Journal of Experimental Social Psychology 47 (2011) 1162–1166

Contents lists available at ScienceDirect

Journal of Experimental Social Psychology

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

Reports

Hemispheric asymmetry in cross-race face recognition☆

Joshua Correll *, Caroline Lemoine, Debbie S. Ma

University of Chicago, Chicago, IL 60637, United States

ARTICLE INFO

Article history:
Received 22 December 2010
Revised 30 March 2011
Available online 13 April 2011

Keywords:
Cross-race recognition
Face recognition
Hemispheric asymmetry

ABSTRACT

This study examines two phenomena related to face perception, both of which depend on experience and holistic processing: perceivers process faces more efficiently in the right hemisphere of the brain (a hemispheric asymmetry), and they typically show greater recognition accuracy for members of their racial ingroup (a cross-race recognition deficit). The current study tests the possibility that these two effects are related. If asymmetry depends on experience, it should be particularly evident with (more familiar) ingroup faces; if cross-race recognition relies on holistic processing, it should be particularly evident for faces presented to the right hemisphere. Black and White participants viewed Black and White faces presented to either the left or right visual field. As predicted, participants showed a more pronounced asymmetry for ingroup (rather than outgroup) faces, and cross-race recognition deficits were more pronounced for stimuli presented to the left (rather than the right) visual field.

As a social species, people have a fundamental concern with the thoughts, feelings and behavior of others. Of course, we cannot directly observe cognition or emotion, but we can infer a great deal from faces. Recognizing old friends, identifying social threats and opportunities, coordinating physical activity all depend on making sense of the faces of other people. It is not surprising, then, that psychology has devoted extensive attention to face perception. The current paper examines two well-researched phenomena. The first is an asymmetry, such that the right hemisphere of the brain is more heavily implicated in face processing than the left. The second is a deficit in the recognition of people from other racial groups. Though these phenomena have generally been studied independently, our findings suggest that they may reflect two facets of a common process.

Hemispheric asymmetries in face recognition

By 9–10 months of age, children begin to show right-hemispheric dominance when discriminating between novel and familiar faces (Passarotti, Smith, DeLano, & Huang, 2007). This asymmetry consolidates during early and middle childhood – seeming to emerge first for highly familiar faces, then extending to less familiar faces (Levine, 1985) – as processing becomes progressively more reliant on regions in and around the right fusiform gyrus. These regions, which have been implicated in configural or holistic processing (Hillger & Koenig, 1991; Dien, 2009), respond with increasing selectively to upright faces (e.g., not upright houses or inverted faces). By adulthood, most perceivers demonstrate faster, more holistic, more accurate processing when faces are presented in the left visual field (LVF) rather than the right visual field (RVF), and are thus preferentially processed in the right hemisphere (Dien, 2009; McCarthy, Puce, Gore, & Allison, 1997). In sum, hemispheric asymmetry in face processing is consolidated during childhood partly as a function of extensive exposure to, and expertise with, faces in the perceiver's environment.

Race-based deficits in face recognition

Clearly, some faces are more common in an individual's environment than others. For example, infants presumably encounter the faces of relatives with much higher frequency than other faces. And, given class- and race-based segregation in many communities (informal though it may be), exposure throughout the lifespan may disproportionately involve people of the same race as the perceiver (Glaeser & Vigdor, 2001). Disproportionate exposure to racial ingroups has been implicated in a phenomenon known variously as the Own-Race Bias, the Other-Race Effect and the Cross-race Recognition Deficit[1] (CRD) (Meissner & Brigham, 2001): in recognition tasks, perceivers are generally more accurate when responding to same-race faces. Like hemispheric asymmetry, the CRD seems to emerge early in development (Kelly, Quinn, Slater, Lee, Ge, & Pascalis, 2007; Sangrigoli & de Schonen, 2004; see Kinzler, Shutts, & Correll,

☆ Author Note: This material is based upon work supported under National Science Foundation Continuing Grant 0642580. We wish to thank Jasmin Cloutier, Katherine D. Kinzler, Howard C. Nusbaum, and Susan C. Levine for many insightful comments on this work.

