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Visual scanning and recognition of Chinese, Caucasian, and racially ambiguous faces: Contributions from bottom-up facial physiognomic information and top-down knowledge of racial categories

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ABSTRACT

Recent studies have shown that participants use different eye movement strategies when scanning own- and other-race faces. However, it is unclear (1) whether this effect is related to face recognition performance, and (2) to what extent this effect is influenced by top-down or bottom-up facial information. In the present study, Chinese participants performed a face recognition task with Chinese, Caucasian, and racially ambiguous faces. For the racially ambiguous faces, we led participants to believe that they were viewing either own-race Chinese faces or other-race Caucasian faces. Results showed that (1) Chinese participants scanned the nose of the true Chinese faces more than that of the true Caucasian faces, whereas they scanned the eyes of the Caucasian faces more than those of the Chinese faces; (2) they scanned the eyes, nose, and mouth equally for the ambiguous faces in the Chinese condition compared with those in the Caucasian condition; (3) when recognizing the true Chinese target faces, but not the true target Caucasian faces, the greater the fixation proportion on the nose, the faster the participants correctly recognized these faces. The same was true when racially ambiguous face stimuli were thought to be Chinese faces. These results provide the first evidence to show that (1) visual scanning patterns of faces are related to own-race face recognition response time, and (2) it is bottom-up facial physiognomic information that mainly contributes to face scanning. However, top-down knowledge of racial categories can influence the relationship between face scanning patterns and recognition response time.

1. Introduction

How we process the faces of own- and other-races similarly and differently is a topic of intense interest in psychology and neuroscience (Hugenberg, Young, Bernstein, & Sacco, 2010; Meissner & Brigham, 2001; Sporer, 2001). The question has received extensive empirical investigation since the early 1900s (Feingold, 1914), in part, because the answers may elucidate a host of important issues in cognitive and social psychology, such as the role of experience in the formation of visual processing expertise and in the emergence of racial prejudice and stereotyping (Hugenberg et al., 2010; Meissner & Brigham, 2001; Shutts & Kinzler, 2007; Sporer, 2001).

It is now well established that individuals process faces from different races differentially. One of the manifestations of such differential processing is the so-called other-race effect (ORE) of face recognition: individuals generally recognize own-race faces more accurately and faster than other-race faces (for reviews, see Anzures et al., 2013; Hugenberg et al., 2010; Meissner & Brigham, 2001). Using event-related potential (ERP) and functional magnetic resonance imaging (fMRI) methodologies, researchers have also observed differences in neural responses when processing own- and other-race faces, such as differences in occipito-temporal N170 amplitude and latency (Stahl, Wiese, & Schweinberger, 2008; Vizioli, Foreman, Rousselet, & Caldara, 2010; Walker, Silvert, Hewstone, & Nobre, 2008), P2 potentials (Lucas, Chiao, & Paller, 2011; Stahl et al., 2008), N200 potentials (Lucas et al., 2011), responsiveness of a broad range of ventral temporal areas (Natu, Raboy, & O'Toole, 2011), and the activation of the ventral occipital temporal cortex including the fusiform face area (Feng et al., 2011; Golby, Gabrieli, Chiao, & Eberhardt, 2001; Natu, Raboy, & O'Toole, 2011).

In recent years, studies have also shown that participants use different eye movement strategies when scanning own- and

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other-race faces, which we would refer to as the other-race scanning effect (ORSE). This effect has been observed among individuals from not only adults (Brielmann, Bülthoff, & Armann, 2014; Brielmann et al., 2014; Fu, Hu, Wang, Quinn, & Lee, 2012; Goldinger, He, & Papesh, 2009; Wu, Laeng, & Magnussen, 2012), but children (Hu, Wang, Fu, Quinn, & Lee, 2014; Kelly et al., 2011) and even infants (Liu et al., 2011; Wheeler et al., 2011; Xiao, Xiao, Quinn, Anzures, & Lee, 2012). For example, Fu et al. (2012) recently demonstrated that the race of a face can influence participants' scanning patterns such that Chinese participants spend more time looking at the eye region of Caucasian faces relative to Chinese faces, and more time looking at the nose and mouth of Chinese faces relative to Caucasian faces. However, not all studies have found this ORSE. For example, Blais and her colleagues reported no differences between fixation patterns on own- and other-race faces (Blais, Jack, Scheepers, Fiset, & Caldara, 2008). It should be noted that they were mainly concerned with differences in face scanning strategies between Asian and Caucasian observers rather than scanning differences between own- and other-race face stimuli within one racial group of participants. However, in the face categorization task of Blais et al., a difference between fixation patterns in Asian compared with Caucasian faces for both Western and Asian observers was in fact apparent but not discussed (see Blais et al., 2008; Fig. 3).

Two important issues remain unresolved. First, it is unclear whether the differential scanning patterns of own- and other-race faces are related to participants' face recognition performance or are epiphenomenal and thus have nothing to do with our encoding and recognition of own- or other-race faces. It has been suggested that the nose centric scanning pattern of Asian observers might facilitate holistic processing for faces in general and own-race faces in particular (Blais et al., 2008; Kelly, Miellet, & Caldara, 2010). To date, no evidence exists to support this speculation. In fact, there is little evidence even to support the idea that Asian observers' nose centric scanning strategies facilitates their face recognition performance. A major goal of the present study was to address this significant gap in the literature.

