



Attending to identity cues reduces the own-age but not the own-race recognition advantage

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ABSTRACT

Adults' ability to recognize individual faces is shaped by experience. Young adults recognize own-age and own-race faces more accurately than other-age and other-race faces. The own-age and own-race biases have been attributed to differential perceptual experience and to differences in how in-group vs. out-group faces are processed, with in-group faces being processed at the individual level and out-group faces being processed at the categorical level. To examine this social categorization hypothesis, young adults studied young and older faces in Experiment 1 and own- and other-race faces in Experiment 2. During the learning phase the identity-matching group viewed faces in pairs and completed a same/different task designed to enhance attention to individuating cues; the passive-viewing group memorized faces presented individually. After the learning phase, all participants completed an identical old/new recognition task. Both passive-viewing groups showed the expected recognition bias, but divergent patterns were observed in the identity-matching groups. Whereas the identity-matching task eliminated the own-age bias, it neither eliminated nor reduced the own-race bias. Collectively, these results suggest that categorization-individuation processes do not play the same role in explaining the two recognition biases.

Adults' ability to recognize individual faces is shaped by experience. Numerous studies have provided evidence that young adults recognize own-race faces more accurately than other-race faces (the *own-race recognition bias*, ORB; reviewed in Bothwell, Brigham, & Malpass, 1989; Meissner & Brigham, 2001). Likewise, they recognize young adult faces more accurately than older adult, child and infant faces (the *own-age recognition bias*, OAB, reviewed in Rhodes & Anastasi, 2012; see Kuefner, Macchi Cassia, Picozzi, & Bricolo, 2008). These biases are evident even when (nearly) identical images are presented during the study and test phase. They provide an opportunity to investigate the impact of experience on the accuracy with which individual faces are recognized and the extent to which differential recognition across face categories is driven by perceptual expertise vs. social cognition.

The most traditional paradigm for examining these biases is the old/new recognition task. During a learning phase, participants are presented with previously unknown faces from two categories (e.g., own vs. other-race; young vs. older adult). In a subsequent test phase, participants are shown the original identities intermixed with novel

identities and asked to decide whether each face had been seen during the learning phase. Using this old/new recognition task, many studies have demonstrated both the own-race (e.g., see Golby, Gabrieli, Chiao, & Eberhardt, 2001; MacLin & Malpass, 2001; Rhodes, Locke, Ewing, & Evangelista, 2009; Semplonius & Mondloch, 2015; Wright, Boyd, & Tredoux, 2003) and the own-age bias (Anastasi & Rhodes, 2006; Bäckman, 1991; He, Ebner, & Johnson, 2011; Wiese, Schweinberger, & Hansen, 2008; Wiese, Wolff, Steffens, & Schweinberger, 2013; Wiese, 2012; Wright & Stroud, 2002; see Rhodes & Anastasi, 2012; Wiese, Komes, & Schweinberger, 2013 for reviews).

Despite numerous replications of both the ORB and the OAB, the mechanisms underlying these biases remain under debate. Both biases have been characterized as a problem of perceptual expertise (e.g., Rhodes, Brake, Taylor, & Tan, 1989; Tanaka, Kiefer, & Bukach, 2004; Valentine, 1991); according to this perspective it is the lack of perceptual experience with other-age and other-race faces that leads to poor recognition. For example, one account suggests that the dimensions we use to encode faces are refined by experience and therefore

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better suited to own-race and young adult faces (Valentine, 1991). Several lines of evidence support this explanation. Adults are more sensitive to differences among faces in feature shape and spacing in own- compared to other-race faces (Hayward, Crookes, & Rhodes, 2013; Michel, Caldara, & Rossion, 2006; Mondloch et al., 2010), they possess separable norms for own- vs. other-race faces (Jaquet, Rhodes, & Hayward, 2007, 2008), and they show greater sensitivity to deviations from a prototypical face when viewing own- compared to other-race faces (Zhou, Short, Chan, & Mondloch, 2016). Although fewer studies have examined the mechanisms underlying the own-age bias, young (and older) adults also show greater sensitivity to deviations from a prototypical face when viewing young compared to older adult faces (Short & Mondloch, 2013), show less consensus in judging attractiveness of older (and other-race) compared to young faces (Zhou et al., 2016), and have separable norms for young vs. older adult faces (Short, Proietti, & Mondloch, 2015).

An alternative explanation is the Social Categorization hypothesis. According to this model, both the ORB and the OAB have their roots in the level at which faces are processed. Whereas in-group faces are processed at the individual level (“That’s Julie”), out-group faces are processed at the categorical level (“That’s a Caucasian/Chinese woman”). Processing a face at the categorical level impairs subsequent recognition (Hugenberg, Young, Bernstein, & Sacco, 2010; Young, Hugenberg, Bernstein, & Sacco, 2012) because features that distinguish between identities within the same category are not encoded—or at least not well. Two lines of evidence are consistent with this hypothesis. First, adults (Ge et al., 2009; Levin, 1996, 2000) and infants (Hayden, Bhatt, Joseph, & Tanaka, 2007) categorize other-race faces faster than own-race faces, suggesting that categorical information is especially salient for out-group faces. A comparable pattern has been observed when adults are asked to classify own-age vs. other-age faces (Wiese et al., 2008; also see Johnston, Kanazawa, Kato, & Oda, 1997). Second, there is some evidence that the own-race and own-age biases can be mimicked by randomly assigning young, own-race faces to a social in-group vs. a social out-group. Under such conditions those faces assigned to a social in-group are recognized more accurately, regardless of whether that group is based on personality (Bernstein, Young, & Hugenberg, 2007; Short & Mondloch, 2010), university affiliation, or socioeconomic status (Shriver, Young, Hugenberg, Bernstein, & Lanter, 2008). Such a finding indicates that it is the level of encoding, perhaps independently of expertise per se, that influences subsequent recognition.

To the extent that the own-race and own-age recognition advantages are attributable to a failure to encode individuating information, it should be possible to reduce or eliminate these effects by providing a task during the learning phase that encourages attention to individuating information. To do so we asked participants to make same/different judgements for pairs of images that comprised either two different images of the same person or images of two different people. To make this same/different task challenging we used ambient images that captured natural variability in appearance (e.g., viewpoint, lighting, camera, expression, hairstyle) rather than the tightly controlled images characteristic of most studies in face recognition. As noted by Burton (2013) such stimuli tap true face recognition, rather than simple image matching. Participants viewed each pair for 5 s and then responded either *same* or *different*. During the subsequent old/new recognition test they saw one image from each pair intermixed with images of novel identities and indicated whether each face had been seen during the learning phase. The images shown during the old/new recognition test were identical to those shown during the learning phase because showing new images of these newly learned images would almost certainly have led to floor effects.

We compared recognition accuracy of participants in this *identity-matching* condition to that of participants in a *passive-viewing* condition who learned the same images in the learning phase, but saw each face individually and were simply instructed to memorize them for a later test. To the extent that participants are biased towards attending to

categorical rather than individuating information when processing older adult and other-race faces (Laurence, Zhou, & Mondloch, 2016; Sporer & Horry, 2011; see also Ellis & Derogowski, 1981) we predicted that the OAB and ORB would be evident in the passive-viewing condition and that learning faces in the context of an identity-matching task would reduce or eliminate these biases.

