DOI: 10.1037/xhp0000460

A New Other-Race Effect for Gaze Perception

Jemma R. Collova, Nadine Kloth, Kate Crookes, Nichola Burton, Cynthia Y.H. Chan, Janet H. Hsiao, Gillian Rhodes

ARC Centre of Excellence in Cognition and its Disorders, Department of Psychology, University of Western Australia, Crawley, WA 6009, Australia University of Western Australia

Author Note

This research was supported by the Australian Research Council (ARC) Centre of Excellence in Cognition and its Disorders (CE110001021) and an ARC Discovery Outstanding Researcher Award to Rhodes (DP130102300). We thank Elinor McKone and William Hayward for access to the Caucasian and Asian face databases, respectively. Finally, we thank Siqi Ji for her help collecting data in Hong Kong and Yong Zhi Foo for his help with the meta-analytic statistics.

Correspondence to: Gillian Rhodes, School of Psychology, University of Western Australia, 35 Stirling Highway, Crawley, WA 6009, AUSTRALIA

Email: gillian.rhodes@uwa.edu.au

Collova, J. R., Kloth, N., Crookes, K., Burton, N., Chan, C. Y .H., Hsiao, J. H., & Rhodes, G. (2017). A new other-race effect for gaze perception. *Journal of Experimental Psychology: Human Perception and Performance, 43(*11), 1857-1863.

Abstract

The well-known other-race effect in face recognition has been widely studied, both for its theoretical insights into the nature of face expertise and because of its social and forensic importance. Here we demonstrate an other-race effect for the perception of a very simple visual signal provided by the eyes, namely gaze direction. In Study 1, Caucasian and Asian participants living in Australia both showed greater perceptual sensitivity to detect direct gaze in own-race than other-race faces. In Study 2, Asian (Chinese) participants living in Australia and Asian (Chinese) participants living in Hong Kong both showed this other-race effect, but Caucasian participants did not. Despite this inconsistency, meta-analysis revealed a significant other-race effect when results for all five participant groups from corresponding conditions in the two studies were combined. These results demonstrate a new other-race effect for the perception of the simple, but socially potent, cue of direct gaze. When identical morphed-race eyes were inserted into the faces, removing race-specific eye cues, no other-race effect was found (with one exception). Thus the balance of evidence implicated perceptual expertise, rather than social motivation, in the other-race effect for detecting direct gaze.

Keywords: face perception, other-race effect, gaze perception, own-race advantage, perceptual expertise

Statement of Public Significance

People tend to be poorer at recognizing other-race faces than own-race faces. This "other-race effect" has been widely studied, both for insights into the nature of perceptual expertise, and for its social and forensic implications. For the first time, we have observed a small, but potentially detrimental other-race effect for the perception of direct gaze. Gaze direction is a powerful social cue and direct gaze establishes an important foundation for communication and can enhance social interactions. A reduced sensitivity to direct gaze in other-race faces may therefore have a variety of consequences on behavioral and cognitive responses to other-race people. We also sought to determine the underlying basis of this other-race effect. There is a long history of difficulty in distinguishing between perceptual expertise and social motivation accounts of other-race effects. Here, our results more clearly link the effect to reduced perceptual expertise with other-race eyes.

A New Other-Race Effect For Gaze Perception

People are poorer at recognizing other-race than own-race[1] faces (for reviews see Anzures, Quinn, Pascalis, Slater & Lee, 2013; Hancock & Rhodes, 2008; Meissner & Brigham, 2001; Rossion & Michel, 2011). Similar other-race effects also occur for face discrimination (Rhodes, Hayward, & Winkler, 2006), and judgements of face attributes, such as sex (O'Toole, Peterson & Deffenbacher, 1996), age (Dehon & Brédart, 2001), and emotional expression (Elfenbein & Ambady, 2002).

Race also affects the use of eye cues. Inferring intentional states from the eyes and using gaze to cue attention are both subject to race effects (Adams et al., 2010; Pavan, Dalmaso, Galfano & Castelli, 2011). Here we ask whether race affects the perception of eye gaze direction, specifically direct gaze. Direct gaze is a potent social signal (for reviews see Itier & Batty, 2009; Senju & Johnson, 2009). It can increase romantic attraction to strangers (Kellerman, Lewis & Laid, 1989), perceived intimacy (Scherer & Schiff, 1973), ability to infer the intentions (Baron-Cohen, 1995), and likelihood of initiating conversation (Cary, 1978). It also affects processing of other face attributes, including expression (Adams & Kleck, 2005), attractiveness (Ewing, Rhodes & Pellicano, 2010), and identity (Kloth, Jeffery & Rhodes, 2015). Clearly, any deficit in perceiving direct gaze in other-race faces could have important social consequences.

To examine whether there is an other-race effect in gaze perception, we asked Caucasian and Asian participants to discriminate direct from averted gaze deviations in own- and other-race faces. We were also interested in the basis of any such effect. Some have emphasized perceptual expertise (e.g., Rossion & Michel, 2011; Tanaka, Heptonstall & Hagen, 2013), whereas others have emphasized socio-cognitive factors (e.g., Bernstein, Young & Hugenberg, 2007; Hugenberg, Wilson, See & Young, 2013; Rodin, 1987; Sporer,

[1] We use the term "race" to refer to a visually distinct social group, not a biological category.

2001) in other-race effects. To distinguish these accounts, we included a “morphed-eye” condition in which all faces had identical eyes (mixed-race morphs), eliminating any influence of race-specific eye expertise. This manipulation should eliminate any other-race effect for gaze perception on a perceptual expertise account.

