enhanced when the spatial configuration of the face is distorted relative to normally configured faces.

2. Experiment 1

2.1. Introduction

The goal of this experiment was to explore the type of physiognomic information that is used to distinguish between own-race and other-race faces. To reach this goal we asked Caucasian Israelis and Chinese participants to classify the race of Israeli and Chinese faces and face parts. Since common sense and folk psychology beliefs are that the single feature which is the most distinctive between Chinese and Caucasian faces is the eyes, we focused particularly on the extent at which classification between these two races is based on the eyes, and whether the reliance on eyes for classifying own- and other-race faces differs in Chinese and Israelis. The participants were instructed to categorize stimuli as representing a Chinese or an Israeli face. There were three stimulus types: full faces, isolated eyes and faces with the eyes concealed. For full faces we expected to replicate the ORCA. If this classification, however, relies primarily on the eyes, presenting isolated eyes should not significantly reduce performance, while concealing the eyes should have a deleterious effect on race classification. However, if as suggested by Harel and Bentin (2009), global information in the face is important for race classification, then we should observe a reduction in face classification performance for isolated eyes as well as when the eyes are concealed relative to full faces,

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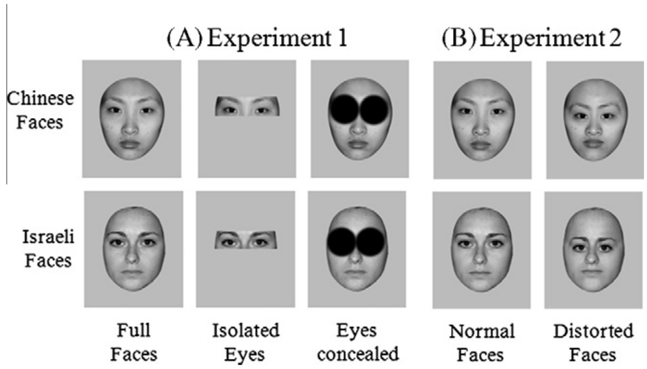

Fig. 1. Examples of the stimuli used in this study.

but even the latter stimuli should be classified correctly above chance. Comparing the ORCA when the different stimulus conditions are mixed within-subjects we could disclose whether this effect is based primarily on eyes, on global face shapes or it is similarly influenced by any type of race-defining information. In the latter case, ORCA should simply correlate with the absolute reaction times (RTs) in each group.

2.2. Methods

2.2.1. Participants

Twenty-four Chinese undergraduates (12 female) were recruited from Dalian Medical University (China) and 24 Israeli undergraduates (14 female) were recruited from the Hebrew University (Israel). Since neither of these populations had much experience with the other-race people, the effect of familiarity with faces from other-race should be conspicuous.[2] In both countries the participants' ages ranged from 20 to 30 years, with no difference between groups. All participants had normal or corrected to normal visual acuity and had no history of psychiatric or neurological disorders. All subjects were right handed based on self report and were paid for participation. They signed an informed consent to participate to this study as requested by the Institutional Review Board (IRB) of the Hebrew University.

2.2.2. Stimuli

Stimuli consisted of 54 grayscale photographs of Chinese (27 male, 27 female) and 54 Israeli (27 male, 27 female). These photographs were used to form three stimulus types, full faces, isolated eyes region and faces with the eyes concealed (Fig. 1A). All faces were of young people (20–30 years old) and were unfamiliar to the participants. They were showed in frontal view, with eyes aligned on the horizontal midline of the screen, and equated for luminance and brightness/contrast by Adobe Photoshop 7.0. Including background, the stimuli included 360 × 360 pixels. Seen from a distance of 70 cm they subtended a 9.9° of visual angle (~12 cm).

2.2.3. Design and procedure

Participants were instructed to classify each stimulus by the race it represents (Chinese or Caucasian[3]) and respond by pressing alternative buttons on the keyboard. Speed and accuracy were equally emphasized. All 324 stimuli (2 races × 3 stimulus types × 54 faces) were randomly presented in a mixed design and the mapping of response hand to the stimulus category was counterbalanced across participants. Each stimulus was presented for 500 ms at the center of the computer screen with an inter-trial interval (ITI) ranging randomly between 400 and 600 ms, starting after response. The participants completed one practice sequence of 24 stimuli (8 from each type, equally representing the two races). These stimuli were not used in the main experiment. The remaining 300 stimuli were presented in two blocks of 150 stimuli each, with a short break in-between. The experiment lasted approximately 15 min.