* Corresponding author at: Department of Psychology, University of Chicago, Chicago, IL 60637, United States.
E-mail address: jcorrell@uchicago.edu (J. Correll).

1 Because Cross-race Recognition Deficit specifies the relevance of both (a) race and (b) recognition, as well as (c) the direction of the effect – a *deficit* in processing the racial outgroup – we prefer and use this term.

0022-1031/$ – see front matter
doi:10.1016/j.jesp.2011.04.001

2010, for a review). At three months of age, infants discriminate between faces that belong to racial outgroups as well as they differentiate between the faces of ingroup members — they can even distinguish the faces of non-human primates. However, between six and nine months, perceptual narrowing occurs, and infants gradually lose the capacity to distinguish between outgroup members — they begin to show a CRD. The onset and magnitude of the CRD seem to depend on the extent of the individual's experience with faces of outgroup members. Infants who are exposed to outgroup faces retain the ability to make distinctions for that group (Pascalis et al., 2005, Sangrigoli & de Schonen, 2004), and adult participants who have more extensive experience with outgroup faces tend to show a less pronounced CRD (Meissner & Brigham, 2001).

Moreover, the CRD (like hemispheric asymmetry) seems to reflect differences in *configural* processing. Participants engage in more holistic processing of ingroup faces and more feature-based processing of outgroup faces (Michel, Caldara, & Rossion, 2006; Michel, Rossion, Han, Chung, & Caldara, 2006). For example, relative to other-race faces, recognition of same-race faces is particularly sensitive to inversion, which is thought to disrupt configural processing (Rhodes, Brake, Taylor, & Tan, 1989).

Integrating hemispheric asymmetry and the CRD

Hemispheric asymmetry and the CRD share a number of characteristics. They both emerge early in the developmental process, depend on extensive exposure, and reflect holistic processing. These parallels raise questions about the relationship between these phenomena. If exposure promotes holistic face processing through the gradual consolidation of activity in the right hemisphere, hemispheric asymmetry may be most pronounced for (more familiar) ingroup faces. By the same token, enhanced configural recognition of ingroup (relative to outgroup) faces may be most pronounced in the right hemisphere, which seems to be more heavily implicated in holistic processing.

A recent study by Turk, Handy, and Gazzaniga (2005) examined the performance of JW, a right-handed White epileptic patient, whose therapy involved complete disconnection of the corpus callosum, severing communication between the hemispheres of the brain. The researchers presented JW with male faces that were either White (his racial ingroup) or Japanese (an outgroup). Initially, a to-be-remembered (TBR) face was presented. Subsequently, the TBR face and a foil appeared in either the LVF or the RVF, and JW was asked to indicate the location of the TBR face. JW demonstrated both an asymmetry (LVF>RVF) and a CRD (White>Japanese). More interestingly, an interaction emerged, such that the hemispheric asymmetry was more pronounced for White (or ingroup) faces; equivalently, the CRD was more pronounced when the test faces were presented in the LVF than in the RVF. These data are fascinating, but they have limitations. Most obviously, they rely on a single participant with severe epilepsy who had undergone extensive brain surgery. It is also possible that the effects were driven by low-level visual properties of the stimuli. That is, the White face stimuli may have differed from the Japanese stimuli along dimensions that selectively improve processing in the right hemisphere (e.g., spatial frequency, Sergent & Hellige, 1986).[2] We do not know if a Japanese version of JW would show enhanced asymmetry in recognition for Japanese faces (because they represent the ingroup) or for White faces (because of visual properties that characterize those images).