In Experiment 1, participants were tested with young and older adult faces; in Experiment 2, they were tested with own- and other-race faces. Studying both the own-race and own-age biases using the same protocol also afforded a unique opportunity to examine the assumption that these two biases reflect the same underlying mechanisms (see Wiese et al., 2008). To the best of our knowledge only two studies have investigated these biases simultaneously. Zhou et al. (2016) provided evidence that young adults are more sensitive to how both own-race and own-age faces differ from an average face than they are to how other-race and older faces differ from an average face. Their finding suggests that the OAB and ORB are both attributable to representations of variability among faces being more refined for own-age, own-race faces. Nonetheless, there is some evidence that the underlying neural mechanisms for the own-race and own-age recognition biases are, at least in part, distinct. Wiese (2012) found a neural correlate for the own-age bias that was independent of face race and a neural correlate for the own-race bias that was independent of face age (see also Wiese et al., 2013). Thus, examining the impact of identity matching on subsequent recognition of both older adult (Experiment 1) and other-race (Experiment 2) faces addresses another important gap in the literature.

1. Experiment 1

Young adults studied young and older faces in either an identity-matching task or a passive-viewing task; we hypothesized that the own-age bias would be reduced or eliminated in the identity-matching condition. The identity-matching condition also afforded an opportunity to investigate the influence of face age on perceivers’ ability to make identity judgements for images that incorporate natural variability in appearance. Previous studies investigated differences in the perceptual processing of own- vs other-race faces using a perceptual matching task and found a deficit for other-race faces (Megreya, White, & Burton, 2011; Meissner, Susa, & Ross, 2013; Laurence et al., 2016). To the best of our knowledge, no study has investigated perceptual matching of young vs. older adult faces using photographs that capture natural variability in appearance. We did so here using a same/different simultaneous matching task.

2. Methods

2.1. Participants

Forty-eight Caucasian undergraduate students from Brock University participated (38 female; M age = 19.63 years, $range$ = 17–26 years). We chose a sample size of 24 participants in line with existing research investigating the own-race bias (e.g., Semplonius & Mondloch, 2015, n = 20 participants/condition; Rhodes et al., 2009, n = 20 participants/condition; Laurence et al., 2016, n = 24 participants/condition) and the own-age bias (e.g., He et al., 2011; n = 25 participants/condition; Proietti, Pisacane, & Macchi Cassia, 2013; n = 18 participants/condition; Short, Semplonius, Proietti, & Mondloch, 2015; n = 20 participants/condition). The sample size of 24 participants per cell gives us more than 95% power to detect an effect size of Cohen’s d = .87, an estimate based on the effect size obtained in a previous study conducted in our lab (Short et al., 2015).

Participants completed a questionnaire assessing their weekly face-to-face contact with both young and older (age 55+) adults (e.g. number of hours of interaction per week). Participants in the final sample reported having extensive contact with young individuals

($M = 43.29$ h/week) and low contact with older adults ($M = 3.93$ h/week). An additional four participants who reported > 10 h/week of contact with older adults were excluded from all analyses. All participants received research credit for their participation.

2.2. Stimuli

A total of 48 Caucasian young adult female identities (aged between 18 and 35) and 48 Caucasian older adult female identities (aged 60 and older) were used as stimuli. The identities were a mixture of minor celebrities (e.g., actresses, novelists, politicians) and non-celebrities; all identities were unfamiliar to participants in Canada. Images were selected from Google Images after using the name of the celebrity and the year as search terms (e.g. “Gloria Hunniford 2014”). Following the procedure in Jenkins, White, Van Montfort, and Burton (2011), we selected two pictures of each identity in which the face exceeded 150 pixels in height, was free from occlusions and captured from a frontal view. All the images were cropped, converted to greyscale and presented on a white background. All faces subtended 7.45×5.73 visual degrees when presented from 60 cm; when presented in pairs, the two images were separated by 13.2 cm.

For each face category, we created two sets of stimuli: Set A and Set B. To create Set A, eight identities were selected to create *same* trials. Both images of each identity were shown during the learning phase; one randomly selected member of each pair (the target image) was shown in the test phase. Sixteen identities were selected to create *different* trials. Pairs were created based on physical similarity (e.g., similar hair colour and weight); one randomly selected member of each pair (the target identity) was shown in the subsequent recognition phase. Set B was the mirror image of Set A. Target identities from *different* trials in Set A were used to create *same* trials in Set B and target images from *same* trials in Set A were paired with a physically similar identity to create *different* trials in Set B. For participants in the identity-matching condition the two images in each pair were presented side-by-side; for participants in the passive-viewing condition the two faces in each pair were presented individually and the entire set of 64 faces was shown in a random order. The remaining 16 identities served as distractor images and thus were presented only in the recognition phase (see procedure).

2.3. Procedure

All procedures in Experiments 1 and 2 received clearance from the Research Ethics Boards of Brock University and were in accordance with the Declaration of Helsinki. Informed written consent was obtained before testing each participant. The experiment began with a learning phase followed by a recognition phase (see Fig. 1). Participants were randomly assigned to one of two learning conditions: identity matching or passive viewing. Following the learning phase, participants from both learning conditions completed an old/new recognition task.

2.4. Learning phase

2.4.1. Identity-matching condition

The identity-matching task comprised 32 trials (16 per facial age). For each face age there were eight “same trials” (two images of the same person) and eight “different trials” (images of two different people). Each pair was presented for 5 s and preceded by a 1 s fixation cross. After the face pair disappeared participants pressed one of two keys (f, k) on the keyboard to indicate whether the two facial images were of the same or different identities. Half of the participants viewed Set A and the other half viewed Set B. The 32 trials were presented in a different random order to each participant and no feedback was given.

2.4.2. Passive-viewing condition

Participants in the passive-viewing condition studied the same 64 images presented to participants in the identity-matching condition.

However, faces were presented individually for 2.5 s (half of the presentation time of face pairs); each face was preceded by a 1 s fixation cross. Faces were presented in a different random order to each participant. Half the participants viewed Set A and half viewed Set B. Participants were instructed to memorize each face and were not told that some identities were represented by two images.

2.5. Recognition phase

Participants in both groups completed the same recognition task. The 32 target images (16 for each face age) were intermixed with a single image of 32 novel identities (16 for each face age). On each of the 64 trials participants were asked to indicate whether they had seen each face during the learning phase by pressing one of two keys (f, k) on the keyboard. Each face was presented until a response was made and was preceded by a 1 s fixation cross.

3. Results

3.1. Identity-Matching task

To compare performance for own- vs. other-race faces on the matching task we analyzed d' —an unbiased measure of accuracy. To compare the pattern of errors for each facial age we conducted additional t-tests with hits (responding ‘same’ on same trials), false alarms (responding ‘same’ on different trials) and criterion (c) as dependent variables.