Accuracy rate and reaction times (RTs) (from the stimulus onset) were recorded and analyzed by ANOVA. For each participant and experimental condition RTs that were more extreme than ±2SD from the mean have been excluded (less than 2%). The Race-of-the-observer (Chinese, Israeli) was a between-groups factor and the Race-of-the-face (own-race, other-race) and Stimulus Type (full faces, isolated eyes, and faces with the eyes concealed) were within-subjects factors. The degrees of freedom for the Type-of-the-stimulus factor were corrected when necessary using the Greenhouse–Geisser epsilon.

2.3. Results

Mean RTs (to correct responses only) and accuracy for the different experimental conditions (two races of faces and three types of stimuli) are presented in Table 1 and the ORCA effects are presented in Fig. 2.

2.3.1. Reaction times

ANOVA showed that there was no main effect of Race-of-the-observer (705 ms and 686 ms for Chinese and Israeli participants, respectively; $F(1,46) < 1.00$). Importantly, there was no interaction between the Race-of-the-observer and any other factor. A significant main effect of Race-of-the-face ($F(1,46) = 13.2$, $MSE = 171$, $p = .001$; partial $\eta^2 = .22$) indicated that other-race stimuli were classified faster (671 ms) than own-race stimuli (720 ms). The main effect of Stimulus Type was also significant ($F(2,92) = 35.85$, $MSE = 165$, $p < .001$; G–G $\varepsilon = .78$; partial $\eta^2 = .44$), indicating that full faces were classified faster (662 ms) than isolated eyes (682 ms, $p < .015$), which were faster than faces with the eyes concealed (742 ms, $p < .001$). Although the ORCA was numerically larger for isolated eyes (61 ms) than for full faces (47 ms) and smallest for faces with eyes concealed (39 ms), the Race-of-the-face effect did not interact with Stimulus Type ($F(2,92) = 1.0$). In fact, none of the interactions were significant. In addition, we found an overall significant positive correlation (Pearson) across all stimulus types between the RT to own-race stimuli and the size of the ORCA ($r = .62$, $p < .001$, two tailed) but not between the RT to other-race stimuli and ORCA ($r = .13$, NS).

2.3.2. Accuracy

The percentage of correct responses was analyzed using the same statistical model as for RTs. Similar to RTs there was no main effect of Race-of-the-observer (85.9% and 88.8% for Chinese and Israelis, respectively; $F(1,46) = 3.0$, $MSE = 6.2$, $p = .091$) and there was no interaction between the Race-of-the-observer and the Race-of-the-face effects ($F(1,46) = 2.7$, $MSE = 7.5$, $p = .104$). The main effect of Stimulus Type was significant ($F(2,92) = 171.3$, $p < .001$; G–G $\varepsilon = .74$; partial $\eta^2 = .79$), reflecting that full faces were classified more accurately (93.8%) than isolated eyes (91.4%, $p < .002$), which, in turn, were classified more accurately than faces with the eyes concealed (76.9%, $p < .001$). Unlike RTs, the main effect of Race-of-the-face was not quite significant (85.7% and 89.1% for other-race and own-race stimuli, respectively; $F(1,46) = 3.0$, $MSE = 8.3$, $p = .088$), but it interacted significantly with the effect of Stimulus Type ($F(2,92) = 3.1$, $MSE = 3.9$, $p < .051$; G–G $\varepsilon = .63$;

[2] No specific measure of familiarity of the Chinese participants with Israeli faces and of Israeli participants with Chinese faces was available. However, relative to the US, Asians are by far less frequent in Israel and Dalian is not on the touristic map of most Israelis.

[3] Because most of Chinese subjects did not know the meaning of "Caucasian", the label of "foreigner" was used for Caucasian faces in Chinese group.

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Table 1
Reaction times in ms (SD) and percentage of accuracy (SD) for own-race and other race faces and face components.

