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CAN PERCEPTUAL EXPERTISE ACCOUNT FOR THE OWN-RACE BIAS IN FACE RECOGNITION? A SPLIT-BRAIN STUDY

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The own-race bias (ORB) in facial recognition is characterised by increased accuracy in recognition of individuals from one's own racial group, relative to individuals from other racial groups. Here we report data from a split-brain patient indicating that the ORB may be tied to functions lateralised in the right cerebral hemisphere. Patient JW (a Caucasian) performed a delayed match-to-sample task for faces that varied both the race of the facial memoranda—Caucasian or Japanese—and the cerebral hemisphere performing the task. While JW's left hemisphere showed no effect of race on facial recognition, his right hemisphere demonstrated a significant performance advantage for Caucasian faces. These findings are discussed in relation to stimulus familiarity and the development of perceptual expertise.

Humans are endowed with an exceptional ability to recognise faces. Interestingly, however, performance on face recognition tasks is significantly better when it involves faces of members of one's own racial group, relative to when remembering faces from other racial groups. Referred to as the own-race bias (ORB)—or cross-race deficit—(Brigham & Malpass, 1985; Chance & Goldstein, 1996; Meissner & Brigham, 2001), this advantage for own-race recognition indicates that the mnemonic processes used to encode and recognise faces differ as a function of the racial category involved. Yet, it remains unclear how to characterise these differences in terms of the underlying perceptual and cognitive processes involved. Towards addressing this issue, here we present evidence from a split-brain patient demonstrating that the ORB is linked to cortical processes lateralised to the right cerebral hemisphere.

Several theories for the ORB have been proposed (see Sporer, 2001), but the most parsimonious explanation is that mnemonic disparity is related to differences in the frequency with which the perceiver encounters—or has had contact

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with—own-race relative to cross-race faces (Brigham & Barkowitz, 1978; Caroo, 1986; Golby, Gabrieli, Chiao, & Eberhardt, 2001). Supporting this proposal, the differential frequency of contact or experience with own- versus cross-race faces has been found to mediate racial face recognition in both children (Feinman & Entwistle, 1976) and adults (Wright, Boyd, & Tredoux, 1999). If valid, how does the level of contact with a particular race relate to mnemonic performance? It has been proposed that the encoding and processing of frequently experienced objects is underpinned by *perceptual expertise* (Diamond & Carey, 1986), which enables familiar objects to be encoded in a holistic manner relative to less familiar objects, which are coded based on their constituent features rather than on the object as a whole (Yin, 1969). As a consequence, perceptual expertise may thus provide a mechanism for efficient exemplar-individuation that would favour more familiar objects over less familiar objects—such as same-race versus cross-race faces.

Importantly, perceptual expertise (or the ability to process configural or coordinate representations) has been tied to cortical processes lateralised in the right cerebral hemisphere (Barton, Press, Keenan, & O'Connor, 2002; De Renzi, 1986; Gauthier, Behrmann, & Tarr, 1999; Gauthier, Skudarski, Gore, & Anderson, 2000; Gazzaniga & Smylie, 1983; Kosslyn, Koenig, Barrett, Cave, Tang, & Gabrieli, 1989; LeGrand, Mondloch, Maurer, & Brent, 2003; Rossion et al., 2000; Schultz et al., 2000). In order to test the hypothesis that the ORB is in fact driven by perceptual expertise, we examined facial recognition performance in a Caucasian split-brain patient (JW). Because the callosal connections between the two cerebral hemispheres have been surgically severed in these patients, visual stimuli presented in the left and right visual fields will be exclusively processed in the right and left cerebral hemispheres, respectively. Split-brain patients thus offer a unique approach for assessing the relative contribution of the two cerebral hemispheres to the own-race bias in face recognition. If the ORB is related to perceptual expertise, it is predicted that JW would show superior recognition performance for Caucasian relative to non-Caucasian faces when his right cerebral hemisphere was performing the task, and likewise, that race would not affect recognition performance when his left hemisphere was performing the task.

METHOD

Case history

JW is a 51-year-old, right-handed Caucasian male who underwent a two-stage callosotomy for the relief of pharmacologically intractable epilepsy in 1979. Stage one included section of the posterior corpus callosum including the splenium. Stage two was performed some 10 weeks later and included sectioning the remaining anterior portion of the corpus callosum. As a result, JW was left with a complete disconnection of the callosal fibres connecting the two cerebral hemispheres (see also Gazzaniga, Nass, Reeves, & Roberts, 1984; Siditis, Volpe, Wilson, & Gazzaniga, 1981, for a more detailed description). JW's experience of Asian individuals was assessed using a modified version of the Plant and Devine (2003) questionnaire (see Appendix A). In this four-item questionnaire, JW scores a mean of 1 (the lowest possible score) for previous experience of Asian people.

