

Attentional Biases and Recognition Accuracy: What Happens When Multiple Own- and  
Other-Race Faces are Encountered Simultaneously?

Thalia Semplonius<sup>1</sup> & Catherine J. Mondloch<sup>1,2</sup>

<sup>1</sup>Department of Psychology, Brock University, St. Catharines, Canada

<sup>2</sup>ARC Centre of Excellence in Cognition and its Disorders, School of Psychology,  
University of Western Australia

Address Correspondence to:

Catherine J. Mondloch, Ph.D.  
Department of Psychology  
Brock University  
500 Glenridge Avenue  
St. Catharines, Ontario  
Canada L2S 3A1  
e-mail: [cmondloch@brocku.ca](mailto:cmondloch@brocku.ca)  
Phone: (905) 688-5550, x5111  
Fax: (905) 688-6922

### Abstract

Adults recognize own-race faces more accurately than other-race faces. We investigated three characteristics of laboratory investigations hypothesized to minimize the magnitude of the ORA: lack of competition for attention and instructions that emphasize individuating faces during the study phase, and a lack of uncertainty during the test phase. Across two experiments, participants studied faces individually, in arrays comprising multiple faces and household objects, or in naturalistic scenes (presented on an eye tracker); they were instructed to remember everything, memorize faces, or form impressions of people. They then completed one of two recognition tasks; an old/new recognition task or a lineup recognition task. Task instructions influence time spent looking at faces but not the allocation of attention to own- versus other-race faces. The magnitude of the ORA was independent of both task instructions and test protocol, and was only minimally influenced by how faces were presented in the study phase. We discuss these results in light of current theories of the ORA.

Keywords: face perception, own-race recognition advantage, visual attention, eye tracker

Attentional Biases and Recognition Accuracy: What Happens When Multiple Own- and Other-Race Faces are Encountered Simultaneously?

Adults recognize own-race faces more accurately than other-race faces (McKone, Brewer, MacPherson, Rhodes, & Hayward, 2007; Sporer, 2001; for a review, see Meissner & Brigham, 2001). This own-race recognition advantage (ORA) is an insidious social problem and may enhance the out-group homogeneity bias, whereby other-race individuals (out-group members) are judged to be more alike than own-race (in-group members) individuals (Ackerman et al., 2006; Hugenberg, Young, Bernstein, & Sacco, 2010; Shriver, Young, Hugenberg, Bernstein, & Lanter, 2008).

Cross-race effects are robust in laboratory tests and in daily life have negative consequences for both the perceiver and the victim of misidentification (see Hugenberg et al., 2010). The ORA has been attributed to differential perceptual expertise: early experience tunes the perceptual system to face characteristics that maximally differentiate individual faces from the category of faces experienced most often (e.g., own-race faces). This account is consistent with evidence that adults are more sensitive to differences among faces in the shape and spacing of facial features in own- than other-race faces (e.g., Hayward, Rhodes, & Schwaninger, 2008; Mondloch et al., 2010)<sup>1</sup>. However, social cognitive factors may overshadow perceptual expertise in explaining the ORA. Indeed,

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<sup>1</sup> Whether holistic processing, a hallmark of face perception, differs for own-versus other-race faces is unclear with some (Hayward, Rhodes, & Schwaninger, 2008; Michel, Rossion, Han, Chung, & Caldara, 2006; Tanaka, Kiefer, & Bukach, 2004), but not all (Harrison et al., in press; Mondloch et al., 2010) studies showing an advantage for own-race faces.

one can mimic the ORA by randomly assigning own-race faces to in- versus out-group membership (based on SES, university affiliation, personality); doing so leads to an in-group recognition advantage (Bernstein, Young, & Hugenberg, 2007; Short & Mondloch, 2010; Shriver et al., 2008). In addition, simply telling participants about the ORA can reduce or eliminate the effect (Hugenberg, Miller & Claypool, 2007). Likewise, although Caucasians showed a discrimination advantage for own-race faces in a composite face task, they showed a similar advantage for own-race faces randomly assigned to the participants' in-group relative to out-group (Harrison, Gauthier, Hayward, & Richler, 2014).

Given the ease with which a recognition advantage for own-race or in-group faces can be elicited or eliminated it is important to investigate parameters that modulate the effect. Mondloch et al. (2010) suggested three characteristics of laboratory studies that might dampen the ORA, particularly in light of social cognitive models. First, faces are presented individually and for a fixed period of time during familiarization. In daily life, we typically encounter multiple faces simultaneously and they compete with each other and their surroundings for attention. Second, participants typically complete a two-alternative forced-choice or an old/new recognition task and so are aware that the probability of any face being familiar is .50. In daily life, we often lack knowledge about whether the target identity is present, thus increasing uncertainty. Third, participants are instructed to remember or judge faces during familiarization. In daily life, we often do not explicitly attempt to memorize faces, especially while engaging in other tasks. If, for example, identity is encoded more automatically for own- than other-race faces, as suggested by evidence that own-race faces are processed at the individual level whereas

other-race faces are processed at the categorical level (Hugenberg et al., 2010; Levin, 2000; Shriver et al., 2008), then encouraging participants to memorize faces may reduce differences in the accuracy with which own- and other-race faces are recognized.