		Own-race stimuli			Other-race stimuli		
		Full faces	Isolated eyes	Eyes concealed	Full faces	Isolated eyes	Eyes concealed
Chinese participants	RTs	692 (192)	726 (182)	780 (209)	633 (95)	650 (91)	749 (176)
	Accuracy	92 (8)	86 (13)	79 (21)	91 (13)	93 (9)	74 (20)
Israeli participants	RTs	679 (96)	700 (96)	742 (91)	645 (109)	654 (103)	697 (112)
	Accuracy	96 (3)	93 (5)	67 (13)	96 (4)	93 (4)	87 (11)

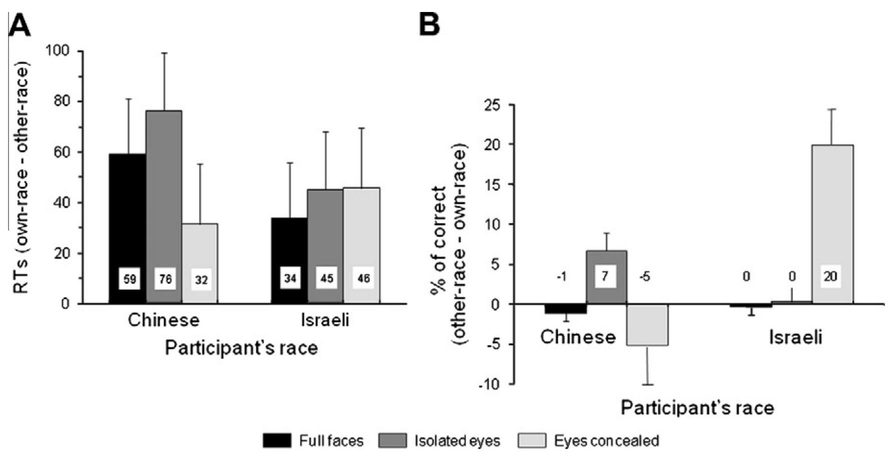

Fig. 2. The ORCA of categorization speed (A) and accuracy (B) of own-race and other-race full faces, isolated eyes, and faces with eyes concealed by Chinese and Israeli participants. More positive values indicate larger ORCA (faster or more accurate categorization of other- than own-race faces). Error bars represent standard errors of the means.

partial $\eta^2 = .06$); interestingly, this interaction was modulated by a second-order interaction with the Race-of-the-observer ($F(2,92) = 12.8$, $MSE = 16.4$ $p < .001$; G–G $\varepsilon = .63$; partial $\eta^2 = .28$). Separate ANOVAs for Chinese and Israeli participants showed that whereas Chinese participants classified all own- and other-race stimuli equally accurate (Race-of-the-face × Stimulus Type interaction, $F(2,46) = 2.3$, $MSE = 4.4$, $p = .116$), for Israelis this interaction was significant ($F(2,46) = 26.1$, $MSE = 2.7$, $p < .001$; partial $\eta^2 = .53$). t-tests showed that full faces and isolated eyes of own-race and other-race faces were classified by Israelis equally accurate, whereas a significant ORCA was found for faces with eyes concealed (67.2% and 87.2% for own- and other-race faces, respectively; $t(23) = 5.192$, $p < 001$).

2.4. Discussion

The current experiment explored the importance of eyes and global face shape for classification of Chinese and Israeli faces by race. Overall we found that full faces are classified faster and more accurately than either isolated eyes or faces with eyes concealed. However, race classification was highly accurate even when it relayed only on the eyes and also if the eyes were concealed, in which case classification was probably based on the global face contour and, possibly, on the nose and the lips thickness. Yet, it is noteworthy that whereas the accuracy for isolated eyes was only about 3% lower than for full faces, when the eyes were concealed classification accuracy was reduced relative to full faces by about 16%. Hence, it appears that although the global contours and perhaps the noses and the lips of Chinese and Israelis are sufficiently different and race-characteristic to allow classification of faces by race, the eyes are a much better cue (at least for distinguishing between Chinese and Israelis). Not surprisingly when all the face is available race classification is best.

As predicted, both Chinese and Israeli participants classified the other-race faster than own-race faces, demonstrating ORCA. Importantly, this effect was not significantly different for full faces, isolated eyes, or faces with the eyes concealed, indicating that other-race faces are classified faster than own-race faces regardless of the physiognomic information on which the decision is based. The significant correlation between the absolute classification time of own-race faces and the size of the ORCA and the absence of such a correlation between ORCA and the RT to other-race faces, suggests that the ORCA reflects primarily the difficulty to classify own-race faces as a homogeneous group rather than facilitation of classifying other-race faces.

Adopting the multidimensional representation model (Valentine, 1991), in a previous paper we accounted for the ORCA in face-race classification suggesting that the easier recognition of individual differences among own-race than among other-race faces renders the "neighborhood" of the former set less homogeneous than the latter set (Zhao & Bentin, 2008). In addition (or alternatively) it is possible that the attempt to individually identify a face might be a default strategy for own-race but not necessarily so for other-race faces. If this is so, allocating attention to the individual-face level (Mr. Chen) might delay its classification as an exemplar of its race group (Chinese). In Experiment 2 we addressed this second account for ORCA by investigating the role of configural processing.