STUDY 1

We measured sensitivity to detect direct gaze in Caucasian and Asian individuals in original (normal) and morphed-eye faces.

Method

Participants

Fifty-eight Caucasian (11 male, *M* = 19.6 years, *SE* = 0.4) and 54 Asian (17 male, *M* = 21.1 years, *SE* = 0.3) students participated for course credit or $10. Asian participants had lived most of their lives in an Asian country and been in Australia for less than 4 years (*M(SE)* = 16(2) months). All participants reported significantly more contact with own- than other-race people (Table 1; Supplementary Materials 1 for additional analyses). Sample size was determined by availability of suitable Asian students in the time-frame of the study.

Table 1

T-tests comparing 1) contact with own- and other-race people for the Caucasian and Asian participants in Study 1 and 2, (as measured by Hancock and Rhodes, 2008) and 2) identity recognition (accuracy on the CFMT; McKone, et al., 2012) for own- and other-race faces, for the Caucasian and Asian participants in Study 2.

	Participant	Own-race		Other-race				
Task	Race (Study)	*M*	*SE*	*M*	*SE*	*t* (df)	*p*	d
Contact	Cauc (1)	5.2	0.1	3.6	0.1	11.87(57)	.001	1.75
	Asian (1)	5.1	0.1	3.0	0.1	13.32(53)	.001	1.83
	Cauc (2)	5.3	0.1	3.6	0.1	14.36(62)	.001	1.86
	Chinese-Aus (2)	5.2	0.1	3.0	0.1	14.17(49)	.001	2.01
	Chinese-HK (2)	5.5	0.1	2.8	0.1	17.06(55)	.001	2.37
CFMT	Cauc (2)	0.80	0.01	.75	.01	4.62(62)	.001	0.63
	Chinese-Aus (2)	0.81	0.02	.71	.02	8.35(49)	.001	1.16
	Chinese-HK (2)	0.82	0.01	.72	.01	7.05	.001	0.99

Stimuli

Colour photographs of 10 female Caucasian faces and 10 female Asian faces with neutral expressions were used in the main task. One additional face of each race was used for practice. Inter-pupil distance was standardized (150 pixels) and an oval mask hid the hair.

Faces measured 9.0° x 12.4° from a viewing distance of 50cm maintained using a chin rest. Averted gaze deviations (1, 2, 4, 6, 8 pixels left and right) were generated using Photoshop (Figure 1a, b). Eyes with direct gaze also had their iris and pupil cut out and pasted back to match the editing of averted-gaze faces. "Morphed-eye" faces with race-ambiguous eyes were created by morphing the 10 Asian and 10 Caucasian faces together and pasting the eye region from this face back into the original faces (Figure 1e). Gaze deviations were then generated as for the original faces (Figure 1c, d).

Procedure

On each trial a face appeared for 400 ms (trials initiated with space-bar), followed by a prompt to respond "*left, direct or right?*" (using labelled keyboard keys). Two blocks of 440 trials were presented in random order. Each contained all combinations of face-race (Caucasian, Asian), face-type (original, morphed-eyes) and gaze deviation (11) for 10 identities per race. Participants began with 22 practice trials (one face from each race at each gaze deviation). Participants also completed other tasks (Supplementary Materials 1 for additional analyses).