Overall accuracy (d') did not differ for young ($M_{d'} = 1.53$; $SD_{d'} = .74$) vs. older ($M_{d'} = 1.51$; $SD_{d'} = .59$) faces, $p = .87$ (Fig. 2a). However, the pattern of errors varied with facial age. The proportion of hits was higher for older ($M = .81$; $SD = .15$) than young ($M = .71$; $SD = 0.16$) faces, $t(23) = 2.30$, $p = .03$, Cohen’s $d = .58$, but so too was the proportion of false alarms ($M_s = .30$ and $.19$; $SD_s = .18$ and $.17$ for older and young faces, respectively; $t(23) = 2.48$, $p = .02$, Cohen’s $d = .65$). This is supported by an analysis showing that participants were less conservative for older ($M_c = -.17$; $SD_c = .42$) than young ($M_c = .16$; $SD_c = .35$) faces, $t(23) = 2.99$, $p = .007$, Cohen’s $d = .85$. Thus, although accuracy in the identity-matching task was comparable across face ages, participants were more likely to make a ‘same’ response when judging older faces than when judging young faces, suggesting some difficulty in telling older adult faces apart.

3.2. Recognition task

To determine whether recognition accuracy varied as a function of face age and learning condition we conducted a 2 (Face Age: Young, Older) \times 2 (Learning Condition: Identity Matching, Passive Viewing) mixed ANOVA with d' as the dependent variable. To investigate the pattern of errors as a function of facial age we conducted three supplemental ANOVAs with hits, false alarms, and criterion as dependent variables. A hit was defined as saying ‘familiar’ when a face had been presented in the learning phase; a false alarm was defined as saying ‘familiar’ when a face had not been presented in the learning phase (i.e., was novel).

The analysis of d' revealed no significant main effects, $p_s > .10$, but there was a significant face age \times learning condition interaction, $F_{1,46} = 4.31$, $p = .04$, $\eta_p^2 = .09$. Paired samples t-tests revealed that accuracy was higher for young ($M_{d'} = 1.92$; $SD_{d'} = .81$) than older ($M_{d'} = 1.63$; $SD_{d'} = .54$) faces in the passive-viewing condition, $t(23) = 2.15$, $p = .04$, Cohen’s $d = .42$. In contrast, there was no effect of face age in the identity-matching condition, $p = .49$, with comparable accuracy for young ($M_{d'} = 2.04$; $SD_{d'} = .81$) and older ($M_{d'} = 2.12$; $SD_{d'} = .65$) faces. As shown in Fig. 2b, the identity matching task improved performance for older adult faces more than for younger faces.

Supplemental Analyses. For hits, there were no significant effects, all $p_s > .25$. For false alarms, there was no main effect of face age, but

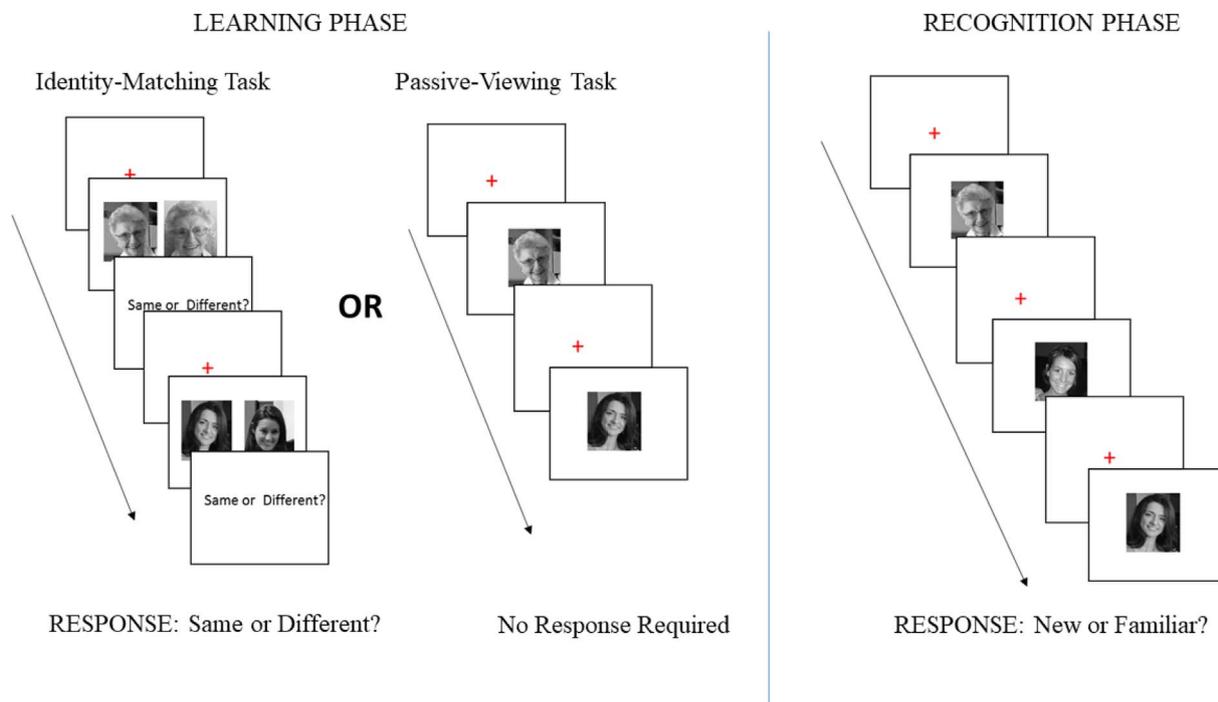


Fig. 1. A schematic diagram of our experimental design. Note. During the learning phase, each face pair was presented for 5 s in the identity-matching condition and each individual face was presented for 2.5 s in the passive viewing condition.

there was significant effect of learning condition, $F_{1, 46} = 3.90, p = .05, \eta_p^2 = .08$; the proportion of false alarms was higher in the passive-viewing condition ($M = .17; SD = 0.10$) than the identity-matching condition ($M = .12; SD = .08$). Critically, there was no face age \times condition interaction, $ps > .12$, suggesting that the reduction of false alarms in the identity-matching condition was comparable for young and older faces. The analysis of criterion revealed no significant effects, $ps > .49$.

4. Discussion

Consistent with numerous past studies, there was an own-age bias when faces were learned in the context of a passive-viewing task. Learning faces in the context of an identity-matching task—a task designed to encourage attention to identity cues—improved accuracy for both young and older adult faces and eliminated the own-age bias. This

outcome is consistent with evidence that the OAB does not differ as a function of whether encoding was incidental vs. intentional (Rhodes & Anastasi, 2012; see also Hyde and Jenkins (1969) for evidence that this pattern extends beyond memory for faces). Nonetheless, elimination of the OAB in the identity-matching group is remarkable given that these participants were not instructed to memorize faces during the learning phase.

Participants’ accuracy in the identity-matching task did not differ for young and older adult faces, but strategy did. Adults made more hits and more false alarms when making same/different judgements about older faces relative to young faces. This finding suggests that the accuracy with which young and older faces are recognized is comparable, but that the pattern of errors might differ; images of two different people are more likely to be confused as belonging to the same person if the faces are older, but two images of the same person are more likely to be perceived as belonging to different people if the faces are young.