We should notice the relative low accuracy at which Israeli faces were classified when the eyes were concealed. In this condition both Chinese and Israeli participants classified Chinese faces more accurately (albeit the 3% *own*-race advantage in the Chinese group was not significant). The simplest account for this pattern is that the face-contour is more characteristic and uniform for Chinese than for Israeli faces. In other words, the categorization of faces with eyes concealed as Chinese or Israelis was influenced pri-

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marily by the distinctive global aspect of the Chinese face. This conclusion goes along with the presumed importance of perceptual factors in face-race categorization although, in this case, it did not lead to ORCA on accuracy. However, the involvement of global perception strategies in race categorization should be considered with caution given some evidence suggesting that global processing is applied to a larger extent to own-race than other-race faces. Such evidence was provided by Michel, Corneille, and Rossion (2007) using the composite-face illusion (Young, Hellawell, & Hay, 1987). The stimuli in that study were morphed faces combining an Asian and a Caucasian face to a similar percentage. The results demonstrated more holistic processing when the morph was categorized as own-race than when it was categorized as other-race. However the composite-face effect is also based on features integration (Hole, 1994) and might also reflect a response-bias (Richler et al., 2008). Therefore, additional studies are needed in order to explore the relative use of global processing of own-race and other-race faces.

Whereas the current experiment shows that the race of full faces was classified faster and more accurately then that of isolated eyes, the performance with these two categories was not strikingly different (20 ms for speed and 2.4% for accuracy). Moreover, the race of isolated eyes was classified much faster and considerably more accurate than that of faces with eyes concealed (60 ms for speed and 14.5% for accuracy). Hence, although the present results showed that the global structure of the face might cue its race even when the eyes are concealed (particularly for Chinese faces), the pattern of the results suggests that the eyes play an important role in race-classification. This could reflect the difference in the shape of Israeli and Chinese eyes, which was detected by a detailed feature analysis, or that the eyes are the first and most important set of inner components that are processed during configural analysis of the face (Bentin et al., 2006). If only the shape of the eyes is needed to determine the race of the face, distorting the configuration of the face should not affect the speed of the race-classification. On the other hand, if configural computations are imposed while processing a face regardless of task, then differences between extracting such codes from own-race and other-race faces should modulate the ORCA. These questions are addressed in Experiment 2.

3. Experiment 2

3.1. Introduction

There is a growing body of evidence that extracting second-order relations (configural codes) is faster and more efficient for own-race than other-race faces (e.g., Rhodes, Hayward, & Winkler, 2006). Since second-order relations are very valuable cues for the distinction between individual faces (e.g., Mckone, Martini, & Nakayama, 2001; Mondloch, Geldart, Maurer, & Le Grand, 2003) this advantage can explain the other-race effect on individual face recognition (ORE). However, more efficient configural processing for own-race faces cannot account for the ORCA in face-race classification unless we make two additional assumptions: The first is that configural codes are not necessary for subordinate categorization of faces by race and the second is that configural computations are imposed on the perceiver while processing own-race but not other-race faces. If both these conditions are met then ORCA could be partly accounted for by the time and effort needed to perform these computations, which might interfere with, and delay the classification of own-race faces by race. Although there is no direct evidence to support either of these assumptions, their plausibility is suggested by a recent demonstration that the race of the face may change face perception strategies while making race decisions (Michel, Corneille, & Rossion, 2007). In that study the authors found larger composite effects when Caucasian participants classified racially ambiguous (morphed) faces as Caucasian than when they classified the same stimuli as Asian. Albeit holistic processing does not imply the extraction of configural codes and, as we mentioned before, perceptual strategies might not be the only factor affecting the composite effect (Richler et al., 2008, 2009) the Michel and colleagues study suggests that own- and other-race faces are processed differently even if face individuation is not required by the task.

In the present experiment we explored the extent at which configural (distinct from holistic) processes are differently applied to own-race and other race faces when face individuation is not required, and if such a difference exists, whether it modulates race decisions. To achieve this goal we manipulated second-order relations between the inner components of Chinese and Israeli faces while Chinese and Israeli participants classified the race of the normally configured and slightly distorted faces. Our working hypothesis was that distortion of second order relations among inner components should increase the time needed to extract the configural codes at least from own-race faces. Therefore, if configural computations delay race-decisions for own-race but have no (or reduced) effect on race decisions for other-race faces, perceivable distortions of second-order relations should augment the ORCA.