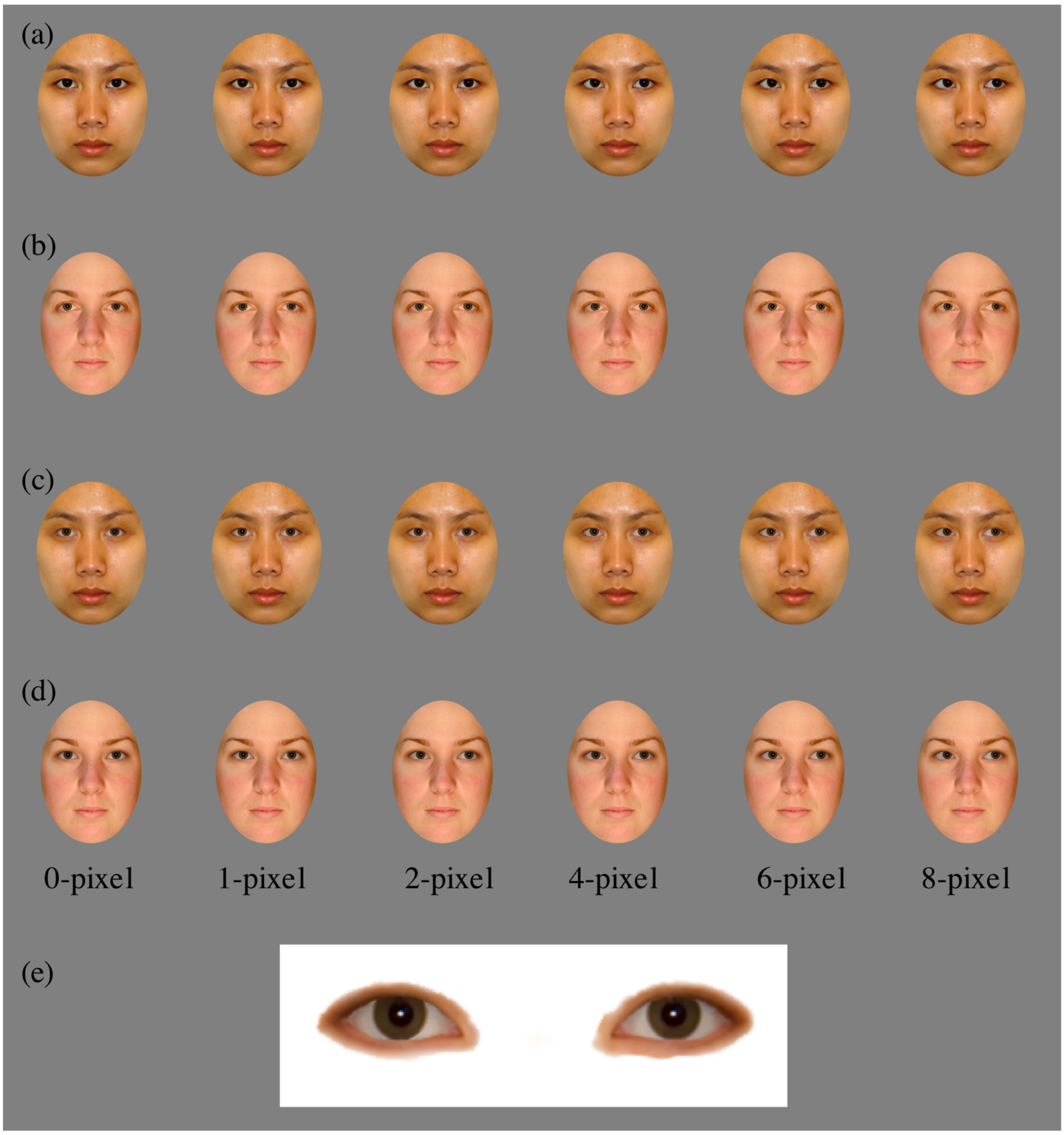

Figure 1. Stimulus examples. Rightward gaze deviations for a) an Asian face, b) a Caucasian face, c) an Asian face with morphed eyes, d) a Caucasian face with morphed eyes, e) the morphed eyes inserted into all faces in the morphed-eyes condition.

Results and Discussion

We measured sensitivity (*d*') to detect direct gaze (collapsing left and right directions), using "direct" responses to direct gaze as hits and "direct" responses to averted gaze deviations as false alarms using standard procedures (Green & Swets, 1966; Stanislaw &

Todorov, 1999). Large gaze deviations (6, 8 pixels) were included only to provide easy trials to maintain motivation and were not intended for inclusion in the analysis. We excluded 1-pixel deviations due to floor effects (all *d*'s < 0.50) (that could generate spurious interactions involving deviation).

We conducted a 5-way repeated-measures analyses of variance (ANOVA) on *d*' scores, with participant-race (Caucasian, Asian) as a between-participants condition, and block (1, 2), face-race (own-race, other-race), face-type (original, morphed-eyes) and gaze deviation (2-pixel, 4-pixel) as within-participant conditions (see Supplementary Materials 2 for *M*s and *SD*s for full design).

There was no main effect of face-race, $F(1, 110) = 0.14$, $p = .708$, $\eta_p^2 = .001$, but face-race interacted with block and face-type, $F(1, 110) = 4.13$, $p = .045$, $\eta_p^2 = .036$ (Figure 2). Separate follow-up 2 x 2 ANOVAs (face-type x face-race) were conducted for each block.

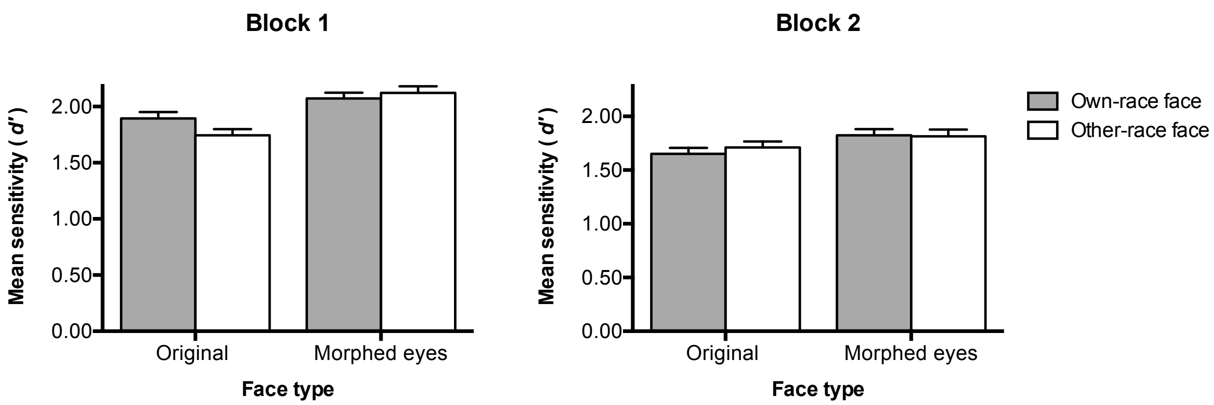

Figure 2. Mean gaze sensitivity (*d*') for own-race and other-race original and morphed-eye faces, in block 1 and block 2. *SE* bars are shown.

In block 1, face-race interacted with face-type, $F(1, 111) = 5.83$, $p = .017$, $\eta_p^2 = .050$, as predicted on the perceptual expertise account: In original faces, sensitivity to direct gaze was better for own-race than other-race faces, $t(111) = 2.51$, $p = .014$, Cohen's $d = 0.22$, but this other-race effect disappeared for morphed-eye faces, $t(111) = -0.83$, $p = .407$, Cohen's $d = 0.08$ (Figure 2). There was no main effect of face-race $F(1, 111) = 1.27$, $p = .262$, $\eta_p^2 = .011$. Overall, sensitivity was better for morphed-eye ($M = 2.10$, $SE = 0.05$) than original ($M = 1.82$, $SE = 0.05$) faces, $F(1,111) = 34.92$, $p < .001$, $\eta_p^2 = .239$, probably because the same eyes were used repeatedly.