Moving beyond visual half-field studies, research examining the interaction of race and hemispheric asymmetry shows mixed results. For example, Stahl, Wiese, and Schweinberger (2008, 2010) examined lateralized event-related potentials to a foveated face that was either a member of the participants' racial ingroup or outgroup. Consistent with the idea that face processing is asymmetrical, they found that the amplitude of the N170 (a component related to face processing) was more pronounced in the right hemisphere than the left. But the moderating effect of race in these studies was unclear. In one study (Stahl et al., 2010), race moderated processing more dramatically in the right hemisphere than in the left during a learning phase (congruent with JW's data) but that pattern did not replicate during the test phase. In another study (Stahl et al., 2008), race affected processing exclusively in the left hemisphere. Using functional brain imaging, Golby, Gabrieli, Chiao, and Eberhardt (2001) found a correspondence between the CRD and race-based processing differences in the *left* fusiform gyrus but also in the *right* hippocampal and parahippocampal gyri. Finally, Vizioli, Rousselet, and Caldera (2010) examined repetition suppression (RS) in the N170, a pattern of adaptation when a stimulus is presented repeatedly. The researchers found RS when a single same-race face was presented twice, a kind of recognition that the stimulus has been seen before. Other-race faces did not exhibit this kind of sensitivity to repetition. Of present interest, this pattern was most pronounced over right occipital/parietal regions, consistent with right lateralization of the CRD. Although some of these results are consistent with Turk and et al. (2005) research, the evidence to date thus seems far from conclusive. The present study therefore directly tests the dual (and complementary) hypotheses that (a) hemispheric asymmetries will be more pronounced for ingroup faces than for outgroup faces, and (b) the CRD will be more evident in the LVF (right hemisphere) than in the RVF (left hemisphere).

Methods

Participants and design

Seventy-four right-handed undergraduates (44 females, mean age = 23.65) at colleges in the Chicago area participated in a face-recognition study. Twenty-five participants self-identified as Black, and 49 as White. One additional Black female participant misunderstood the instructions and was excluded from analysis. Participants completed a visual half-field face-recognition task that presented a TBR face, which was either White or Black, and thus either a racial ingroup member or an outgroup member. This face appeared in either the left or right visual field. The design involved a 2 (Participant Race: Black vs. White) × 2 (TBR Race: Ingroup vs. Outgroup) × (Visual Field: LVF vs. RVF) design, with repeated measures on the latter two factors.

Materials and procedure

We used Macintosh computers with 17-inch screens set to a resolution of 800 × 600. Each trial began with a fixation cross followed by a series of 2–4 letters presented briefly (500 ms) at the center of the computer screen (a fixation point). Participants were instructed to monitor these letters and to press the space bar as soon as a vowel appeared. Failure to respond within 750 ms terminated the trial and prompted an instruction to respond more quickly. This exercise was designed to ensure that participants were attending to the center of the computer screen immediately before the TBR face appeared (Levine & Koch-Weser, 1982). When participants identified the vowel within the time window, a TBR face was presented for 250 ms in either the LVF or RVF (ports were centered at 150 pixels, roughly 6°, to the left and right of fixation, respectively). Subsequently, a test array was presented for an indefinite period of time (see Fig. 1). The array consisted of 8 faces: the TBR face and 7 same-race foils. Participants were instructed to identify the TBR face by typing a number from 1 to 8. The study began with computerized instructions followed by 4 practice trials and 128 test trials (each face was presented four times in each visual field). The task employed digitized color photographs of 8 Black and 8 White faces (150 pixels × 177 pixels). A standard oval mask was imposed to remove hair and clothing. Test arrays were

[2] See Purcell, Stewart, and Skov (1996) for similar concerns regarding the face-in-the-crowd effect of Hansen and Hansen (1988).