3.2. Methods

3.2.1. Participants

The participants were 28 Chinese undergraduates from Dalian Medical University in China (14 females, age-range 20–26 years) and 28 Israeli undergraduates from Hebrew University (16 female, age-range 21–28 years). Out of this sample, 14 Chinese and 14 Israeli participated in a behavioral experiment designed to compare the ability of each ethnic group to discriminate own-race and other race distorted faces from the normally configured faces. The other 14 Chinese and 14 Israelis[4] we tested in the race classification experiment. None of these participants took part in Experiment 1. They signed informed consent to participate in the study.

3.2.2. Stimuli

The stimuli were based on the faces used in Experiment 1. The distortion of second order relations in each of these faces were made by reducing the distance between the eyes by 20%, lowering the eyes and the eyebrows level relative to the tip of the nose by 20% and reducing the distance between the root of the nose and the mouth by 20% (Fig. 1B). The stimuli were equated for luminance and brightness/contrast using Adobe Photoshop 7.0 (TM).

3.2.3. Procedure

In "distortion detection task" the participants were told that the configuration of the inner components in some faces is abnormal and instructed to distinguish between "normal" and "distorted" faces by pressing alternative buttons (counter-balanced among subjects). Stimulus exposure was terminated by the participant's response and an ITI of 800 –1200 ms separated the response from the next stimulus.

The procedure of race classification task was the same as in Experiment 2. Accuracy rates and reaction times (RTs) measured from the stimulus onset were recorded and analyzed by ANOVA. For each participant and experimental condition RTs that were more extreme than ±2SD from the mean have been excluded (less than 2%). The Race-of-the-observer (Chinese, Israeli) was a between-groups factor and the within-subjects factors were Race-

[4] One Israeli subject has been excluded from the analysis for technical reasons.

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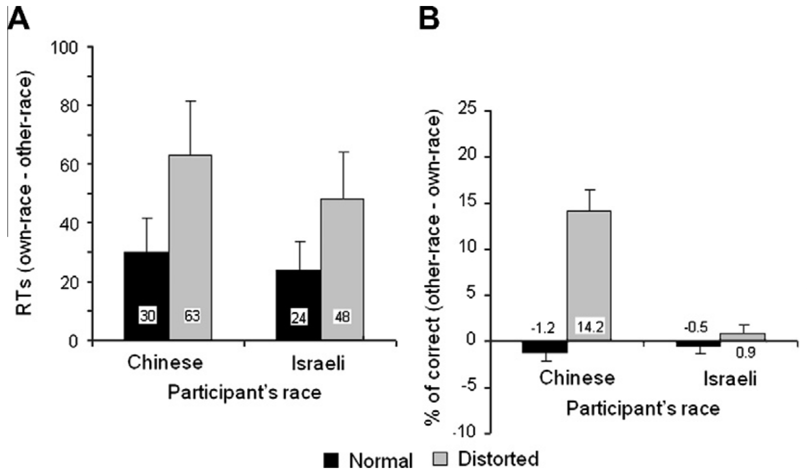

Fig. 3. The ORCA of categorization speed (A) and accuracy (B) of own-race and other-race normal and distorted faces by Chinese and Israeli participants. More positive values indicate larger ORCA (faster or more accurate categorization of other- than own-race faces). Error bars represent standard errors of the means.

Table 2
Reaction times in ms (SD) and percentage of accuracy (SD) for own-race and other-race normally configured and configural-distorted faces and distorted face-distortion effects.

		Own-race stimuli			Other-race stimuli		
		Normal faces	Distorted faces	Distortion effect	Normal faces	Distorted faces	Distortion effect
Chinese participants	RTs	531 (77)	552 (85)	21 ms	501 (95)	489 (81)	−12 ms
	Accuracy	91.6 (8)	80 (18)	−11.4%	90.4 (6)	94.2 (4)	3.8%
Israeli participants	RTs	578 (86)	604 (101)	26 ms	554 (85)	556 (90)	2 ms
	Accuracy	96.7 (5)	94.6 (6)	−2.1%	96.2 (3)	95.5 (4)	−0.7%

of-the-face (own-race, other-race) and Stimulus Type (normally configured faces, distorted faces).