To this end, we asked Chinese participants without any direct contact with foreign individuals to remember and then recognize own-race Chinese faces and other-race Caucasian faces. We used a high-temporal resolution eye tracker to observe participants' eye movements during encoding and recognition of the faces and then correlated their eye movement patterns during encoding and recognition to their recognition performance. We expected to replicate the more nose-centric pattern for the own-race Chinese faces and the more eye-centric pattern for Caucasian faces. If such scanning patterns are epiphenomenal with respect to face encoding, we would not expect to obtain any significant correlations between participants' eye movement patterns and their recognition performance. However, if participants are indeed scanning faces for critical information to encode, we should observe significant correlations between face recognition performance and the way in which participants' scanned the faces. Further, such correlations should differ for own- and other-race faces.

The second outstanding issue in the literature is the mechanism underlying Chinese observers' differential scanning of own- and other-race faces. Several possibilities could account for this effect. One possibility, the facial physiognomy hypothesis, is that Chinese faces have a different face morphology in terms of their physiognomic features relative to Caucasian faces. This explanation offers a highly bottom-up account, suggesting that the difference in own- and other-race face scanning is mainly governed by the physical features of faces. By this account, higher-level cognition should not influence significantly how individuals scan own- and other-race faces. Indeed, it has been shown that Chinese faces tend to have wider noses and smaller mouth widths than Caucasians (Le, Farkas, Ngim, Levin, & Forrest, 2002). In addition, it is possible that diagnostic physiognomic features differentiating individual Chinese faces may lie in the nose region, whereas those differentiating Caucasian faces may lie in the eye region. Also, Chinese eyes are less variable than Caucasian eyes (e.g., Le et al., 2002). For example, nearly all Chinese have black eyes, whereas Caucasian eye colors vary greatly. Thus, Chinese observers may scan more the Chinese nose region because this region affords more optimal information to differentiate individual Chinese faces than Caucasian faces, whereas they scan more the Caucasian eye region because it affords more optimal information to differentiate individual Caucasian faces than Chinese faces.

Another possibility is the so-called enculturation hypothesis. It has been suggested that in the west, making eye contact is an important social behavior one must learn in order to ensure successful social interaction (Argyle & Cook, 1976). Failure to maintain appropriate eye contact is associated with various problems such as autism and social anxiety. For this reason, westerners tend to scan the eyes of a face. In contrast, Asian societies including Chinese ones discourage direct eye contact with another interlocutor during face-to-face interaction (Li, 2004). This is because staring at the eyes of another has long been considered to be socially inappropriate. Such behavior is considered impolite and immodest. In particular, when one does so to a person of a higher social hierarchy, the former might be construed as showing disrespect to the latter. For this reason, there is evidence to show that Asian children and even infants are socialized not to have sustained eye contact with another person (Kisilevsky et al., 1998). It has been suggested by Fu and his colleagues (2012) that due to such early enculturation of gaze norms, when Chinese adults are presented with static faces of their own race, they continue their adherence to their culture's gaze norm. Because the gaze norm is learned to govern interactions among in-group members, when looking at out-group Caucasian faces, Chinese adults do not feel obliged to abide by this norm and therefore show increased visual attention towards Caucasian eyes. It should be noted, however, that Asians generally display less attention to the eye regions of both Asian and Caucasian faces than Caucasian observers (Blais et al., 2008; Kelly et al., 2010).

The enculturation hypothesis emphasizes more the role of top-down processes in the differential patterns of own- and other-race scanning. This hypothesis is in line with the socio-cognitive theoretical framework which proposes that individuals adopt different processing strategies depending on whether faces are categorized as own- or other-race (Hugenberg, Miller, & Claypool, 2007; MacLin & Malpass, 2003). Recent studies have supported the socio-cognitive theoretical perspective and found that cues which indicate membership in a particular group can not only influence encoding strategies, but also later recognition accuracy of the faces. For example, Michel, Corneille, and Rossion (2007) and Michel, Corneille, and Rossion (2010) found that Caucasian participants processed ambiguous Asian/Caucasian faces more holistically when they were categorized or perceived as own-race faces rather than other-race faces. Several studies also found that participants showed better recognition memory for racially ambiguous faces that were categorized or encouraged to be categorized as own-race faces compared to other-race faces (MacLin & Malpass, 2001; Pauker et al., 2009; Shutts & Kinzler, 2007).

To date, no clear evidence exists to support either the facial physiognomic hypothesis or the enculturation hypothesis. Thus, the second major goal of the present study aimed to test these two hypotheses directly. In particular, we used a novel design to avoid a major confound in some of the existing studies (e.g., Fu et al., 2012) where the Chinese and Caucasian faces used in those studies were different in various aspects of their physiognomy (e.g., the shape and size of the eyes, nose, and mouth). In our