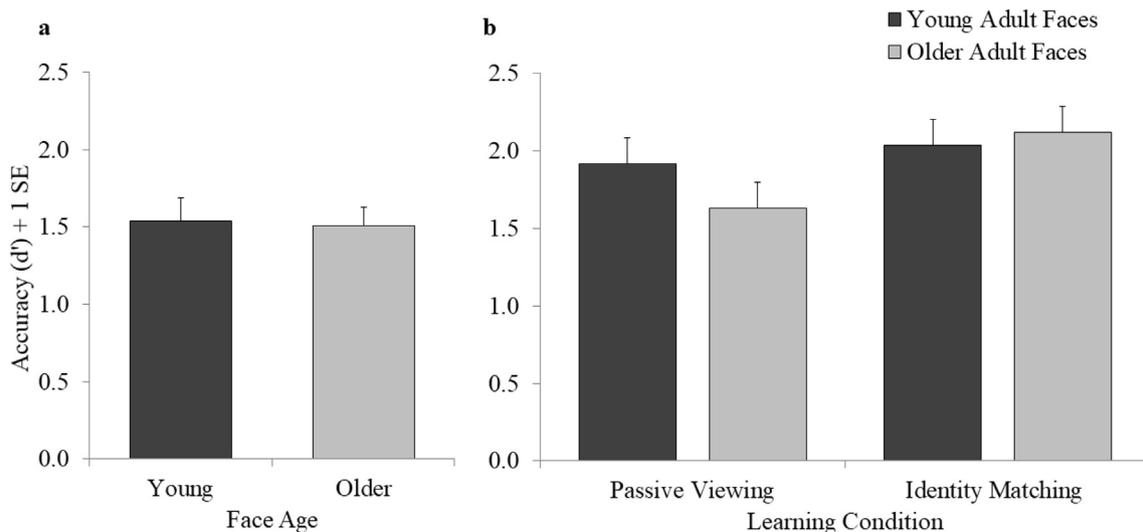


Fig. 2. Overall accuracy (d') in the identity-matching task (Panel a) and the old/new recognition task (Panel b) in Experiment 1.

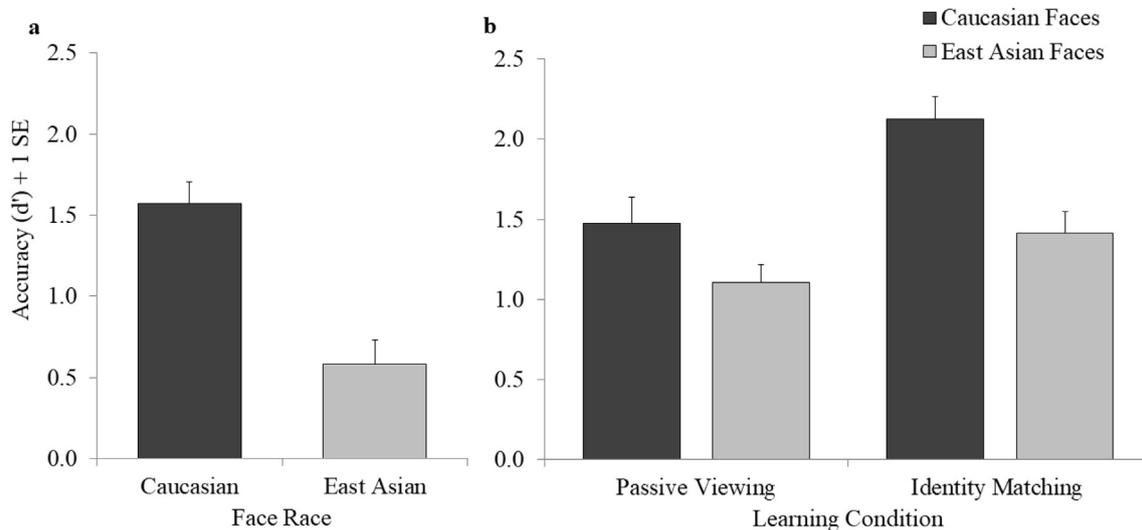


Fig. 3. Overall accuracy (d') in the identity-matching task (Panel a) and the old/new recognition task (Panel b) in Experiment 2.

These findings provide novel insights about perceptual and cognitive mechanisms underlying the own-age bias. Although perceptual expertise certainly contributes to the own-age advantage seen in young adults (see Short & Mondloch, 2013), our results suggest that the own-age bias derives, at least in part, from differences in categorization/individuation processes. Unless explicitly instructed to attend to identity cues, older faces are less likely to be processed at the individual level than are young faces. We argue this point further in the General Discussion. First, however, we investigated whether the same manipulation eliminates another well-established effect: the own-race recognition advantage.

5. Experiment 2

In Experiment 2 we used a paradigm identical to that used in Experiment 1 except older adult faces were replaced with young, other-race faces. Doing so allowed us to examine whether completing the identity-matching task with own- and other-race faces would improve performance on the subsequent old/new recognition task and reduce or eliminate the own-race bias, as it reduced the own-age bias in Experiment 1. We also examined the influence of face race on accuracy in the identity-matching task.

Based on previous studies (Megreya et al., 2011; Meissner et al., 2013) we predicted more accurate performance for own- compared to other-race faces on the matching task. When asked to find a target identity in a lineup comprising 10 images, participants make fewer hits and more false alarms when viewing other-race compared to own-race faces (Megreya et al., 2011). Likewise, when asked to sort a pile of 40 photographs such that each pile contains all of the images of one identity, participants make more piles (i.e., perceive more identities) when sorting other-race than own-race faces (Laurence et al., 2016; see also Meissner et al., 2013; Sporer, Trinkl, & Guberova, 2007, for poor performance with other-race faces in identity-matching tasks). Nonetheless, to the extent that the ORB is driven by the same mechanisms underlying the OAB it should be eliminated or mitigated in the identity-matching condition.

6. Method

6.1. Participants

Forty-eight Caucasian undergraduate students from Brock University participated in this study (44 female; M age = 20.13 years, range = 18–25 years). The sample size of 24 participants per cell gives

us more than 95% power to detect an effect size of Cohen's $d = 1.16$ for the other-race bias, an estimate based on the effect size obtained in a previous study conducted in our lab (Short et al., 2015; Semplonius & Mondloch, 2015).

Participants completed a questionnaire assessing their weekly face-to-face contact with both Caucasian and East Asian (herein “Asian” for ease of reporting) individuals (e.g. number of hours of interaction per week; number of close friends). An additional six participants who reported > 10 h of contact/week and/or provided a general statement indicating extensive experience with Asian individuals (e.g., “I lived in China for 4 years in the past”) were excluded from the final sample. Participants in the final sample reported to have extensive contact with Caucasian individuals ($M = 56.14$ h/week) and low contact with Asian individuals ($M = 2.43$ h/week)—a pattern comparable to that of participants in Experiment 1. All participants received research credit for their participation.

6.2. Stimuli and procedure

The stimuli and procedures were identical to Experiment 1 except older adult faces were replaced with young East Asian faces.