In block 2, performance was again better for morphed-eye ($M = 1.82$, $SE = 0.05$) than original ($M = 1.68$, $SE = 0.04$) faces, $F(1, 111) = 8.37$, $p = .005$, $\eta_p^2 = .070$. There was no main effect of face-race, $F(1, 111) = 0.28$, $p = .601$, $\eta_p^2 = .002$, and no interaction between with face-type, $F(1, 111) = 0.54$, $p = .466$, $\eta_p^2 = .005$.

With 440 trials in block 1, we speculate that the absence of an other-race effect for original faces in block 2 might reflect learning effects and/or fatigue effects. Consistent with the latter possibility, performance declined from block 1 ($M = 1.96$, $SE = 0.04$) to block 2 ($M = 1.75$, $SE = 0.04$), $F(1, 110) = 33.64$, $p < .001$, $\eta_p^2 = .234$. Moreover, although block interacted with both face-type $F(1, 110) = 4.40$, $p = .038$, $\eta_p^2 = .038$, and gaze deviation, $F(1, 110) = 19.46$, $p < .001$, $\eta_p^2 = .150$, performance declined for both face-types (morphed-eyes: block 1 $M = 2.10$, $SE = 0.04$; block 2 $M = 1.82$, $SE = 0.05$; original faces: block 1 $M = 1.82$, $SE = 0.05$; block 2 $M = 1.68$, $SE = 0.04$), and both gaze deviations (2-pixels: block 1 $M = 1.12$, $SE = 0.04$; block 2 $M = 0.97$, $SE = 0.04$; 4-pixels: block 1 $M = 2.80$, $SE = 0.05$, block 2 $M = 2.53$, $SE = 0.05$), ts > 2.69, ps < .008. An alternative possibility is that the other-race effect in block 1 was a chance finding, and therefore we will seek to replicate it in Study 2.

The 5-way ANOVA yielded other effects that were of no theoretical significance (Supplementary Materials 2).

STUDY 2

The other-race effect for original faces in Study 1 was only seen in the first of two lengthy blocks, so we sought to replicate it here in a single block of similar length to block 1 of Study 1. We again included morphed-eye faces, to confirm that any other-race effect disappeared when identical morphed-race eyes appeared in Asian and Caucasian faces, as predicted by a perceptual expertise account. We also manipulated orientation (upright, inverted) to check that eyes were being processed using high-level cues, which would be disrupted by inversion (Campbell, Heywood, Cowey, Regard & Landis, 1990; Vecera & Johnson, 1995).

Method

Participants

Sixty-three Caucasian students (21 male, M = 19.7 years, SE = 0.5), 50 Chinese (21 male, M = 22.0 years, SE = 0.1) students living in Australia (Chinese-Aus) (Asian-born, living in Australia for less than 4 years, $M(SE)$ = 12(2) months) and 56 Chinese students living in Hong Kong (Chinese-HK) (17 male, M = 19.3 years, SE = 0.2) participated. All participants reported significantly more contact with own-race than other-race people and showed poorer recognition of other-race faces (Table 1; analysis in Supplementary Materials 1). Sample size was pre-determined by a power calculation, using the effect size observed from Study 1 (d = 0.22), with a significance level of .05, and power of 0.8. We needed 165 participants and recruited 169.

Stimuli and Procedure

Upright and inverted versions of the direct gaze, 2- and 4-pixel (left and right) gaze-deviation stimuli from Study 1 were used. Participants saw every combination of face-race (Caucasian, Asian), face-type (original, morphed-eyes), gaze deviation (direct, 2-pixel left and right, 4-pixel left and right), and face orientation (upright, inverted), for 10 identities per race (400 trials, cf. 440 in Study 1 block 1). Participants completed 20 practice trials (one original face per race at both orientations and all gaze deviations). A small 20-pixel jitter in location was used to minimize afterimages and to prevent a strategic, screen position based approach to the task. Participants completed two additional tests to confirm that the morphed-eye faces did not affect perception of the face's race (see Supplementary Materials 3 for details), as well as Chinese and Caucasian-Australian versions of the Cambridge Face Memory Test (CFMT) and contact questionnaire (see Supplementary Materials 1 for further details).

Results and Discussion

As expected, sensitivity was greater for upright (M = 1.80, SE = 0.03) than inverted (M = 1.42, SE = 0.03) faces, $t(168) = 12.90$, p <.001, Cohen's d = 14.38, confirming use of high-level face cues. We then conducted a 4-way ANOVA on d' scores for upright faces, with face-type (original, morphed-eyes), face-race (own-race, other-race) and gaze deviation (2-pixel, 4-pixel) as within-participant conditions and participant-race (Caucasian, Chinese-Aus, Chinese-HK) as a between-participant condition (see Supplementary Materials 2 for *M*s and *SD*s for full design).

Face-race did not interact with face-type, $F(1, 166) = .012$, p = .914, η_p^2<.001. However, it did interact with face-type and participant-race, $F(2, 166) = 4.00$, p = .020, η_p^2 = .046. Face-race also interacted with participant-race, $F(1, 166) = 3.63$, p = .029, η_p^2 = .042. To follow up the three-way interaction, we conducted separate 2 x 2 ANOVAs for each participant-race.