3.3. Results

3.3.1. Detection of face distortion

As revealed by d' measures, Israelis distinguished between normally configured and distorted faces much better for own-race ($d' = 1.8$) than for other-race faces ($d' = 1.5$; $t(13) = 2.273$, $p < .05$). Chinese participants were equally efficient with faces of both races ($d' = 1.0$ and $d' = 1.1$ for own-race and other-race faces, respectively; $t(13) = 1.205$, $p = .25$). A Group (Chinese, Israelis) by Face race (own-race, other-race) ANOVA showed that this interaction was significant [$F(1,26) = 7.1$, $MSE = .1$, $p < .025$, partial $\eta^2 = .21$]. In addition, the analysis showed that Israelis were better than Chinese at distinguishing between normal and configural distorted faces [$F(1,26) = 4.7$, $MSE = 1.0$, $p < .05$, partial $\eta^2 = .15$]. However, post hoc analysis in each group indicated that both the Chinese and the Israelis detected face distortion significantly above chance [Chinese: $t(13) = 7.3$, $p < .001$ and $t(13) = 8.3$, $p < .001$ for Chinese and Israeli faces, respectively; Israelis: $t(13) = 6.2$, $p < .001$ and $t(13) = 9.9$, $p < .001$ for Chinese and Israeli faces, respectively].

3.3.2. Race classification performance

3.3.2.1. Reaction times. As evident in Fig. 3, for both groups of participants the ORCA was larger when classifying configural distorted faces than normally configured faces. As predicted, relatively to normally configured faces, distortion delayed race classification of own-race faces but not of other race faces (Table 2). In addition, both groups were less accurate classifying own-race faces as own-race if they were distorted than if they were normally configured (see accuracy analysis below). This tendency to consider distorted faces as other-race was more conspicuous for Chinese participants who were faster classifying other-race distorted faces as "foreigners" than classifying normally configured other-race faces as "foreigners".

ANOVA confirmed these observations. The Race-of-the-face × Stimulus Type interaction was significant [$F(1,25) = 20.3$, $MSE = 272$, $p < .001$; partial $\eta^2 = .45$]. Post hoc analysis of this interaction revealed that the ORCA was significant for both normally configured faces [$t(27) = 3.723$, $p < .001$] and for distorted faces [$t(27) = 7.339$, $p < .001$], but it was significantly larger for the latter than for the former faces set [$F(27) = 4.254$, $p < .001$]. There was no main effect of Race-of-the-observer [$F(1,25) = 2.8$, $MSE = 29{,}166$, $p = .108$; partial $\eta^2 = .10$] and no second order interaction [$F(1,25) < 1.0$].

3.3.2.2. Accuracy. Distortion also reduced the classification accuracy for own-race faces but had only very small effect on other-race faces. Israelis were more accurate than Chinese [$F(1,25) = 9.9$, $MSE = 1.2$, $p < .005$; partial $\eta^2 = .28$]. Across groups there was a significant Race-of-the-face × Stimulus Type interaction [$F(1,25) = 14.1$, $MSE = .03$, $p < .001$; partial $\eta^2 = .29$] which, unlike RTs, it was qualified by a second order interaction with Race-of-the-observer [$F(1,25) = 10.1$, $MSE = .03$, $p < .005$; partial $\eta^2 = .29$]. Further investigation of the second order interaction on accuracy was based on separate ANOVA for each nationality group. These analyses showed that the Race-of-the-face × Stimulus Type interaction was significant in the Chinese group [$F(1,13) = 16.0$, $MSE = .05$, $p < .005$; partial $\eta^2 = .55$], but not in the Israeli group [$F(1,13) < 1.00$]. t-tests showed that in the Chinese group the ORCA on accuracy was significant for distorted faces [$t(13) = 2.753$, $p < .025$] but not for normally configured faces [$t(13) = .553$, $p = .590$].

3.4. Discussion

In the current experiment we investigated the implications of configural computations on processing own-race and other-race faces in a race categorization task. Supporting previous studies we found that for both stimulus-type conditions Chinese and Israeli participants classified other-race faces faster than own-race faces (ORCA). However, the ORCA on the race classification time was twice as big for distorted faces as for normally configured faces; moreover, for accuracy, we found ORCA only for distorted faces, particularly in the Chinese group.

It is revealing that the augmentation of ORCA resulted primarily from an enhanced difficulty to classify distorted faces as own-race, whereas the classification of other-race faces was much less affected by distortion, if at all. This pattern indicates that configural distortion affected race detection primarily for own-race faces, which supports our hypothesis that an important source of ORCA is uncontrolled application of configural computations while seeing an own-race face but not while seeing another-race face. According to this view, the configural computations involved in face individuation are applied to own-race faces by default and interfere with their classification by race.