7. Results

7.1. Identity-matching task

Participants were more accurate when making same/different judgements for own- ($M_{d'} = 1.57$, $SD_{d'} = .64$) than other-race ($M_{d'} = .58$, $SD_{d'} = .74$) faces, $t(23) = 6.58$, $p < .001$, Cohen's $d = 1.43$ (Fig. 3a). This difference in accuracy was driven by worse discrimination of other-race faces; whereas the proportion of hits (responding ‘same’ on same trials) was comparable for own- ($M = .68$, $SD = .15$) and other-race ($M = .63$, $SD = .19$) faces, $p = .30$, Cohen's $d = 0.29$, participants made more false alarms (responding ‘same’ on different trials) for other-race ($M = .42$, $SD = .18$) than own-race ($M = .15$, $SD = .13$) faces, $t(23) = 7.20$, $p < .001$, Cohen's $d = 1.78$. This pattern is reflected in a less conservative criterion for other-race ($M_c = -.09$, $SD_c = .36$) than own-race ($M_c = .28$, $SD_c = .31$) faces, $t(23) = 3.79$, $p = .001$, Cohen's $d = 1.09$. Thus, matching identity was more difficult for other-race faces, an effect driven by the difficulty of telling other-race faces apart.

7.2. Recognition task

The analysis of d' revealed main effects of both learning condition,

$F_{1, 46} = 7.25$, $p = .01$, $\eta_p^2 = .14$, and face race, $F_{1, 46} = 41.72$, $p < .001$, $\eta_p^2 = .48$; accuracy was higher after completing the identity-matching task ($M_d' = 1.77$, $SD_d' = .63$) than after the passive-viewing task ($M_d' = 1.29$, $SD_d' = .60$), and for own- ($M_d' = 1.8$, $SD_d' = .80$) than other-race ($M_d' = 1.26$, $SD_d' = .63$) faces. The significant interaction between face race and learning condition, $F_{1, 46} = 4.00$, $p = .05$, $\eta_p^2 = .08$, indicates that the magnitude of the ORB was influenced by how faces were studied. Paired samples t-tests revealed a significant ORB in both the identity-matching condition, $t(23) = 6.59$, $p < .001$, Cohen's $d = 1.04$, and the passive-viewing condition, $t(23) = 2.91$, $p = .008$, Cohen's $d = .56$. The interaction was driven by the ORB being larger in the identity-matching condition ($M_{diff} = .71$; $SD_{diff} = .53$) than in the passive-viewing condition ($M_{diff} = .38$; $SD_{diff} = .63$) (Fig. 3b)—a pattern opposite that seen for young vs. older faces. Indeed, d' increased more in the identity-matching condition relative to the passive-viewing condition for own-race ($M_d' = 2.12$, $SD_d' = .70$ vs. $M_d' = 1.48$, $SD_d' = .78$) than other-race ($M_d' = 1.41$, $SD_d' = .66$ vs. $M_d' = 1.10$, $SD_d' = .55$) faces. In short, there was no evidence that performing the identity-matching task reduced the ORB.

That the identity-matching task had a different impact on the accuracy with which other-race and older adult faces were recognized was confirmed by an analysis in which data from the two experiments were combined. An Experiment (Face Race/Face Age) \times Learning Condition \times Face Type (In-Group vs. Out-Group) ANOVA revealed a significant 3-way interaction, $F_{1, 46} = 8.31$, $p = .005$, $\eta_p^2 = .08$.

Supplemental Analyses of the ORB. For hits, there was no main effect of face race or learning phase, $ps > .20$. The significant face race \times learning condition interaction, $F_{1, 46} = 7.67$, $p = .008$, $\eta_p^2 = .14$, revealed that the proportion of hits was comparable for own- ($M = .73$, $SD = .21$) and other-race ($M = .69$, $SD = .15$) faces in the identity-matching condition, $p > .25$, but higher for other-race ($M = .71$, $SD = .15$) than own-race ($M = .62$, $SD = .19$) faces in the passive-viewing condition, $t(23) = -2.63$, $p = .02$, Cohen's $d = 0.57$. Making more hits for other- than own-race faces in the passive-viewing task does not indicate higher accuracy. An analysis of false alarms revealed a significant effect of face race, $F_{1, 46} = 41.05$, $p < .001$, $\eta_p^2 = .47$ and a significant effect of learning condition, $F_{1, 46} = 8.99$, $p = .004$, $\eta_p^2 = .16$, with no face race \times learning condition interaction, $p = .36$. Participants made more false alarms for other-race ($M = .27$, $SD = .16$) than own-race ($M = .12$, $SD = .10$) faces, and after passive-viewing ($M = .24$, $SD = .11$) than after the identity-matching task ($M = .15$, $SD = .08$). Finally, the analysis of criterion revealed no main effect of learning phase, $p > .43$. There was a main effect of face race, $F_{1, 46} = 18.13$, $p < .001$, $\eta_p^2 = .28$, indicating the use of a more conservative strategy for own- ($M_c = .36$, $SD_c = .39$) than other-race ($M_c = .06$, $SD_c = .36$) faces. The interaction between face race and learning condition did not reach significance, $p = .09$, $\eta_p^2 = .06$.

8. Discussion

Consistent with numerous past studies, there was an own-race recognition advantage when faces were learned in the context of a passive-viewing task. Learning faces in the context of an identity-matching task—a task designed to encourage attention to identity cues—improved overall accuracy, but did not reduce the magnitude of the ORB. Indeed, there was a tendency for the ORB to be augmented in the identity-matching condition. This finding is inconsistent with claims that the ORB is largely a result of differences in social cognition (i.e., to own-race faces being processed at the individual level while other-race faces are processed at the categorical level). Rather our finding points to the importance of perceptual expertise. This conclusion is consistent with accuracy in the identity-matching task being higher for own-race than other-race faces.

We note that performance for Caucasian faces in the passive viewing task was diminished in Experiment 2 relative to Experiment 1 (i.e., when the faces were studied in the context of other-race faces), despite

these faces being identical across experiments. Although a preliminary pattern, and one that should be tested for replicability, one possibility is that the cognitive load associated with learning other-race faces (which were recognized less accurately than other-age faces) impacted recognition of young, own-race faces. Studying the impact of context on the recognition of faces is a rich avenue for future research.

9. General discussion

Across two studies, we replicated the well-established own-age and own-race biases when participants were instructed to memorize a set of individually presented faces. In an old/new recognition task, participants recognized own-age faces more accurately than other-age faces (Experiment 1) and own-race faces more accurately than other-race faces (Experiment 2). The novel contribution of our work lies in contrasting the accuracy of participants in the standard passive-viewing condition with that of participants who completed an identity-matching task during the learning phase. We did so to contrast two explanations for these recognition biases: Differential perceptual expertise (Rhodes et al., 1989; Tanaka et al., 2004; Valentine, 1991) and differences in the extent to which faces from these categories are processed at the individual vs. categorical level (e.g., Hugenberg et al., 2010). The identity-matching task was designed to enhance attention to individuating cues: Faces were presented in pairs and participants were asked to decide whether each pair contained two images of the same person or images of two different people. To the extent that the OAB and ORB are driven by other-age and other-race faces being processed at the categorical level, these recognition biases should be reduced or eliminated in the identity-matching condition relative to the passive-viewing condition.

Our findings provide evidence that the OAB and ORB are not driven by identical underlying mechanisms. The identity-matching condition eliminated the OAB, but did not even reduce the magnitude of the ORB. We conclude that the relative contributions of perceptual expertise vs. social cognition differ for these two face categories, with social cognition making a larger contribution to the own-age bias and perceptual expertise making a larger contribution to the own-race bias.

