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The neural correlates of memory encoding and recognition for own-race and other-race faces

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ABSTRACT

People are generally better at recognizing faces from their own race than from a different race, as has been shown in numerous behavioral studies. Here we use event-related potentials (ERPs) to investigate how differences between own-race and other-race faces influence the neural correlates of memory encoding and recognition. ERPs of Asian and Caucasian participants were recorded during the study and test phases of a Remember–Know paradigm with Chinese and Caucasian faces. A behavioral other-race effect was apparent in both groups, neither of which recognized other-race faces as well as own-race faces; however, Caucasian subjects showed stronger behavioral other-race effects. In the study phase, memory encoding was assessed with the ERP difference due to memory (Dm). Other-race effects in memory encoding were only found for Caucasian subjects. For subsequently "recollected" items, Caucasian subjects showed less positive mean amplitudes for own-race than other-race faces indicating that less neural activation was required for successful memory encoding of own-race faces. For the comparison of subsequently "recollected" and "familiar" items, Caucasian subjects showed similar brain activation only for own-race faces suggesting that subsequent familiarity and recollection of own-race faces arose from similar memory encoding processes. Experience with a race also influenced old/new effects, which are ERP correlates of recollection measured during recognition testing. Own-race faces elicited a typical parietal old/new effect, whereas old/new effects for other-race faces were prolonged and dominated by activity in frontal brain regions, suggesting a stronger involvement of post-retrieval monitoring processes. These results indicate that the other-race effect is a memory encoding- and recognition-based phenomenon.

1. Introduction

It is easier to recognize own-race faces than those of another race. This so-called other-race effect (also known as the own-race bias, cross-race effect, other-ethnicity effect, same-race advantage) is well-documented in behavioral research (e.g., Meissner & Brigham, 2001; Valentine, 1991) and in research on the neural correlates of perception (e.g., Gajewski, Schlegel, & Stoerig, 2008; Stahl, Wiese, & Schweinberger, 2008; Tanaka & Pierce, 2009; Wiese, Stahl, & Schweinberger, 2009). Although the other-race effect is rooted in differences in memory performance, systematic assessments of the neural correlates of memory processes are comparatively rare (Golby, Gabrieli, Chiao, & Eberhardt, 2001; Lucas, Chiao, & Paller, 2011; Stahl, Wiese, & Schweinberger, 2010). The present study uses event-related potentials (ERPs) to determine how lifelong experience with a race optimizes memory encoding and the subsequent recognition of faces from that race.

1.1. Memory processes underlying the other-race effect

Several behavioral studies have shown that own-race faces are more accurately recognized than other-race faces (e.g., Meissner & Brigham, 2001; Valentine, 1991). Recent studies have used specific tasks to refine these results and draw inferences about the two independent components of processing thought to underlie recognition memory: recollection and familiarity (Jacoby, 1991; Mandler, 1980; see Yonelinas, 2002, for a review). *Recollection* corresponds to the retrieval of specific, meaningful information about a studied face and its learning context. In this case, the subject remembers not just the face, but also such information as where the person was last seen or what the person's name is. *Familiarity* lacks the retrieval of such episodic details and arises instead from identifying a global similarity between a seen face and information stored in memory. In this instance, the subject knows that he or she has seen the person, but cannot recall any additional contextual information.

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Various experimental paradigms are used to measure recollection and familiarity. The one most often used is the Remember–Know procedure (Tulving, 1985). Participants are asked to indicate the reasons for classifying a previously studied item as “old.” If aspects from the study episode are recalled together with the item, participants shall judge this item as “remembered.” If participants feel that the item is old but do not remember any details from the study phase, they are asked to judge it as “known.” “Remember” responses indicate recollection-based retrieval and “know” responses familiarity-based retrieval.

Previous research has suggested that both recollection and familiarity are influenced by the race of a face. Studies using Remember–Know tasks have shown that the own-race advantage results from higher “remember” hit rates for own-race as compared to other-race faces and thus from more accurate recollection-based processing of studied faces (Horry, Wright, & Tredoux, 2010; Marcon, Susa, & Meissner, 2009; Meissner, Brigham, & Butz, 2005). These studies have also reported fewer false alarms for own-race than for other-race faces. Familiarity has been linked to false alarm rates in Remember–Know tasks (Diana, Reder, Arndt, & Park, 2006), and it is thus likely that familiarity processes are enhanced for own-race faces as well. This influence of familiarity is only seen in false alarms but not in hit rates.

Previous behavioral other-race studies have also suggested that the other-race effect is an encoding-related phenomenon because superior and more detailed memory encoding facilitates the recognition of own-race faces (Marcon et al., 2009; Meissner et al., 2005). This is in accordance with studies on the Remember–Know procedure, which have shown that recollection, as compared to familiarity, is influenced by a deeper (i.e., generative or semantic) memory encoding (e.g., Yonelinas, 2002).

1.2. Theoretical accounts of the other-race effect in memory

Different theories have been put forward to account for the other-race effect in memory. Two different, but not mutually exclusive perspectives shall be briefly considered.