An alternative account for the augmentation of the ORCA for distorted faces could be that even slightly distorted faces look foreign and, therefore, there is a bias towards classifying distorted faces as "other-race". Tentative support for such an account might be found in the accuracy pattern of Chinese participants who classified 20% of the distorted own-race faces as other-race as opposed to only 8.4% misclassification of normally configured own-race faces. Albeit possible, there are several reasons to consider this account less likely. One reason is that we did not see a similar pattern with Israeli participants. This asymmetry is particularly intriguing because Chinese participants were less able to detect face distortion than the Israeli participants across the faces' race. Moreover, the distortion detection results suggest that distortions were more easily detected in Israeli faces than in Chinese faces by both groups of participants. Hence, if the reason for the ORCA augmentation for distorted faces would be that such faces are more easily classified as other-race, we should expect larger ORCA in Israelis than in Chinese with a special advantage of Israeli distorted faces. In fact, the opposite pattern was found. The ORCA for distorted faces was larger for the Chinese participants, that is, larger when the own-race faces were Chinese.

A second reason to doubt the response-bias account is suggested by the comparison of RTs to normal and distorted faces in the own-race and other-race face sets. Bias to classify distorted faces as other-race should have reduced the RT to other-race faces and increase the accuracy of their classification. Although a tendency for such effects are discerned in the performance of the Chinese participants, it was considerably smaller than the effect of distortion on own-race faces and completely absent in the performance of the Israeli group.

4. General discussion

The goal of this study was to shed additional light on perceptual characteristics of face-race recognition and explore putative perceptual factors accounting for the faster subordinate classification of other-race faces, by race (the other-race classification advantage – ORCA) From a sociological perspective the ORCA has been frequently interpreted as a tendency to classify members of a minority group first by race and only after that as individuals (Hugenberg, Miller, & Claypool, 2007; Maclin & Malpass, 2001; for a similar explanation addressing the ORE see Johnson & Fredrickson, 2005). This interpretation led to the hypothesis that race is processed as a facial feature, which is, perhaps, more conspicuous in other-races than in own-race (Levin, 2000). Whereas the social bias could account for the faster identification of other races, it does not provide a full mechanistic account for ORCA and, specifically, it does not preclude the possibility that perceptual factors might also explain this other-race-identification advantage. In fact, the in order for the social bias to be effective, the physiognomic differences between races must be perceived.

The perceptual factors that were suggested here to affect the categorization of a face's race are associated with the reduced familiarity that most people have with other-race faces relative to own-race faces. As a consequence of the reduced familiarity perceptual representations of individual other-race faces are less distinct forming a denser and more homogeneous neighborhood which facilitates their perception as a group (Valentine, 1991). More recent research addressed the question of whether processing of own-race and other-race faces differ at the *perceptual* level (e.g., Michel, Corneille, & Rossion, 2007; Michel, Rosssion, et al., 2006; Tanaka, Kiefer, & Bukach, 2004). Most of these studies focused on individual face matching using the composite-face paradigm and suggested that holistic processes are more prevalent in this task while matching own-race than other-race faces. Moreover, linking the familiarity account with the holistic processing account McKone and colleagues (2007) demonstrated that increasing familiarity with other-race faces increases the tendency to use holistic processing in face recognition. However, since these studies investigated the recognition of faces at the individual level, it is difficult to extrapolate their findings to subordinate face categorization by race. Here we extended the study of perceptual factors affecting face-race categorization, assessing the relative distinctive value of eyes compared with full faces and faces with eyes concealed for classifying face stimuli as Chinese or Caucasian. Moving from face features to face configuration we investigated how spatial distortion of the inner face configuration (while preserving the global structure) affects the classification of own-race and other-race faces by race. In order to minimize previous experience with faces of different races (cf., Chiroro et al., 2008; Walker et al., 2008) we tested participants in China who had very limited exposure to Western (Israeli) faces and participants in Israel who had limited experience with Chinese faces.

Across the two experiments and the two groups of participants ORCA was consistently evident in the speed of the face-race classification but not always on accuracy. This pattern suggests that the face-race can be discerned equally accurate within or across race but there are processing differences that modulate the speed at which own- and other-race faces are classified. The positive correlation found in Experiment 1 between the magnitude of the ORCA and the RTs to own-race faces and the absence of a correlation between the ORCA and the RTs to other-race faces indicate that the culprit process delays the classification of own-race faces rather than facilitating the classification of other-race faces.