Performance in the identity-matching task supports our conclusion that perceptual expertise plays an especially important role in the ORB. Participants made more errors in the identity-matching task when judging other-race than own-race faces, an effect driven by *different* trials. In contrast, face age did not impact participants' overall accuracy in the identity-matching task. Indeed, accuracy on the identity-matching task was lower for other-race faces ($M_d' = .58$) than older adults faces ($M_d' = 1.51$). These contrasting patterns suggest that the ability to extract identity information is impaired when judging other-race faces, but not other-age faces, and support our conclusion that the OAB and the ORB are not two sides of the same coin.

Our finding that the identity-matching task did not reduce the ORB is consistent with one previous study in which participants learned own- and other-race faces either individually or in arrays comprising objects and multiple faces—a manipulation designed to increase competition for attention (Semplonius & Mondloch, 2015). Whereas the authors predicted that the ORB would increase in the context of increased competition for attention, their results showed the opposite pattern. The ORB was larger when faces were studied individually. Studying faces individually (relative to in arrays) conferred a larger benefit on own-race faces, just as the identity-matching task conferred a larger benefit on own-race faces than other-race faces in the current study. It appears that learning faces under ideal conditions enhances the ORB, likely because it maximizes the impact of perceptual expertise. In contrast, studying faces under ideal conditions appears to improve the recognition of older adults faces and eliminate the OAB.

10. Strengths and limitations

A strength of our study is that we used the same protocol to investigate both the own-race and the own-age bias, with the same young Caucasian faces being presented during the learning and recognition phases across experiments. Furthermore, we ensured that all participants had minimal experience with the out-group category (i.e., older adult individuals; East Asian individuals). Thus, it is unlikely that the quantity of experience was a confounding factor that might explain the different pattern of results across the two experiments (see Wan, Crookes, Reynolds, Irons, & McKone, 2015), although it is possible that the quality of experience differed.

We note three limitations to our study. First, numerous researchers are calling for a significant shift in how we investigate face recognition (see Burton, 2013). Ideally, each face should be represented by multiple images that capture within-person variability in appearance. Such an approach, which we applaud, assesses identity recognition rather than simple image recognition. While we took this approach in the identity-matching task, we were unable to do so for our recognition test. Had we presented new images of learned identities in the recognition phase it is likely that performance would have approached chance levels. After all, performance for unfamiliar faces is quite poor even in simultaneous matching tasks (e.g., Jenkins et al., 2011; Laurence et al., 2016; Megreya et al., 2011; Meissner et al., 2013).

Second, accuracy on the identity-matching task was lower for other-race faces ($M_d' = .58$) than older adult faces ($M_d' = 1.51$). Likewise, accuracy on the recognition task for participants in the standard passive-viewing condition was lower for other-race faces ($M_d' = 1.10$) than older adult faces ($M_d' = 1.63$). Thus, one possibility is that the OAB was more easily eliminated by the identity-matching task because the older faces were less challenging than the other-race faces. To investigate this possibility, we tested an additional sample ($N = 15$) with older faces in the identity-matching condition. We increased task difficulty by placing an oval occluder over each face to eliminate hair cues. Doing so successfully reduced overall accuracy on the recognition task, but accuracy remained comparable for young ($M_d' = 1.28$) and older faces ($M_d' = 1.33$), $p > .76$. Thus even under more difficult task conditions the young face advantage was absent when the learning phase drew attention to identity cues. We argue that poor identity matching of other-race faces and poor recognition of them regardless of how faces are learned is the point—both reflect a lack of perceptual expertise that is not easily overcome. The extent to which other-race faces being especially hard to encode and recognize (relative to other-age faces) contributes to this pattern should be investigated in future studies. This could be done by contrasting recognition of relatively easy-to-recognize vs. hard-to-recognize faces from all categories in the passive-viewing vs. identity-matching conditions.

Third, our participants were all young Caucasian adults. Ideally, studies investigating the OAB and the ORB would include a complete cross-over design (i.e., older adults and Eastern Asian participants) to avoid any possibility of a stimulus effect. We controlled for stimulus effects by using the same faces under two different task conditions; nonetheless future studies should incorporate two participant groups.

11. Social categorization vs. Perceptual expertise

Perceptual expertise almost certainly contributes to the OAB; both young and older adults are more sensitive to deviations from an average face and show more consensus in attractiveness judgements when viewing young than older faces (Short & Mondloch, 2013; Zhou et al., 2016). Also, perceptual experience with other-age faces modulates the OAB, suggesting that experience is an important factor in the expression of the age bias (Kuefner et al., 2008; Macchi Cassia, Picozzi, Kuefner, & Casati, 2009; Proietti et al., 2013).

Likewise, social cognitive factors almost certainly contribute to the ORB, although the extent of their influence might vary across

populations. Under some conditions (e.g., when White participants are tested with Black faces: Hugenberg, Miller, & Claypool, 2007; Rhodes et al., 2009; Young & Hugenberg, 2012) simply instructing participants to increase their effort in learning other-race faces reduces the ORB (see Wan et al., 2015 for a discussion).

The complex contributions of social cognition vs. perception is abundantly clear when one considers evidence that the strength of these two influences varies across contexts within a face category. For example, when two categories share a similar social status (e.g., Asian and Caucasian faces in Australia), the ORB might exclusively reflect the impact of perceptual expertise (Wan et al., 2015). Under these conditions neither motivation-to-individuate instructions (Tullis, Benjamin, & Liu, 2014; Wan et al., 2015) nor categorizing Asian faces as belonging to an in-group eliminate the ORB (Kloth, Shields, & Rhodes, 2014). In contrast, such manipulations can reduce the ORB in Caucasian Americans (Hayden et al., 2007; Young & Hugenberg, 2012) where social motivation might play a larger role (see DeLozier & Rhodes, 2015, Exp. 2 for evidence that motivation can influence the own-race bias when participants can control encoding). Likewise, the OAB varies within populations as a function of task (Proietti, Macchi Cassia, & Mondloch, 2015). These findings are consistent with our discovery that the relative contribution of social cognition vs. perception also varies across face categories within a population.

12. Conclusion

Face matching and face memory are extremely important across a range of applied settings (e.g. checking passports at an airport, selling age-restricted goods, eyewitness testimony). Understanding the mechanisms underlying differential recognition across face categories is an essential step towards improving performance. Our findings demonstrate that providing a task that requires attention to identity information during perceptual encoding of older adult faces overcomes the own-age bias in face memory, likely because doing so leads to a richer perceptual representation of the images studied. It is not the case that we *cannot* remember older adult faces; we simply do so less accurately, unless we explicitly attend to individuating information. Conversely, that same task does not overcome the own-race bias. We *cannot* remember other-race faces and are more likely to make errors even in an identity-matching task. Thus, other protocols should be investigated to reduce this important recognition bias. Our findings add to growing evidence that although both recognition biases reflect overlapping mechanisms, they should not be treated interchangeably. Just as the neural mechanisms underlying the own-age and own-race biases are not identical (Wiese et al., 2008), our results suggest that the relative weighting of social categorization and perceptual expertise differ across categories. In short, a one-theory-fits-all approach to understanding the effect of face category on face recognition is limited.