The overarching goal of the current set of experiments was to study the influence of each of these factors on the magnitude of the ORA. The extent to which each of these factors modulates the ORA has important implications for theories of face perception and for applied settings (e.g., airport security, eyewitness testimony). In Experiment 1 we investigated the effects of presenting faces individually versus simultaneously during the study phase and of increasing uncertainty during the test phase. In Experiment 2 we presented faces in naturalistic scenes to investigate the effects of task instruction and to examine attentional mechanisms underlying the ORA.

### **Experiment 1**

Experiment 1 was designed to investigate the influence of attentional competition during the study phase and uncertainty during the test phase on the magnitude of the ORA. During the study phase half of the participants viewed faces individually and half viewed faces in arrays comprising eight faces (four Caucasian, four Asian) and multiple household objects. During the test phase half of the participants within each study group completed an old/new recognition task and half completed a modified lineup task in which eight faces (four Caucasian) were presented simultaneously and participants were asked to indicate any that were familiar.

We hypothesized that presenting own- and other-race faces simultaneously during the study phase would enhance the ORA. Faces receive preferential attention when viewed in the context of non-face stimuli. For example, in a visual search task, face

distracters interfere with detection of non-face target stimuli (butterflies) but butterfly distracters do not interfere with detection of faces (Langton, Law, Burton, & Schweinberger, 2008) and when viewing scenes, adults attend more to faces than bodies and objects (Birmingham, Bischof, & Kingstone, 2008). However, the amount of attention received may vary across face category (Rodin, 1987). When faces are presented in pairs, adults look longer at the own-race member of each pair (Lovén et al., 2012) and in a change detection paradigm, adults are faster at detecting changes in own- than other-race faces (Humphreys, Hodsoll, & Campbell, 2005). To the extent that differential attention to own- versus other-race faces mediates the relationship between social categorization and recognition in daily life, traditional paradigms in which isolated faces are presented for a fixed period may minimize the ORA.

Second, we hypothesized that increasing uncertainty during the test phase would enhance the ORA. In many studies designed to investigate the ORA, participants complete an old/new recognition task in which the studied faces (old) are embedded among new faces; the probability of each face being familiar is .50. Although not explicitly told that half of the faces are familiar, many participants likely make this assumption. This probability is explicit when a two-alternative forced-choice task is used; in this protocol participants know that one member of each face pair is familiar. In contrast, when we attempt to recognize an individual in daily life, we do not know whether the individual we are trying to recognize is actually present (e.g., whether that person is in the shopping center or at the movie theater). The challenge faced on a daily basis is better captured by line-up tasks in which multiple faces are presented and the target face is present or absent (Carlson, Gronlund, & Clark, 2008; Clark & Davey, 2005;

Lindsay & Wells, 1985). Studies in which a lineup task has been used to study the ORA have presented each participant with a single target face (own- or other-race; Wright, Boyd, & Tredoux, 2001) or multiple targets, with an array being presented after each study face (e.g., Marcon, Meissner, Frueh, Susa, & MacLin, 2010). We directly compared performance on a conventional old/new task with performance on a modified line-up task in which participants viewed test stimuli in arrays comprised of eight faces (four own-race) and were asked to indicate any faces that were familiar. All lineups were “target present” and the number of targets per array varied between one and three for each face race. We hypothesized that the ORA would be larger when test faces were viewed in arrays than when participants completed the old/new task in the test phase.

### Methods

**Participants.** Caucasian undergraduate students from Brock University ( $n = 80$ , 66 female,  $M_{\text{age}} = 19.53$  years, range = 17-26 years) participated. All participants gave informed consent and received either course research credit or a small honorarium. Participants indicated low experience with people of Asian ethnicity based on their responses on a questionnaire (see Procedure and Results). An additional two participants were excluded due to program malfunction ( $n = 1$ ), or because they perseverated on one response during the recognition task ( $n = 1$ ).

**Materials.** The familiarization and testing tasks were programmed in Superlab 4.5 and presented on a 24” LG computer monitor. All face stimuli were neutral expression, front-facing colour photographs. The Caucasian faces were acquired from the Center for Vital Longevity Face Database (Minear & Park, 2004) and the Asian faces were acquired from the Face Perception Lab database at Brock University. Thirty-two

faces (half Caucasian; half male) served as target faces in both the familiarization and test phases, and an additional 32 faces (half Caucasian; half male) served as distracters during the test phase. The familiarization faces were approximately 3.9 cm tall whereas the test faces were approximately 8.9 cm tall.

***Familiarization phase.*** During familiarization, 32 faces (half Caucasian; half male) were presented either in arrays (simultaneous familiarization) comprising eight faces (four male; four Caucasian) and household objects (e.g., paperclips, earrings, etc.) or individually (sequential familiarization). To control for the possibility that placement in the array would influence recognition accuracy, two versions of each array were created such that the locations of Asian and Caucasian faces were reversed (see Figure 1a).