Stimuli and procedure

The experiment was performed using a Macintosh G4 laptop computer using Psyscope software (Cohen, Macwhinney, Flatt, & Provost, 1993). Colour digital photographs of male Caucasian and Japanese faces were used as stimuli for the experiment. Within each racial group, 12 pairs of faces were matched on the basis of broad physical appearance (e.g., hair colour and style, eye colour, facial expression, and skin tone); on each trial, a single face from one of these pairs was presented as the target face to-be-remembered, and then the pair was presented together during the test phase as target and similar distractor. Which face

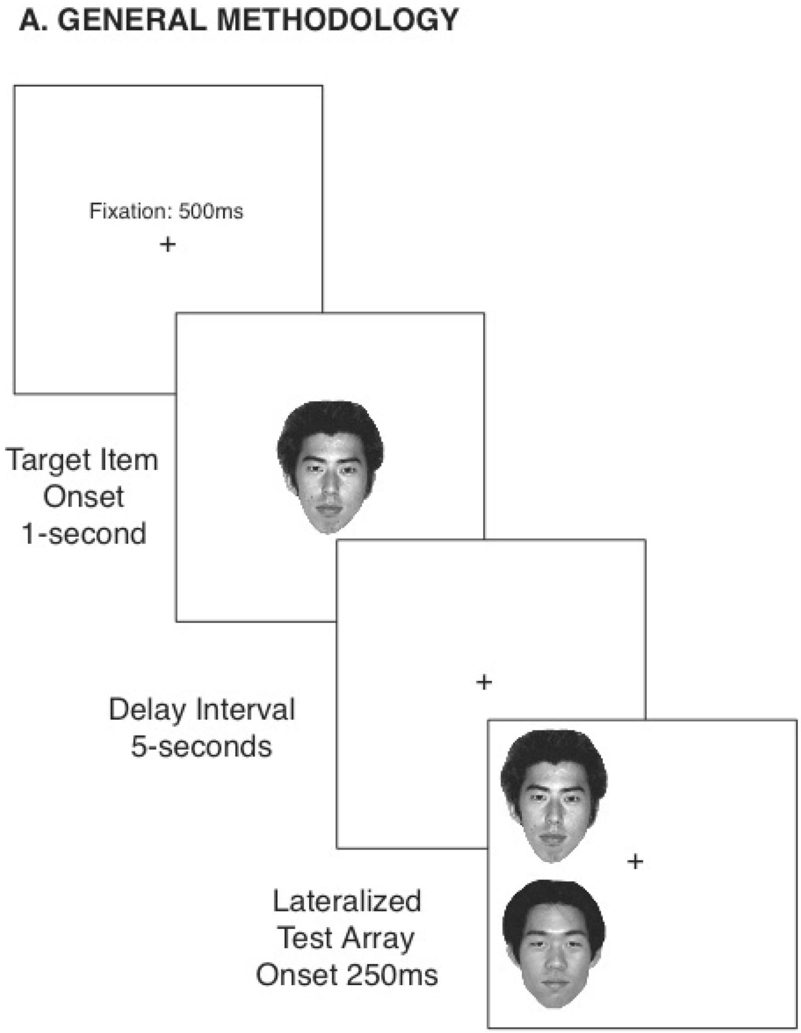

Figure 1. *Sequence and timing of stimuli. Shown is a Japanese pair of faces.*

of the pair was used as distractor was randomised across trials, along with the order of race. Each face image subtended to 4.5° by 4.5° of visual angle at a viewing distance of 57 cm. Each trial began with a fixation point for 500 ms, followed by a centrally presented face for 1 s. Following a 5 s retention interval, facial recognition performance was then assessed by presenting the target and distractor faces for 250 ms, always in either the left or right visual field (6.3° to centre from fixation), and always in a stacked manner such that one face was above the horizontal meridian and the other was below the meridian. JW was asked to identify whether the top or bottom face was the target by means of a two-choice button-press. Each testing session had 96 randomly presented trials, during which each pair of faces was presented 4 times (twice to each cerebral hemisphere). A total of

11 testing sessions were performed by JW, all on separate days.[1]