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References

- Anastasi, J. S., & Rhodes, M. G. (2006). Evidence for an own-age bias in face recognition. *North American Journal of Psychology*, 8(2), 237–252.
- Bäckman, L. (1991). Recognition memory across the adult life span: The role of prior knowledge. *Memory and Cognition*, 19(1), 63–71. <http://dx.doi.org/10.3758/BF03198496>.
- 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. <http://dx.doi.org/10.1111/j.1467-9280.2007.01964.x>.
- Bothwell, R. K., Brigham, J. C., & Malpass, R. S. (1989). Cross-racial identification. *Personality and Social Psychology Bulletin*, 15(1), 19–25. <http://dx.doi.org/10.1177/0146167289151002>.
- Burton, M. A. (2013). Why has research in face recognition progressed so slowly? The importance of variability. *The Quarterly Journal of Experimental Psychology*, 66(8), 1467–1485. <http://dx.doi.org/10.1080/17470218.2013.800125>.
- DeLozier, S., & Rhodes, M. G. (2015). The impact of value-directed remembering on the own-race bias. *Acta psychologica*, 154, 62–68. <http://dx.doi.org/10.1016/j.actpsy.2014.11.009>.
- Ellis, H. D., & Derogowski, J. B. (1981). Within-race and between-race recognition of transformed and untransformed faces. *The American Journal of Psychology*, 94(1), 27. <http://dx.doi.org/10.2307/1422341>.
- Ge, L., Zhang, H., Wang, Z., Quinn, P. C., Pascalis, O., Kelly, D., ... Lee, K. (2009). Two faces of the other-race effect: Recognition and categorisation of Caucasian and Chinese faces. *Perception*, 38, 1199–1211. <http://dx.doi.org/10.1068/p6136>.
- Golby, A. J., Gabrieli, J. D., Chiao, J. Y., & Eberhardt, J. L. (2001). Differential responses in the fusiform region to same-race and other-race faces. *Nature Neuroscience*, 4(8), 845–850. <http://dx.doi.org/10.1038/90565>.
- Hayden, A., Bhatt, R. S., Joseph, J. E., & Tanaka, J. W. (2007). The other-race effect in infancy: Evidence using a morphing technique. *Infancy*, 12(1), 95–104.
- Hayward, W. G., Crookes, K., & Rhodes, G. (2013). The other-race effect: Holistic coding differences and beyond. *Visual Cognition*, 21(9–10), 1224–1247. <http://dx.doi.org/10.1080/13506285.2013.824530>.
- He, Y., Ebner, N. C., & Johnson, M. K. (2011). What predicts the own-age bias in face recognition memory? *Social Cognition*, 29(1), 97–109.
- Hugenberg, K., Miller, J., & Claypool, H. M. (2007). Categorization and individuation in the cross-race recognition deficit: Toward a solution to an insidious problem. *Journal of Experimental Social Psychology*, 43(2), 334–340. <http://dx.doi.org/10.1016/j.jesp.2006.02.010>.
- Hugenberg, K., Young, S. G., Bernstein, M. J., & Sacco, D. F. (2010). The categorization-individuation model: An integrative account of the other-race recognition deficit. *Psychological Review*, 117(4), 1168–1187. <http://dx.doi.org/10.1037/a0020463>.
- Hyde, T. S., & Jenkins, J. J. (1969). Differential effects of incidental tasks on the organization of recall of a list of highly associated words. *Journal of Experimental Psychology*, 82(3), 472–481. <http://dx.doi.org/10.1037/h0028372>.
- Jaquet, E., Rhodes, G., & Hayward, W. G. (2007). Opposite aftereffects for Chinese and Caucasian faces are selective for social category information and not just physical face differences. *The Quarterly Journal of Experimental Psychology*, 60(11), 1457–1467. <http://dx.doi.org/10.1080/17470210701467870>.
- Jaquet, E., Rhodes, G., & Hayward, W. G. (2008). Race-contingent aftereffects suggest distinct perceptual norms for different race faces. *Visual Cognition*, 16(6), 734–753. <http://doi.org/10.1080/13506280701350647>.
- Jenkins, R., White, D., Van Montfort, X., & Burton, A. M. (2011). Variability in photos of the same face. *Cognition*, 121(3), 313–323. <http://dx.doi.org/10.1016/j.cognition.2011.08.001>.
- Johnston, R. A., Kanazawa, M., Kato, T., & Oda, M. (1997). Exploring the structure of multidimensional face-space: The effects of age and gender. *Visual Cognition*, 4(1), 39–57. <http://dx.doi.org/10.1080/1713756750>.
- Kloth, N., Shields, S. E., & Rhodes, G. (2014). On the other side of the fence: Effects of social categorization and spatial grouping on memory and attention for own-race and other-race faces. *PLoS ONE*, 9(9), 1–10. <http://dx.doi.org/10.1371/journal.pone.0105979>.
- Kuefner, D., Macchi Cassia, V., Picozzi, M., & Bricolo, E. (2008). Do all kids look alike? Evidence for another-age effect in adults. *Journal of Experimental Psychology: Human Perception and Performance*, 34(4), 811–817. <http://dx.doi.org/10.1037/0096-1523.34.4.811>.
- Laurence, S., Zhou, X., & Mondloch, C. J. (2016). The flip side of the other-race coin: They all look different to me. *British Journal of Psychology*, 107, 374–388. <http://dx.doi.org/10.1111/bjop.12147>.
- Levin, D. T. (1996). Classifying faces by race: The structure of face categories. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 22(6), 1364–1382. <http://dx.doi.org/10.1037/0278-7393.22.6.1364>.
- Levin, D. T. (2000). Race as a visual feature: Using visual search and perceptual discrimination tasks to understand face categories and the cross-race recognition deficit. *Journal of Experimental Psychology: General*, 129(4), 559–574. <http://doi.org/10.1037/0096-3445.129.4.559>.
- Macchi Cassia, V., Picozzi, M., Kuefner, D., & Casati, M. (2009). Why mix-ups don't happen in the nursery: Evidence for an experience-based interpretation of the other-age effect. *The Quarterly Journal of Experimental Psychology*, 62(6), 1099–1107. <http://dx.doi.org/10.1080/17470210802617654>.
- MacLin, O. H., & Malpass, R. S. (2001). Racial categorization of faces: The ambiguous race face effect. *Psychology, Public Policy, and Law*, 7(1), 98–118. <http://doi.org/10.1037/1076-8971.7.1.98>.
- Megreya, A. M., White, D., & Burton, A. M. (2011). The other-race effect does not rely on memory: Evidence from a matching task. *Quarterly Journal of Experimental Psychology*, 64(8), 1473–1483. <http://dx.doi.org/10.1080/17470218.2011.575228>.
- 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. <http://dx.doi.org/10.1037/1076-8971.7.1.3>.
- Meissner, C. A., Susa, K. J., & Ross, A. B. (2013). Can I see your passport please? Perceptual discrimination of own- and other-race faces. *Visual Cognition*, 21(9–10), 1287–1305. <http://dx.doi.org/10.1080/13506285.2013.832451>.
- Michel, C., Caldara, R., & Rossion, B. (2006). Same-race faces are perceived more holistically than other-race faces. *Visual Cognition*, 14(1), 55–73. <http://dx.doi.org/10.1080/13506280500158761>.