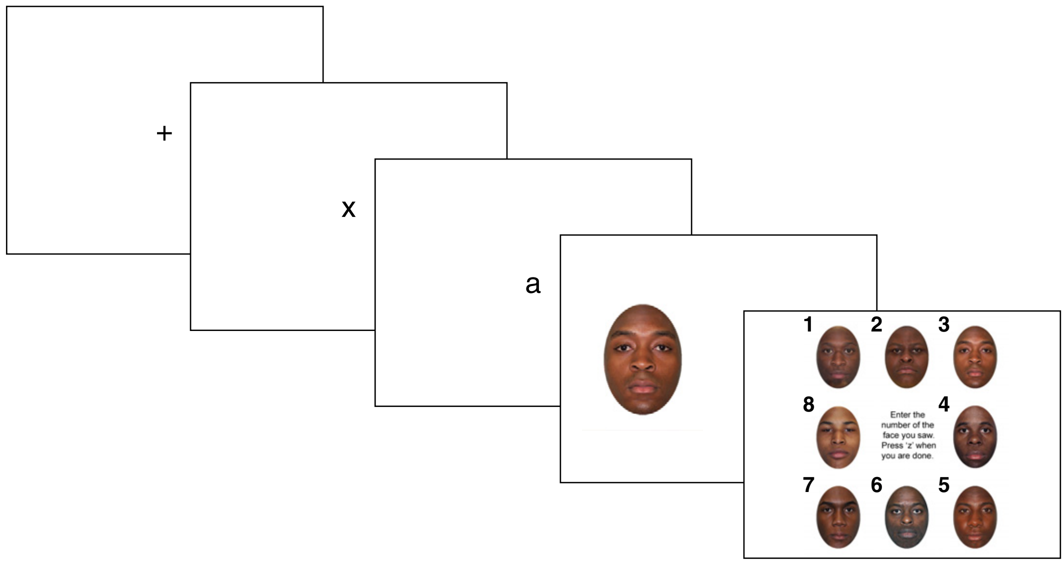

Fig. 1. Example stimuli from the recognition task.

generated by randomly assigning the Black and White faces to positions along the periphery of a 3×3 grid. This process was repeated 8 times for the Black faces and 8 times for the White faces to generate 8 separate arrays for each set of photos. On each trial, the TBR face and the same-race test array were randomly selected.

Results

Participants failed to identify the vowel on 6.3% of trials, terminating the trial. Based on the remaining trials, we computed four accuracy rates for each participant: LVF-Ingroup, LVF-Outgroup, RVF-Ingroup, and RVF-Outgroup. These rates were submitted to a 2 (Participant Race: Black vs. White) $\times$ 2 (TBR Race: Ingroup vs. Outgroup) $\times$ 2 (Visual Field: LVF vs. RVF) mixed-model analysis of variance with repeated measures on the latter two factors (see Fig. 2). We predicted two main effects: higher recognition accuracy for faces presented to the LVF rather than the RVF (i.e., an asymmetry), and higher accuracy for ingroup faces than outgroup faces (i.e., a CRD). More interestingly, we predicted an interaction which can be described in two meaningful ways: the magnitude of the asymmetry should be greater for familiar ingroup faces than for less familiar outgroup faces; equivalently, the magnitude of the CRD should be greater for faces presented to the LVF rather than the RVF.

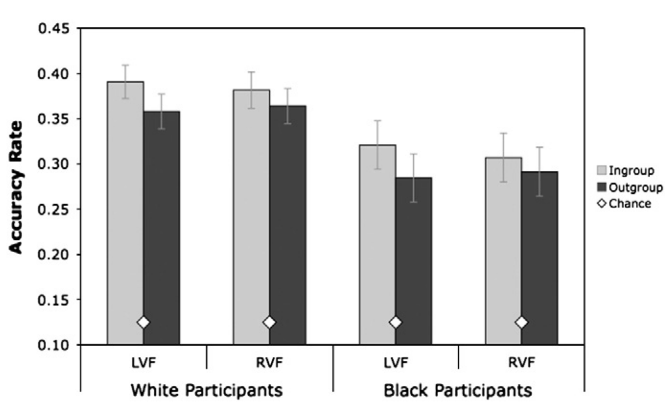

Fig. 2. Mean accuracy rates (+/−SEM) by Participant Race, TBR Race and Visual Field. Accuracy based solely on chance is indicated by diamonds.

Between-participant effect

We found a main effect of Participant Race, $F(1,72) = 5.11$, $\eta^2 = 0.066$ and $p < 0.027$, such that, irrespective of TBR Race and Visual Field, Black participants ($M = 0.301$) were less accurate than White participants ($M = 0.374$). This effect was not anticipated.

Hemispheric asymmetry

The data revealed no evidence of an overall asymmetry, $F(1,72) = 0.29$, $\eta_p^2 = 0.004$ and $p < 0.589$. Controlling for Participant Race and collapsing across TBR Race, accuracy rates in the LVF were comparable to accuracy rates in the RVF. This (lack of) asymmetry was not moderated by Participant Race, $F(1,72) = 0.04$, $\eta^2 = 0.001$ and $p < 0.835$.