Caucasian participants showed no interaction between face-race and face-type $F(1, 62) = 1.33$, p = .254, η_p^2 = .021 (Figure 3a) and no main effect of face-race, $F(1, 62)$ = 2.37,

p = .129, η_p^2 = .037. The same was true for Chinese-Aus participants (face-race x face-type: $F(1, 49) = 1.18$, p = .283, η_p^2 = .023; face-race: $F(1, 49) = 1.95$, p = .169, η_p^2 = .038) (Figure 3b). However, Chinese-HK participants showed a significant interaction, $F(1, 55) = 5.26$, p = .026, η_p^2 = .087 (Figure 3c), with an other-race effect for original, $t(55) = 2.81$, p = .007, Cohen's d = .38, but not morphed-eye, $t(55) = 0.16$, p = .873, Cohen's d = -0.02, faces, consistent with a perceptual expertise account. There was no main effect of face-race, $F(1, 166) = 1.44$, p = .232, η_p^2 = .042, as in Study 1.

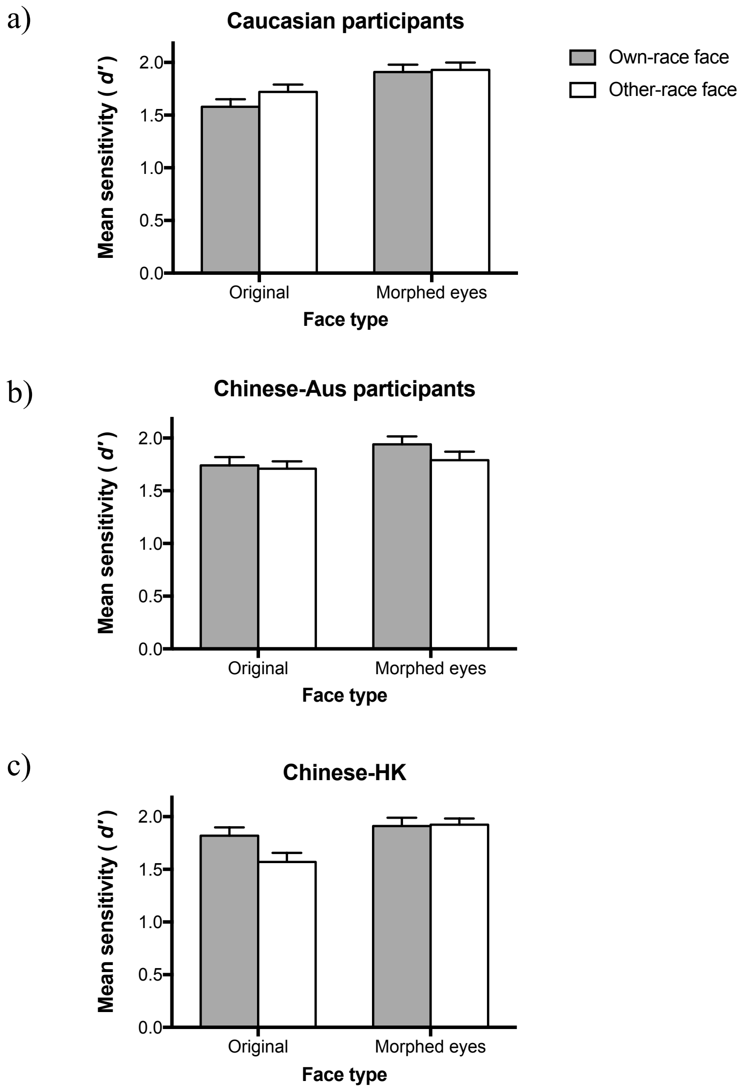

Figure 3. Mean gaze sensitivity (*d*') for own-race and other-race original and morphed-eye upright faces, for a) Caucasian b) Chinese-Aus and c) Chinese-HK participants. *SE* bars are shown.

There was a significant interaction between face-race, participant-race and gaze deviation, $F(2, 166) = 3.20$, $p = .043$, $\eta_p^2 = .037$. We performed separate 2-way ANOVAs for each gaze deviation. At the 2-pixel level, where performance was poor, there was no significant main effect of face-race, $F(1,166) = 0.20$, $p = .657$, $\eta_p^2 = .017$, and no face-race by participant-race interaction, $F(1, 166) = 0.59$, $p = .555$, $\eta_p^2 = .007$ (Figure 4). At the 4-pixel level, where performance was better, there was no main effect of face-race, $F(1, 166) = 2.95$, $p = .088$, $\eta_p^2 = .017$, but face-race interacted significantly with participant-race, $F(2, 166) = 5.05$, $p = .007$, $\eta_p^2 = .057$. There was an own-race advantage for both Chinese-Aus, $t(49) = 2.17$, $p = .035$, Cohen's $d = 0.31$, and Chinese-HK participants, $t(55) = 2.01$, $p = .050$, Cohen's $d = 0.27$, but not for Caucasian participants, $t(62) = 1.71$, $p = .091$, Cohen's $d = 0.14$ (Figure 4). We note that this effect did not interact with face type (i.e. there was an own-race advantage for both the original and morphed eye faces), contrary to a perceptual expertise account.