In the first experiment we found that although the Chinese and Israeli races can be distinguished on the basis of either isolated eyes or faces with eyes concealed the classification of the race is faster and more accurate for full faces, when full physiognomic information is available. Hence, whereas different face features can be identified as characteristic to particular races, clearly the eyes are not used selectively to define either the Chinese or the Israeli race (or the difference between the two) at the perceptual level. Nonetheless, significant ORCA was found for all stimulus types. This pattern is consistent with previous findings showing that the ORE for face individuation is also obtained for individual components (Hayward, Rhodes, & Schwaninger, 2008).

Moreover, although there was no statistical difference between the sizes of ORCA for different stimulus types, these differences were not negligible. In fact, the ORCA was 61 ms for full faces, 47 ms for isolated eyes and only 39 ms for faces with eyes concealed. Hence, although features of other-race faces are classified faster than own race features, this advantage might be modulated by the amount and the type of the available physiognomic infor-

Please cite this article in press as: Zhao, L., & Bentin, S. The role of features and configural processing in face-race classification. *Vision Research* (2011), doi:10.1016/j.visres.2011.10.001

mation in the image as well as the typicality of a particular feature for a particular race. For example, whereas the shape of the eyes is evidently a distinctive feature when comparing Chinese and Israelis, the color of the skin or the thickness of the lips might be more important than eyes while discriminating between Israelis and Africans (cf., Hills & Lewis, 2006, for relevant evidence concerning ORE).

Based on the correlation between the magnitude of the ORCA and the RTs to own-race faces, as well as on previous evidence that own-race faces are processed with predilection to the individual level (Tanaka, 2001; see Anaki and Bentin (2009) and D'Lauro, Tanaka, and Curran (2008) for constraints and limitations of this tendency), and on models assuming that face individuation requires the extraction and computation of configural relations between face components (Levine & Calvanio, 1989; for a review see Maurer, Le Grand, & Mondloch, 2002; Mckone, Martini, & Nakayama, 2001; Rhodes et al., 1989), we hypothesized that the delay in the classification of own-race faces might reflect the interference of configural computations, which although irrelevant to face categorization by race, are imposed by the familiarity with own-race faces. This hypothesis was supported in Experiment 2 where the ORCA was significantly enhanced by configural distortions reflecting primarily modulation of the response to own-race faces. Note that although this view is similar to Levin's suggestion (2000) that the ORCA reflects primarily a delay of own-race recognition (rather than facilitation of the other-race recognition) the mechanism accounting for this delay is different. Whereas Levin proposes that the delay is caused by the time needed to determine that the "race-feature" is absent, we found a perceptual source that could account for it. Specifically, the own-race classification is delayed by the processing of configural metrics which distinguish among individual faces and, therefore, may interfere with the extraction of (race) features which are common to a group of faces. The two accounts, however, are not mutually exclusive.

Finally, the current data do not support the assumption that the tendency for holistic processing of faces is more conspicuous in Asians than in Caucasians (Tanaka, Kiefer, & Bukach, 2004). In that study the authors found that Caucasians recognized own-race faces more holistically than other-race faces whereas Asians recognized holistically both own-race and other-race faces. The ORCA for faces with eyes concealed (i.e., ORCA based primarily on global shapes) was not modulated by the race of the observer in the RT analysis, albeit it was larger for Israelis than Chinese in the analysis of accuracy. Yet, this pattern was determined by the reduced ability of the Israelis to correctly classify own-race faces when the classification was constrained only to the analysis of the global face shape. Hence, if anything the Israelis were *less* efficient in recognizing the global shape of own-race faces.

In conclusion, the present study pointed to perceptual processing differences between own-race and other-race faces that might account for the robust other-race advantage found while faces are categorized by race. Other-race faces are classified on the basis of race-specific information accumulated from the global face shape as well as individual components, and this process is not interfered with by configural computations. The classification of own-race faces by race is interfered with and delayed by the default application of configural computations that are regularly used for distinguishing among individual faces but probably irrelevant for race categorization. Although it does not disconfirm the possible involvement of a social bias in addressing own-race and other-race faces, (e.g., Bernstein, Young, & Hugenberg, 2007), the present study demonstrate that perceptual factors per se might account for ORCA, independently of such bias. Future studies should address the possible interaction between perceptual and social factors in determining the race of a person based on her face.

Acknowledgment

This study was funded by NIMH Grant R01 MH 64458-09 to S.B.

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Please cite this article in press as: Zhao, L., & Bentin, S. The role of features and configural processing in face-race classification. *Vision Research* (2011), doi:10.1016/j.visres.2011.10.001