Cross-race recognition deficit

We observed a main effect of TBR Race, $F(1,72) = 33.59$, $\eta_p^2 = 0.318$ and $p < 0.001$ (see Table 1). Controlling for Participant Race and collapsing across Visual Field, participants were more accurate for ingroup faces than outgroup faces. This CRD was not moderated by Participant Race, $F(1,72) = 0.01$, $\eta^2 = 0.000$ and $p < 0.911$, offering no evidence that Black and White participants differed with respect to the magnitude of the CRD.

Table 1
Accuracy rates and contrasts reflecting hemispheric asymmetry and CRD.

	Mean	St dev	Test	t	p
Accuracy rates					
LVF-Ingroup	0.367	0.133	Chance	15.69	<0.001
LVF-Outgroup	0.333	0.137	Chance	13.03	<0.001
RVF-Ingroup	0.356	0.142	Chance	15.69	<0.001
RVF-Outgroup	0.339	0.139	Chance	13.03	<0.001
Cross-race recognition deficit					
Total CRD	0.051	0.071	Zero	6.13	<0.001
LVF CRD	0.034	0.049	Zero	5.91	<0.001
RVF CRD	0.017	0.050	Zero	2.94	0.004
LVF–RVF asymmetry					
Total asymmetry	0.004	0.074	Zero	0.50	0.615
Ingroup asymmetry	0.011	0.047	Zero	1.96	0.054
Outgroup asymmetry	−0.006	0.053	Zero	−1.02	0.311
CRD × Visual Field	0.017	0.069	Zero	2.13	0.036

Asymmetries in cross-race recognition

Most critical for the current paper, we found an interaction between TBR Race and Visual Field, $F(1,72) = 4.48$, $\eta_p^2 = 0.059$ and $p < 0.038$, which can be understood in two ways.

First, this interaction suggests that the magnitude of hemispheric asymmetry depends on TBR Race (see Fig. 3, top panel). Although there was no evidence of asymmetry *on average*, the interaction emerges because participants demonstrated asymmetry selectively with ingroup faces, $F(1,72) = 3.90$, $\eta_p^2 = 0.051$ and $p < 0.053$. Among outgroup faces there was no comparable effect, $F(1,72) = 0.97$, $\eta_p^2 = 0.013$ and $p < 0.329$.

An alternative conceptualization involves recognizing that the magnitude of the CRD depends on Visual Field (see Fig. 3, bottom panel). Though the CRD was evident in both the LVF, $F(1,72) = 32.04$, $\eta_p^2 = 0.308$ and $p < 0.001$, and the RVF, $F(1,72) = 7.34$, $\eta_p^2 = 0.093$ and $p < 0.008$, it was significantly stronger and fully double in magnitude when presented in the LVF ($M = 0.034$) rather than the RVF ($M = 0.017$).

Again, these effects did not depend on Participant Race. Neither the TBR Race × Visual Field interaction, $F(1,72) = 0.12$, $\eta^2 = 0.002$ and $p < 0.731$, nor any of the simple effects, $F(1,72) < 0.20$, $\eta^2 < 0.003$ and $p < 0.65$, were moderated by Participant Race.

Discussion

The present research tested recognition of racial ingroup and outgroup faces presented to either the LVF or RVF. The data showed a clear advantage for recognition of ingroup faces relative to outgroup faces (CRD), but that advantage was more pronounced when the faces were presented to the LVF. In addition, the data showed evidence of greater accuracy for faces presented to the LVF relative to the RVF, but only for ingroup faces. This pattern is remarkably consistent with the data reported by Turk, et al. (2005) in their study of the epileptic patient, JW.