RESULTS

Analysis was based on performance accuracy. Each of the 11 testing sessions was considered as a separate observation in a 2 (left hemisphere vs. right hemisphere) $\times$ 2 (Caucasian vs. Japanese face) repeated measures ANOVA. The results showed a dissociation in JW's face recognition performance as a function of the hemisphere performing the task (Figure 2), with the right hemisphere outperforming the left, $F(1, 10) = 14.48$, $MSE = 71.27$, $p < .004$. More importantly, however, there was a significant effect of race on recognition accuracy, $F(1, 10) = 40.41$, $MSE = 99.00$, $p < .001$, which also interacted with the hemisphere performing the task, $F(1, 10) = 12.76$, $MSE = 40.09$, $p = .005$. We thank two anonymous reviewers for highlighting the potential problem of floor effects in the data for Japanese face recognition. In order to ensure that performance in these cells was significantly different from chance, we ran one-sample t-tests on each of the three ANOVA cells where performance was low. Performance in the left hemisphere for Japanese faces showed a percentage accuracy score of 56.44% (2.27%, 1 *SE*). A one-sample t-test contrasting this with chance performance (50%) shows a significant difference, $t(10) = 2.833$, $p < .02$, 2-tailed; similarly, performance accuracy for Japanese faces in the right hemisphere was 59.09% (2.30%) and this was also significantly different from chance, $t(10) = 3.95$, $p < .01$, 2-tailed. Finally, recognition accuracy for Caucasian faces in the left hemisphere was 60.98% (3.29%), and this was also significantly different from chance, $t(10) = 3.34$, $p < .01$, 2-tailed. The interaction was confirmed via separate ANOVAs within each hemisphere, which showed no influence of race on recognition performance in the left hemisphere, $F(1, 10) = 2.57$, $MSE = 6.55$, but a significant effect of race in the right hemisphere, $F(1, 10) = 43.52$, $MSE = 132.55$, $p < .0001$.

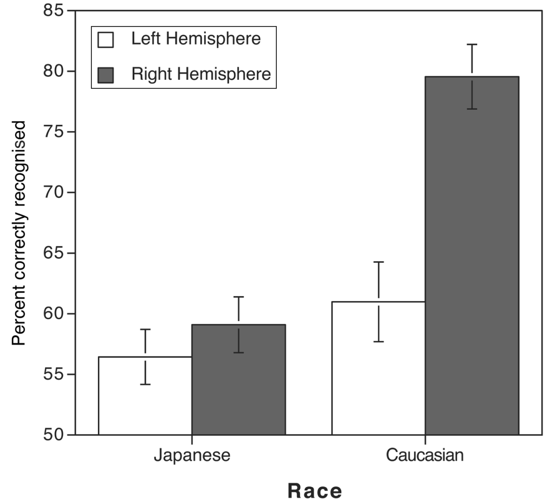

Figure 2. *Accuracy performance for JW as a function of the hemisphere performing the task and the race of the face pair. An interaction between hemisphere and race was found such that recognition performance was unaffected by race for the left hemisphere, whereas the right hemisphere was more accurate for Caucasian faces relative to Japanese faces.*

DISCUSSION

Our data are consistent with the proposal that the ORB in face recognition reflects in part greater perceptual expertise (the ability to engage in configural processing) in processing own-race faces, relative to faces from other races (Fallshore & Schooler, 1995; Rhodes, Brake, Taylor, & Tan,

[1] Nine neurologically normal Caucasian participants were also tested, each on one single occasion. They were drawn from the pool of undergraduate students at Dartmouth College. All participants gave informed consent to the experiment and received either class credit or financial compensation for their involvement. Face recognition in these subjects was characterised by a significant effect of race, $F(1, 8) = 14.79$, $MSE = 69.44$, $p > .005$, but there was no effect of visual field, $F(1, 8) = 0.26$, $MSE = 1.00$, and no interaction, $F(1, 8) = 0.10$, $MSE = 0.44$. Mean recognition performance levels for the race effect were: 81.26% (*SE* 4.34%) for Japanese and 92.82% (*SE* 1.65%) for Caucasian faces.