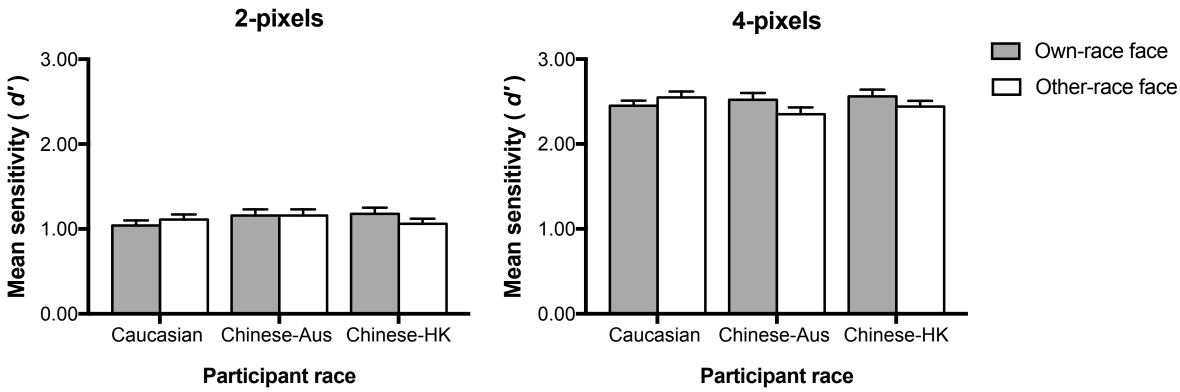

Figure 4. Mean gaze sensitivity (*d*') for own-race and other-race faces for the Caucasian, Chinese-Aus, and Chinese-HK participants, for the 2-pixel and 4-pixel conditions in the upright faces. *SE* bars are shown.

Returning to the 4-way ANOVA, not surprisingly, sensitivity was greater for 4-pixel ($M = 2.48$, $SE = 0.04$) than 2-pixel ($M = 1.12$, $SE = 0.03$) deviations, $F(1, 166) = 2805.73$, *p*

< .001, η_p^2 = .944. Participants were also more sensitive to the morphed-eye faces (*M* = 1.90, *SE* = 0.04) than original (*M* = 1.69, *SE* = 0.04) faces, $F(1, 166) = 45.27$, $p < .001$, η_p^2 = .214, consistent with Study 1, likely reflecting their greater repetition. Face-race interacted with face type and gaze deviation, $F(1, 166) = 4.14$, $p = .044$, η_p^2 = .024, but follow-up analyses revealed this interaction had no theoretical significance (see Supplementary Materials 2). For a summary of all significant effects from the ANOVA, see Supplementary Materials 2. There were no other significant effects (all *F*s < 2.82, *p*s > .062, η_p^2 < .03).

We also calculated bias (Criterion C) to report direct gaze in own- and other-race faces in Study 1 and Study 2, but found no consistent other-race effects (Supplementary Materials 4).

Meta-analysis of Study 1 and 2 other-race effects in gaze perception

We calculated an overall effect size for the other-race effect, using data from the original, upright faces in Study 2 and comparable conditions in Study 1 (2- and 4-pixel deviations for original faces in block 1). We used the metafor package (Viechtbauer, 2010) in R.2.1 (R Core Team, 2015) and Dunlap, Cortina, Vaslow and Burke's (1996) method for calculating effect sizes. There was a small, but significant other-race effect for gaze direction perception, with a 95% confidence interval that excluded zero ($d_{overall}$ = 0.13, 95 % CI = 0.01-0.25, p = .035) (Figure 5).