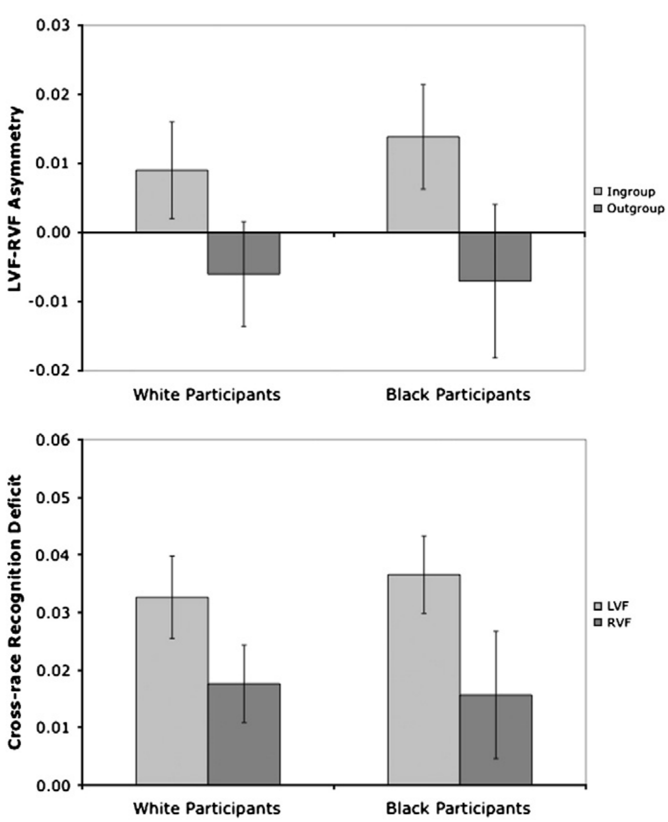

Fig. 3. Two interpretations of the TBR Race × Visual Field interaction. Top panel: mean asymmetry (+/−SEM) by Participant Race and TBR Race. The asymmetry in face recognition (LVF>RVF) emerges for same-race (ingroup) faces, but not for outgroup faces. Bottom panel: mean CRD (+/−SEM) by Participant Race and Visual Field. The deficit in cross-race recognition is more pronounced when faces are presented to the LVF rather than the RVF.

Critically, in the present study, the effects did not differ as a function of participant race. Black participants showed a more pronounced hemispheric asymmetry for Black (relative to White) faces; White participants showed a more pronounced hemispheric asymmetry for White (relative to Black) faces. Because the LVF advantage always accrued to the ingroup face (whether Black or White), the effects cannot be explained by low-level visual properties of the stimuli. They are necessarily driven by the match between the participant's own race and the race of the face.

Hemispheric asymmetry and the CRD constitute two prominent, long-standing effects in the literature on face processing. Ultimately, our results suggest that these phenomena may tell part of a more complex, interactive story. Hemispheric asymmetries exist, suggesting that face recognition relies on holistic, integrative processing. But in the present data, those asymmetries do not apply universally. They seem to characterize processing of ingroup faces only (faces with which perceivers have extensive experience). Similarly, participants show a CRD, but that deficit is most dramatic when faces are presented to the LVF, preferentially accessing regions of the brain involved in holistic face processing.

These results clearly echo existing work suggesting that, relative to ingroup faces, outgroup faces are processed less holistically and more in terms of discrete features. One question that arises from this pattern of data involves the degree to which other-race faces are processed as faces, per se, as distinct from other complex visual stimuli. In an intriguing paper, Rossion et al. (2000) challenged the claim that the right hemisphere responds preferentially to faces, whereas the left hemisphere is involved in visual processing of objects more generally, but does not respond specifically to faces. The researchers examined activity in the middle fusiform gyrus as participants made both feature-specific and holistic judgments of faces and, separately, of houses. In line with earlier work, they found greater activation in the right hemisphere when participants made holistic (rather than feature-specific) judgments about faces, suggesting that the right hemisphere is implicated in typical holistic face processing. They also found greater left hemisphere activation when participants made feature-based rather than holistic judgments. Critically, the left fusiform's sensitivity to the judgment task only emerged for faces. (The region did not differentiate in a similar way between feature-based and holistic judgments of houses.) Based on these data, the researchers argued that, in both the left and right hemispheres, the fusiform gyrus is especially sensitive to faces, but whereas the right hemisphere processes faces holistically, the left processes faces in a piecemeal fashion. The authors suggest that the left fusiform gyrus demonstrates face-specific processing that is also feature-based. Our own data suggest that outgroup faces do not induce right lateralized processing, but Rossion's findings suggest that perceivers may engage in face-specific processing of outgroup faces (in either hemisphere). Our data thus are mute about the degree to which perceivers process outgroup faces in a *feature-based-but-still-face-specific* fashion or (b) in a more general fashion, as they might process other complex visual stimuli.