Perceptual expertise accounts (Meissner & Brigham, 2001; Rossion & Michel, 2011; Valentine, 1991) propose that the other-race effect is based on perceptual mechanisms that develop with increasing experience. Greater experience with own-race faces leads to better, more efficient memory processes for own-race faces only (Michel, Caldara, & Rossion, 2006; Michel, Rossion, Han, Chung, & Caldara, 2006; Tanaka, Kiefer, & Bukach, 2004). Supporting evidence for this view includes the intensification of the other-race effect from childhood to adult age (Chance, Turner, & Goldstein, 1982), the attenuation or even reversal of the other-race effect when children are adopted in an other-race environment (Bar-Haim, Ziv, Lamy, & Hodes, 2006; Sangrigoli, Pallier, Argenti, Ventureyra, & de Schonen, 2005), and the disappearance of the other-race effect after intensive other-race training (Goldstein & Chance, 1985; Tanaka & Pierce, 2009). Furthermore, the diagnostic information used to individuate faces differs within a race (Furl, Phillips, & O’Toole, 2002) and can only be learned over time (Hills & Lewis, 2006). Finally, the perceptual processing advantages that characterize own-race face recognition are similar to the processes that experts exhibit for the recognition of objects in their domain of expertise (Bukach, Gauthier, & Tarr, 2006; Scott, Tanaka, Sheinberg, & Curran, 2006, 2008).

In contrast to expertise-based interpretations, *socio-cognitive accounts* seek the origin of the other-race effect primarily in the social lives of humans but also suggest the influence of some expertise factors (Hugenberg, Young, Bernstein, & Sacco, 2010). They assume that poor recognition of other-race faces is caused by motivational and/or attentional factors that overemphasize the race (or group membership) of faces at the expense of their individuality. In-group/out-group differences (Sporer, 2001), situational contexts (Hugenberg, Miller, & Claypool, 2007; Wilson & Hugenberg, 2010), or racial biases (Levin, 2000) can lead to preferences in such processes as the individuation of own-race faces or the categorization of other-race faces, which can cause other-race effects in memory performance. Results of a recent study, however, did not support these assumptions (Rhodes, Lie, Ewing, Evangelista, & Tanaka, 2010). In accordance with behavioral studies of the other-race effect (see Section 1.1), socio-cognitive accounts attribute the other-race effect to differences in memory encoding (Hugenberg et al., 2010).

1.3. Electrophysiological correlates of memory processes

The present report focuses on three memory-related ERPs: difference due to memory (Dm), the parietal old/new effect, and the late-frontal old/new effects. All ERPs are commonly measured as difference waves between experimental conditions (e.g., “remember” minus “know”, “remember” minus new). As compared to the parietal and late frontal old/new effects, research on the Dm showed less consistent results with regard to its time course, scalp distributions, and task sensitivities.

A Dm reflects the encoding of new representations into long-term memory and, in most studies on face recognition, is characterized by a central–parietal positivity between 300 and 1000 ms in the study phase of an experiment (e.g., Sommer, Schweinberger, & Matt, 1991; Yovel & Paller, 2004). The central–parietal scalp topography is consistent with prefrontal, medial-temporal, and parietal areas that have been identified as brain regions generating subsequent memory effects in fMRI studies (Kim, 2011; Spaniol et al., 2009). Dms are obtained by sorting ERPs recorded in the study episode according to the participant’s memory judgments in the subsequent recognition test. In most studies on face recognition, faces that were correctly recognized in the test phase (i.e., old hits) elicited more positive activity over central–parietal regions than faces that were subsequently forgotten (i.e., old items incorrectly judged as “new,” e.g., Sommer et al., 1991). In most Remember–Know studies, test items that were subsequently judged as “remembered” were found to show a greater central–parietal positivity during the study phase than test items that were subsequently judged as “known” (e.g., Friedman & Johnson, 2000; Yovel & Paller, 2004). A recent study found differences in Dms for own-race and other-race faces (Lucas et al., 2011). The Dm between subsequently, correctly recognized and subsequently forgotten items was larger for own-race than other-race faces.

Each of the two retrieval processes underlying recognition memory, familiarity and recollection (Jacoby, 1991; Mandler, 1980; Yonelinas, 2002), has been associated with characteristic ERPs measured by differences between successfully recognized old and correctly rejected new items in the test phase. The parietal old/new effect is a parietal positivity between 500 and 800 ms that is considered an index of recollection because it varies with the recollection of information from the study episode (Curran, 2000; Curran & Hancock, 2007; Rugg & Curran, 2007; Yovel & Paller, 2004). It is most likely generated in the parietal cortex (Spaniol et al., 2009).[1] A few studies have provided evidence for the influence of increased experience on the parietal old/new effect. Stahl et al. (2010) found

[1] The FN400, a frontal positivity between 300 and 500 ms, is thought to reflect processes of familiarity (see Rugg and Curran, 2007, for a review). It distinguishes hits from correct rejections without being influenced by the recollection of details from the study episode (e.g., Curran, 2000; Curran and Hancock, 2007; Rugg and Curran, 2007). In the present study, we did not find a significant FN400 and thus restrict our report to the parietal and late-frontal old/new effects.