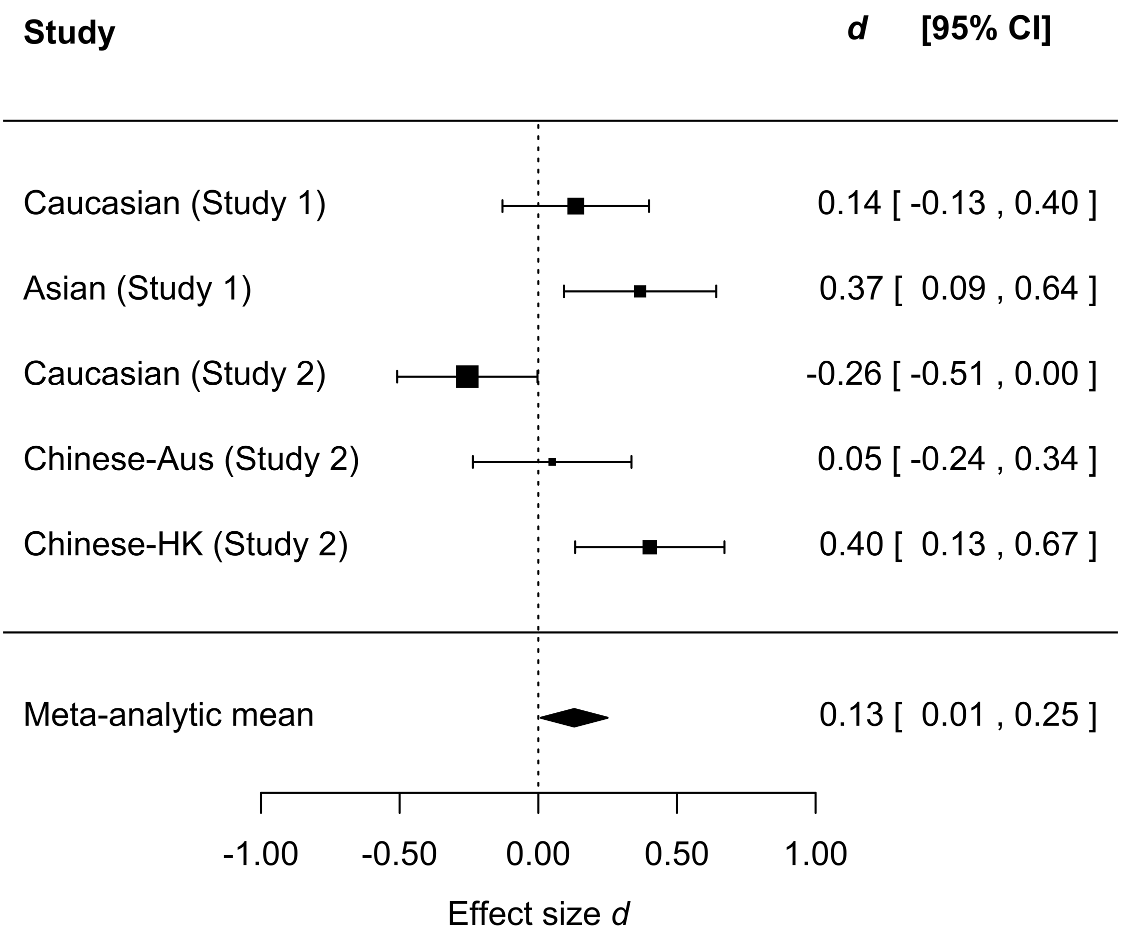

Figure 5. Parameter estimates (effect size and 95% confidence intervals) for the other-race effect for gaze perception, for the 5 participant groups from Study 1 and Study 2. The size of the squares represents relative sample sizes (Study 1: Caucasian N = 58, Asian N = 54; Study 2: Caucasian N = 63, Chinese-Aus N = 50, Chinese-HK N = 56).

General Discussion

We found an other-race effect in the perception of a very simple cue, direct gaze. Both Asian and Caucasian participants discriminated direct from averted gaze more poorly for other-race faces in Study 1. In Study 2 we replicated this effect for the Chinese-HK participants, as well as the Chinese-Aus participants (for direct vs 4-pixels), but not the

Caucasian participants. A meta-analysis combining effect sizes for comparable conditions from both studies showed a small, but significant, overall effect. Thus, even a very simple visual cue may be susceptible to an other-race effect.

Importantly, this other-race effect was eliminated when identical (morphed-race) eyes appeared in all the faces, for three of the four groups who showed the effect (Caucasian and Asian participants in Study 1 and Chinese-HK participants in Study 2). This interaction is predicted by a perceptual expertise account. In only one case did we fail to find the interaction (Chinese-Aus participants in Study 2), consistent with a socio-cognitive account. Thus the balance of evidence supports a perceptual expertise account: Reduced sensitivity to direct gaze in other-race faces appears to reflect reduced expertise with other-race eye cues.

We digitally manipulated gaze direction, as in many studies (e.g. Jun, Mareschal, Clifford & Dadds, 2013; Mareschal, Calder & Clifford, 2013; Pavan, et al, 2011). This method does not capture all cues to gaze direction (e.g., reflections) and an expertise-based, other-race effect in gaze perception could well be larger and/or more robust if real gaze deviations were used.

For the first time, we have observed a small, but potentially detrimental other-race effect for gaze perception. It is noteworthy that other-race effects extend to such a simple, yet important visual signal as gaze direction. Humans attend to the eyes significantly more than any other facial feature (Janik, Wellens, Goldberg & Dell'Osso, 1978) and in particular, use gaze direction as a powerful social cue. Perceiving gaze as direct, favors positive social interactions. Direct gaze increases attraction between individuals (Stass & Willis, 1967), perception of intimacy (Scherer & Schiff, 1973) the ability to infer the intentions of others (Baron-Cohen, 1995) and the likelihood of initiating conversation (Cary, 1978). Direct gaze also modulates cognitive processes and activity in the social brain (Senju & Johnson, 2009). Faces with direct gaze are more likely to be remembered (Adams, Pauker, & Weishbuch,

2010) and capture attention (Senju, Hasegawa & Tojo, 2005), than faces with averted gaze. The reduced sensitivity to direct gaze in other-race faces that we observed may have a variety of effects on both behavioral and cognitive responses to other-race people.

References

Adams R. B., Jr. & Kleck, R. E. (2005). Effects of direct and averted gaze on the perception of facially communicated emotion. *Emotion*, *5*(1), 3-11.

Adams, R. B., Jr., Pauker, K., & Weisbuch, M. (2010). Looking the other way: The role of gaze direction in the cross-race memory effect. *Journal of experimental social psychology*, *46*(2), 478-481.

Adams, R. B., Jr., Rule, N. O., Franklin, R. G., Jr., Wang, E., Stevenson, M. T., Yoshikawa, S. & Ambady, N. (2010). Cross-cultural reading the mind in the eyes: An fMRI investigation. *Journal of Cognitive Neuroscience*, *22*(1), 97-108.

Anzures, G., Quinn, P., Pascalis, O., Slater, A., & Lee, K. (2013). Development of own-race biases. *Visual Cognition, 21(9-10), 1165-1182*. doi:10.1080/13506285.2013.821428

Baron-Cohen, S. (1995). *Mindblindness: An Essay on Autism and Theory of Mind*. Cambridge, Mass: MIT Press.

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*(8), 706-712.

Cary, M. S. (1978). The role of gaze in the initiation of conversation. *Social Psychology*, *41*(3), 269-271.

Campbell, R., Heywood, C. A., Cowey, A., Regard, M., & Landis, T. (1990). Sensitivity to eye gaze in prosopagnosic patients and monkeys with superior temporal sulcus ablation. *Neuropsychologia*, *28*(11), 1123-1142.

Dehon, H., & Brédart, S. (2001). Another-race effect in age estimation from faces. *Perception*, *30*(9), 1107-1114.

Dunlap, W. P., Cortina, J. M., Vaslow, J. B., & Burke, M. J. (1996). Meta-analysis of experiments with matched groups or repeated measures designs.

Elfenbein, H. A., & Ambady, N. (2002). On the universality and cultural specificity of emotion recognition: a meta-analysis. *Psychological bulletin*, *128*(2), 203- 235.

Ewbank, M. P., Jennings, C., & Calder, A. J. (2009). Why are you angry with me? Facial expressions of threat influence perception of gaze direction. *Journal of vision*, *9*(12), 1-7.