Another critical question, from our perspective, involves the genesis of this race-sensitive asymmetry. It is possible that the effects of race, reported here, stem from experience-dependent changes in the way the brain processes different kinds of faces. Because ingroup faces are typically more prevalent than outgroup faces at all stages of development, humans may begin to differentiate between ingroup and outgroup during infancy (Sangrigoli & de Schonen, 2004). Those differences may subsequently be consolidated on a neural level during middle childhood (Golarai et al., 2007), and by adulthood, ingroup and outgroup faces may promote very different kinds of neural responses in a fairly stimulus-specific, bottom–up fashion.

The effects reported here may also reflect the operation of metacognitive or motivational top–down processing differences. For example, Bernstein and Hugenberg (Bernstein, Young, & Hugenberg, 2007; Hugenberg & Corneille, 2009) have shown that deficits in recognition and holistic processing, like race-based deficits, can be induced by categorizing faces as members of a (non-racial) outgroup. White participants typically recognize White faces fairly well. But accuracy plummets when those racial-ingroup faces are described as students who attend a different school — turning them, arbitrarily, into outgroup members. And, just as a recognition deficit can be created for same-race faces, it can be reduced for other-race faces. Seemingly trivial manipulations, such as the induction of a positive mood (Johnson & Fredrickson, 2005) or simple instructions to pay attention to the features that distinguish outgroup faces (Hugenberg, Miller, & Claypool, 2007) can attenuate or eliminate the typical CRD. These results suggest that mood, motivation and construal can dramatically alter face processing.

It would be intriguing to integrate the current visual half-field methodology (or more sophisticated physiological measurement techniques) with either a mood manipulation or with instructions to individuate outgroup members. If hemispheric asymmetry depends on these top–down factors, such studies might clarify the processes that mediate previously reported top–down effects. For example, Johnson and Fredrickson (2005) proposed that positive mood reduces the CRD because it promotes holistic processing, implicitly suggesting that mood-based improvements in cross-race recognition will be associated with increases in right-lateralized processing for the outgroup. By contrast, Hugenberg et al. (2007) described their effects in terms of increased attention to individuating features. Their manipulation may have encouraged more extensive but still atomistic and feature-based (and, thus, potentially left-lateralized) processing for the outgroup. By investigating the differential involvement of the right and left hemispheres, future research may help us better understand how perceivers use racial categories to subdivide the social environment, and how that default processing is moderated by factors like intention and mood.

References

Bernstein, M. J., Young, S. G., & Hugenberg, K. (2007). The cross-category effect: Mere social categorization is sufficient to elicit an own-group bias in face recognition. *Psychological Science*, *18*, 709–712.

Dien, J. (2009). A tale of two recognition systems: Implications of the fusiform face area and the visual word form area for laterality theories. *Neuropsychologia*, *47*, 1–16.

Glaeser, E. L., & Vigdor, J. L. (2001). *Racial segregation in the 2000 census: Promising news*. Survey Series. Washington, D. C: Brookings Institution.

Golarai, G., Ghahremani, D. G., Whitfield-Gabrieli, S., Reiss, A., Eberhardt, J. L., Gabrieli, J. D. E., et al. (2007). Differential development of high-level visual cortex correlates with category-specific recognition memory. *Nature Neuroscience*, *10*(4), 512–522.

Golby, A. J., Gabrieli, J. D. E., Chiao, J. Y., & Eberhardt, J. L. (2001). Differential responses in the fusiform region to same-race and other-race faces. *Nature Neuroscience*, *4*, 845–850.

Hansen, C. H., & Hansen, R. D. (1988). finding the face in the crowd: An anger superiority effect. *Journal of Personality & Social Psychology*, *54*, 917–924.

Hillger, L. A., & Koenig, O. (1991). Separable mechanisms in face processing: Evidence from hemispheric specialization. *Journal of Cognitive Neuroscience*, *3*, 42–58.

Hugenberg, K., & Corneille, O. (2009). Holistic processing is tuned for in-group faces. *Cognitive Science*, *33*, 1173–1181.