1989; but see also Valentine & Bruce, 1986). Indeed, JW reports no actual contact with Asian individuals and this is reflected in impoverished memory performance in his right cerebral hemisphere for Japanese faces. Perceptual expertise is characterised by a shift in processing strategy from feature-based representations encoded by the left hemisphere to holistic representations encoded by the right hemisphere (Rossion et al., 2000). Within this context, JW's superior performance for Caucasian faces processed by the right cerebral hemisphere—relative to when processing Japanese faces—would be ascribed to greater configural or coordinate processing undertaken on own-race faces. At the same time, although the right hemisphere appears to show a dominance over the left in terms of face processing per se (e.g., Kanwisher, McDermott, & Chun, 1997), this general hemispheric asymmetry—while explaining JW's poor performance for all faces processed by the left hemisphere—cannot explain why the right-hemisphere advantage seen in JW was race-specific. Instead, JW's data pattern is suggestive of right-lateralised configural processing of Caucasian faces.

Importantly, the data from this study are in direct contrast with a recent neuroimaging study by Golby et al. (2001), who examined the correlation between the fMRI response during face encoding and subsequent long-term recognition memory for those faces. Specifically, although the Golby study reported an own-race bias in memory performance, the effect was correlated with left- rather than right-lateralised cognitive processes. One possible explanation for the apparent contradiction between this result and ours is the difference in memory duration employed across the two experiments, as we utilised a short-term memory delay consistent with retention in working memory, but Golby et al. were interested in measuring recognition performance associated with long-term episodic memory. How might this change the nature of processing involved? Memory for faces over retention intervals extending beyond about 10 s appears to be functionally dependent upon left-hemisphere structures (Haxby, Ungerleider, Horwitz, Rapoport, & Grady, 1995). At these longer durations the iconic representation held by the right hemisphere is transformed via feature elaboration into a more durable representation. Indeed, these lateralised transformations are reflected in subjects' reported change in style from visual encoding of the face to a concentration on "distinctive features or expressions when the delay was longer" (Haxby et al., 1995, p. 79). If so, this could then account for why—despite likely contributions of right-hemisphere perceptual expertise processes in the encoding of same-race faces—Golby et al. found the ORB to be correlated with haemodynamic activity in the left hemisphere.

In summary, our data indicate that the ORB in face recognition appears to be dependent upon right-lateralised cognitive processes. While feature-based or categorical representations employed by the left hemisphere may enable a degree of successful face processing across all racial face-types, it is clearly not as effective as relying on right-hemisphere processes associated with perceptual expertise, reflected in more configural or coordinate representations. Levine (1996) argues that for Caucasian individuals, cross-race face processing is characterised by the encoding of a race-specific visual feature. This type of information processing leads to faster classification of cross-race faces, but does not afford sufficient information with which to individuate exemplars from this group, and thus inevitably leads to impoverished recognition performance. Simply encoding the presence of a race-specifying feature would therefore lead to large numbers of false-positive identification errors for cross-race faces, since the majority of faces will contain such a feature. Indeed, a pattern of high numbers of both hits and false alarms is a characteristic of cross-race face recognition (Glanzer & Adams, 1990; Meissner & Brigham, 2001). This "mirror effect" in hits and false-positives is also a characteristic of left-hemisphere visual recognition performance (Metcalfe, Funnell, & Gazzaniga, 1995). The data obtained from a Caucasian split-brain patient in this study further emphasise differences in lateral processing undertaken on own- and cross-race face exemplars.

Since cross-race face recognition was no different in each cerebral hemisphere, our data also support the notion that processes engaged by the right hemisphere during face encoding may not necessarily be face-specific. Rather, for JW at least, they may be better characterised as specific to own-race faces, and thus reflect processes associated with perceptual expertise or configural processing that can be applied across any number of different stimulus types for which the perceiver has sufficient previous experience (Gauthier et al., 1999, 2000; Gauthier, Curran, Curby, & Collins, 2003).

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APPENDIX A

Quantity of previous interracial contact (modified from Plant & Devine, 2003)

Amount of previous experience with Asian people

1. In the past, I have interacted with Asian people in many areas of my life (e.g., school, friends, work, clubs).

(Strongly Disagree) 1 2 3 4 5 6 7 8 9 (Strongly Agree)

2. The neighborhood(s) I grew up in had mostly White people.

(Strongly Disagree) 1 2 3 4 5 6 7 8 9 (Strongly Agree)
Reverse Scale

3. The high school I attended had mostly White students.

(Strongly Disagree) 1 2 3 4 5 6 7 8 9 (Strongly Agree)
Reverse Scale

4. In the past, I have rarely interacted with Asian people.

(Strongly Disagree) 1 2 3 4 5 6 7 8 9 (Strongly Agree)
Reverse Scale