Ewing, L., Rhodes, G., & Pellicano, E. (2010). Have you got the look? Gaze direction affects judgements of facial attractiveness. *Visual Cognition*, *18*(3), 321-330.

Green, D. M. & Swets, J. A. (1966). *Signal detection theory and psychophysics*. New York: Wiley.

Hancock, K. J., & Rhodes, G. (2008). Contact, configural coding and the other-race effect in face recognition. *British Journal of Psychology*, *99*(1), 45-56.

Hood, B. M., Macrae, C. N., Cole‐Davies, V., & Dias, M. (2003). Eye remember you: The effects of gaze direction on face recognition in children and adults. *Developmental Science*, *6*(1), 67-71.

Hugenberg, K., Wilson, J., See, P., & Young, S. (2013). Towards a synthetic model of own group biases in face memory. *Visual Cognition*, *21*(9-10). doi:10.1080/13506285.2013.821429

Itier, R. J., & Batty, M. (2009). Neural bases of eye and gaze processing: the core of social cognition. Neuroscience & Biobehavioral Reviews, 33(6), 843-863.

Janik, S. W., Wellens, A. R., Goldberg, M. L., & Dell'Osso, L. F. (1978). Eyes as the center of focus in the visual examination of human faces. *Perceptual and Motor Skills*, *47*(3), 857-858.

Jun, Y. Y., Mareschal, I., Clifford, C. W., & Dadds, M. R. (2013). Cone of direct gaze as a marker of social anxiety in males. *Psychiatry research*, *210*(1), 193-198.

Kellerman, J., Lewis, J., & Laird, J. D. (1989). Looking and loving: The effects of mutual gaze on feelings of romantic love. *Journal of Research in Personality*, *23*(2), 145-161.

Kloth, N., Altmann, C. S., & Schweinberger, S. R. (2011). Facial attractiveness biases the perception of eye contact. *The Quarterly Journal of Experimental Psychology*, *64*(10), 1906-1918.

Kloth, N., Jeffery, L., & Rhodes, G. (2015). Gaze direction affects the magnitude of face identity aftereffects. *Journal of vision*, *15*(2), 22-22.

Lobmaier, J. S., Tiddeman, B. P., & Perrett, D. I. (2008). Emotional expression modulates perceived gaze direction. *Emotion*, *8*(4), 573-577.

Mareschal, I., Calder, A. J., & Clifford, C. W. (2013). Humans have an expectation that gaze is directed toward them. *Current Biology*, *23*(8), 717-721.

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, and Law*, *7*(1), 3-35.

McKone, E., Stokes, S., Liu, J., Cohan, S., Fiorentini, C., Pidcock, M., ... & Pelleg, M. (2012). A robust method of measuring other-race and other-ethnicity effects: The Cambridge Face Memory Test format. *PLoS One*, *7*(10), e47956.

Nichols, K. A., & Champness, B. G. (1971). Eye gaze and the GSR. *Journal of Experimental Social Psychology, 7*(6), 623-626.

O'Toole, A. J., Peterson, J., & Deffenbacher, K. A. (1996). An 'other-race effect' for categorizing faces by sex. *Perception, 25*(6), 669-676.

Pavan, G., Dalmaso, M., Galfano, G., & Castelli, L. (2011). Racial group membership is associated to gaze-mediated orienting in Italy. *PLoS One*, *6*(10). doi: 10.1371/journal.pone.0025608

R Core Team (2015). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/.

Rhodes, G., Hayward, W. G., & Winkler, C. (2006). Expert face coding: Configural and component coding of own-race and other-race faces. *Psychonomic Bulletin and Review, 13*(3), 499-505.

Rodin, M. J. (1987). Who is memorable to whom: A study of cognitive disregard. *Social Cognition*, *5*(2), 144-165.

Rossion, B., & Michel, C. (2011). An experience-based holistic account of the other-race face effect. In A. J. Calder, G. Rhodes, M. H. Johnson & J. V. Haxby (Eds.), *Oxford Handbook of Face Perception* (pp. 215-243). Oxford: Oxford University Press.

Scherer, S. E., & Schiff, M. R. (1973). Perceived intimacy, physical distance and eye contact. *Perceptual and motor skills*, *36*(3), 835-841.

Senju, A., Hasegawa, T., & Tojo, Y. (2005). Does perceived direct gaze boost detection in adults and children with and without autism? *The stare-in-the-crowd effect revisited. Visual Cognition, 12*(8), 1474-1496.

Senju, A., & Johnson, M. H. (2009). The eye contact effect: mechanisms and development. *Trends in cognitive sciences*, *13*(3), 127-134.

Sporer, S. L. (2001). Recognizing faces of other ethnic groups: An integration of theories. *Psychology, Public Policy, and Law*, *7*(1), 36-97.

Stanislaw, H., & Todorov, N. (1999). Calculation of signal detection theory measures. *Behavior research methods, instruments, & computers*, *31*(1), 137-149.

Stass, J. W., & Willis Jr, F. N. (1967). Eye contact, pupil dilation, and personal preference. *Psychonomic science*, *7*(10), 375-376.

Tanaka, J. W., Heptonstall, B., & Hagen, S. (2013). Perceptual expertise and the plasticity of other-race face recognition. *Visual Cognition*, *21*(9-10), 1183-1201.

Vecera, S. P., & Johnson, M. H. (1995). Gaze detection and the cortical processing of faces: Evidence from infants and adults. *Visual Cognition*, *2*(1), 59-87.

Viechtbauer, W. (2010). Conducting meta-analyses in R with the metafor package. *J Stat Softw*, *36*(3), 1-48.