Hugenberg, K., Miller, J., & Claypool, H. (2007). Categorization and individuation in the cross-race recognition deficit: Toward a solution to an insidious problem. *Journal of Experimental Social Psychology*, *43*, 334–340.

Johnson, K. J., & Fredrickson, B. L. (2005). We all look the same to me: Positive emotions eliminate the own-race bias in face recognition. *Psychological Science*, *16*, 875–881.

Kelly, D. J., Quinn, P. C., Slater, A. M., Lee, K., Ge, L., & Pascalis, O. (2007). The other-race effect develops during infancy: Evidence of perceptual narrowing. *Psychological Science*, *18*(12), 1084–1089.

Kinzler, K. D., Shutts, K., & Correll, J. (2010). Priorities in social categories. *European Journal of Social Psychology*, *40*, 581–592.

Levine, S. C. (1985). Developmental change in right hemisphere involvement in face recognition. In C. T. Best (Ed.), *Developmental neuropsychology and education: Hemispheric function and integration*. New York: Academic Press.

Levine, S. C., & Koch-Weser, M. P. (1982). Right hemisphere superiority in the recognition of famous faces. *Brain and Cognition*, *1*, 10–22.

McCarthy, G., Puce, A., Gore, J. C., & Allison, T. (1997). Face-specific processing in the human fusiform gyrus. *Journal of Cognitive Neuroscience*, *9*, 604–609.

Meissner, C. A., & Brigham, J. C. (2001). Thirty years of investigating the own-race bias in memory for faces: A meta-analytic review. *Psychology, Public Policy, & Law*, *7*, 3–35.

Michel, C., Caldara, R., & Rossion, B. (2006a). Same-race faces are perceived more holistically than other-race faces. *Visual Cognition*, *14*, 55–73.

Michel, C., Rossion, B., Han, J., Chung, C., & Caldara, R. (2006b). Holistic processing is finely tuned for faces of one's own race. *Psychological Science*, *17*, 608–615.

Pascalis, O., Scott, L. S., Kelly, D. J., Shannon, R. W., Nicholson, E., Coleman, M., et al. (2005). Plasticity of face processing in infancy. *Proceedings of the National Academy of Science*, *102*, 5297–5300.

Passarotti, A. M., Smith, J., DeLano, M., & Huang, J. (2007). Developmental differences in the neural bases of the face inversion effect show progressive tuning of face-selective regions to the upright orientation. *NeuroImage*, *34*(4), 1708–1722.

Purcell, D. G., Stewart, A. L., & Skov, R. (1996). It takes a confounded face to pop out of a crowd. *Perception*, *25*, 1091–1108.

Rhodes, G., Brake, S., Taylor, K., & Tan, S. (1989). Expertise and configural coding in face recognition. *British Journal of Psychology*, *80*, 313–331.

Rossion, B., Dricot, L., Devolder, A., Bodart, J. M., Crommelinck, M., De Gelder, B., et al. (2000). Hemispheric asymmetries for whole-based and part-based face processing in the human fusiform gyrus. *Journal of Cognitive Neuroscience*, *12*, 793–802.

Sangrigoli, S., & de Schonen, S. (2004). Recognition of own-race and other-race faces by three-month old infants. *Journal of Child Psychology and Psychiatry*, *45*, 1–9.

Sergent, J., & Hellige, J. B. (1986). Role of input factors in visual-field asymmetries. *Brain and Cognition*, *5*, 174–199.

Stahl, J., Wiese, H., & Schweinberger, S. R. (2008). Expertise and own-race bias in face processing: An event-related potential study. *Neuroreport*, *19*, 583–587.

Stahl, J., Wiese, H., & Schweinberger, S. R. (2010). Learning task affects ERP-correlates of the own-race bias, but not recognition memory performance. *Neuropsychologia*, *48*, 2027–2040.

Turk, D. J., Handy, T. C., & Gazzaniga, M. S. (2005). "Can perceptual expertise account for the own-race bias in face recognition? A split-brain study". *Cognitive Neuropsychology*, *22*, 877–883.

Vizioli, L., Rousselet, G. A., & Caldera, R. (2010). Neural repetition suppression to identity is abolished by other-race faces. *Proceedings of the National Academy of Sciences*, *107*, 20081–20086.