- Mondloch, C. J., Elms, N., Maurer, D., Rhodes, G., Hayward, W., Tanaka, J. W., & Zhou, G. (2010). Processes underlying the cross-race effect: An investigation of holistic, featural, and relational processing of own- vs other-race faces. *Perception*, 39, 1065–1085. <http://dx.doi.org/10.1068/p6608>.
- Proietti, V., Macchi Cassia, V., & Mondloch, C. J. (2015). The own-age face recognition bias is task dependent. *British Journal of Psychology*, 106(3), 446–467. <http://dx.doi.org/10.1111/bjop.12104>.
- Proietti, V., Pisacane, A., & Macchi Cassia, V. (2013). Natural experience modulates the processing of older adult faces in young adults and 3-year-old children. *PLoS One*, 8(2), e57499. <http://dx.doi.org/10.1371/journal.pone.0057499>.
- Rhodes, M. G., & Anastasi, J. S. (2012). The own-age bias in face recognition: A meta-analytic and theoretical review. *Psychological Bulletin*, 138(1), 146–174. <http://dx.doi.org/10.1037/a0025750>.
- Rhodes, G., Brake, S., Taylor, K., & Tan, S. (1989). Expertise and configural coding in face recognition. *British Journal of Psychology*, 80(3), 313–331. <http://dx.doi.org/10.1111/j.2044-8295.1989.tb02323.x>.
- Rhodes, G., Locke, V., Ewing, L., & Evangelista, E. (2009). Race coding and the other-race effect in face recognition. *Perception*, 38(2), 232–241. <http://dx.doi.org/10.1068/p6110>.
- Semplonius, T., & Mondloch, C. J. (2015). Attentional biases and recognition accuracy: What happens when multiple own- and other-race faces are encountered simultaneously? *Perception*, 44(1), 52–70. <http://dx.doi.org/10.1068/p7892>.
- Short, L., & Mondloch, C. J. (2010). The importance of social factors is a matter of perception. *Perception*, 39(11), 1562–1564. <http://dx.doi.org/10.1068/p6758>.
- Short, L., & Mondloch, C. J. (2013). Aging faces and aging perceivers: Young and older adults are less sensitive to deviations from normality in young adult faces. *Perception*, 42(8), 795–812. <http://dx.doi.org/10.1068/p7380>.
- Short, L., Proietti, V., & Mondloch, C. J. (2015). Representing young and older adult faces: Shared or age-specific prototypes? *Visual Cognition*, 23(8), 939–956. <http://dx.doi.org/10.1080/13506285.2015.1115794>.
- Short, L., Semplonius, T., Proietti, V., & Mondloch, C. J. (2015). Differential attentional allocation and subsequent recognition for young and older adult faces. *Visual Cognition*, 22, 1272–1295.
- Shriver, E. R., Young, S. G., Hugenberg, K., Bernstein, M. J., & Lanter, J. R. (2008). Class, race, and the face: Social context modulates the cross-race effect in face recognition. *Personality & Social Psychology Bulletin*, 34(2), 260–274. <http://dx.doi.org/10.1177/0146167207310455>.
- Sporer, S. L., & Horry, R. (2011). Pictorial versus structural representations of ingroup and outgroup faces. *Journal of Cognitive Psychology*, 23(8), 974–984. <http://dx.doi.org/10.1080/20445911.2011.594434>.
- Sporer, S. L., Trinkl, B., & Guberova, E. (2007). Matching faces: Differences in processing speed of out-group faces by different ethnic groups. *Journal of Cross-Cultural Psychology*, 38(4), 398–412. <http://dx.doi.org/10.1177/0022022107302310>.
- Tanaka, J. W., Kiefer, M., & Bukach, C. M. (2004). A holistic account of the own-race effect in face recognition: Evidence from a cross-cultural study. *Cognition*, 93(1), B1–9. <http://dx.doi.org/10.1016/j.cognition.2003.09.011>.
- Tullis, J. G., Benjamin, A. S., & Liu, X. (2014). Self-pacing study of faces of different races: Metacognitive control over study does not eliminate the cross-race recognition effect. *Memory & Cognition*, 42(6), 863–875. <http://dx.doi.org/10.3758/s13421-014-0409-y>.
- Valentine, T. (1991). A unified account of the effects of distinctiveness, inversion, and race in face recognition. *The Quarterly Journal of Experimental Psychology Section A: Human Experimental Psychology*, 43(2), 161–204. <http://dx.doi.org/10.1080/14640749108400966>.
- Wan, L., Crookes, K., Reynolds, K. J., Irons, J. L., & McKone, E. (2015). A cultural setting where the other-race effect on face recognition has no social-motivational component and derives entirely from lifetime perceptual experience. *Cognition*, 144, 91–115. <http://dx.doi.org/10.1016/j.cognition.2015.07.011>.
- Wiese, H. (2012). The role of age and ethnic group in face recognition memory: ERP evidence from a combined own-age and own-race bias study. *Biological Psychology*, 89(1), 137–147. <http://dx.doi.org/10.1016/j.biopsycho.2011.10.002>.
- Wiese, H., Komes, J., & Schweinberger, S. R. S. (2013). Ageing faces in ageing minds: A review on the own-age bias in face recognition. *Visual Cognition*, 21(9–10), 1337–1363. <http://dx.doi.org/10.1080/13506285.2013.823139>.
- Wiese, H., Schweinberger, S. R., & Hansen, K. (2008). The age of the beholder: ERP evidence of an own-age bias in face memory. *Neuropsychologia*, 46(12), 2973–2985. <http://dx.doi.org/10.1016/j.neuropsychologia.2008.06.007>.
- Wiese, H., Wolff, N., Steffens, M. C., & Schweinberger, S. R. (2013). How experience shapes memory for faces: An event-related potential study on the own-age bias. *Biological Psychology*, 94(2), 369–379. <http://dx.doi.org/10.1016/j.biopsycho.2013.07.001>.
- Wright, D. B., Boyd, C. E., & Tredoux, C. G. (2003). Inter-racial contact and the own-race bias for face recognition in South Africa and England. *Applied Cognitive Psychology*, 17(3), 365–373. <http://dx.doi.org/10.1002/acp.898>.
- Wright, D. B., & Stroud, J. N. (2002). Age differences in lineup identification accuracy: People are better with their own age. *Law and Human Behavior*, 26(6), 641–654. <http://dx.doi.org/10.1023/A:1020981501383>.
- Young, S. G., & Hugenberg, K. (2012). Individuation motivation and face experience can operate jointly to produce the own-race. *Social Psychological and Personality Science*, 3(1), 80–87.
- Young, S. G., Hugenberg, K., Bernstein, M. J., & Sacco, D. F. (2012). Perception and motivation in face recognition: A critical review of theories of the cross-race effect. *Personality and Social Psychology Review*, 16(2), 116–142. <http://dx.doi.org/10.1177/1088868311418987>.
- Zhou, X., Short, L., Chan, H. S. J., & Mondloch, C. J. (2016). Judging normality and attractiveness in faces: Direct evidence of a more refined representation for own-race, young adult faces. *Perception*, 45(9), 973–990. <http://dx.doi.org/10.1177/0301006616652044>.