***Test phase.*** During the test phase, 64 faces (32 target; 32 distracter) were presented either in arrays (array testing) or individually (old/new testing). Each array had four Caucasian faces in the top row and four Asian faces in the bottom row. Arrays comprising exclusively male or female faces were presented in a random order. The number of target faces in each row varied between one and three. To reduce response biases the participants were not provided any information about the number of familiar faces in each array (i.e., that each row contained at least one but no more than three familiar faces).

***Contact questionnaire.*** Upon finishing the recognition task, participants completed a questionnaire to assess amount of contact or experience with people of Asian ethnicity. For example, participants indicated how many of their top 10 friends were of Asian ethnicity, and how much current (i.e., interactions during recreation periods) and previous (i.e., attended a high school at which there were many Asian students) experience they had with Asian people.

***Procedure.*** The procedure had clearance from Brock University's Research Ethics Board. After providing informed consent, participants in all conditions were seated approximately 60cm from the computer monitor.

Participants in the sequential-old/new condition ( $n = 20$ ) studied each face individually and were administered the old-new task in the testing phase. Each face was presented for 2s during familiarization and until a response was made during testing. During each phase, faces were presented in a different random order to each participant. Participants responded "old" or "new" to each face using the 'Z' and 'X' (counterbalanced) keys on a keyboard.

Participants in the simultaneous-array group ( $n = 20$ ) studied faces in arrays comprising faces and objects and were administered the array task in the test phase. Each familiarization array was shown for 24s and participants were instructed to remember everything in the array<sup>2</sup>. During the test phase, participants were instructed to point to the familiar faces in each of the test arrays and the experimenter recorded responses; each array was presented until the participant indicated he/she was ready to move on.

To isolate the influences of study vs. testing method on recognition accuracy, we tested two control groups ( $n = 20$  per group). The simultaneous–old/new group studied faces simultaneously but received the old-new test. The sequential-array group studied faces sequentially but received the array recognition test.

### Results

Overall, participants indicated minimal contact with Asian people with 73 of the 80 participants having zero ( $n = 60$ ) or one ( $n = 13$ ), Asian friend.

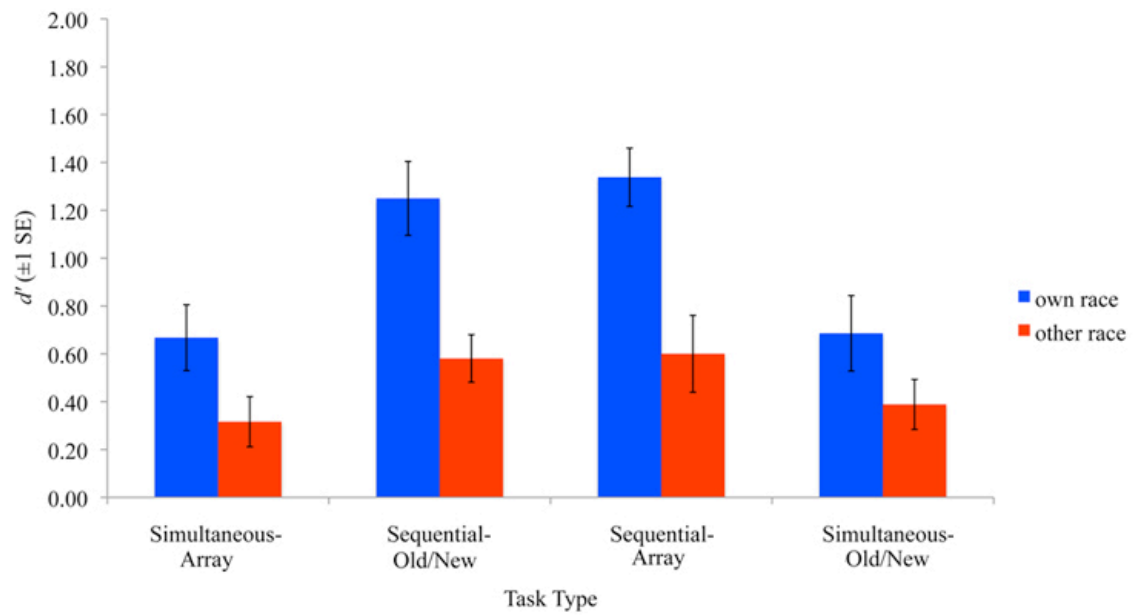
We calculated  $d'$  (an unbiased measure of discrimination accuracy) and criterion ( $c$ ; a measure of response bias) using Macmillan and Creelman's (1991) method for each participant and each face race. For the simultaneous test arrays, each face in the array was treated as a trial. Selecting a face as familiar was scored as a hit if the face had been presented in a study array and as a false alarm if it had not been presented previously. Failing to select a face as familiar was scored as a correct rejection if it had not been presented in the study array but as a miss if it had been presented. Thus each face in the

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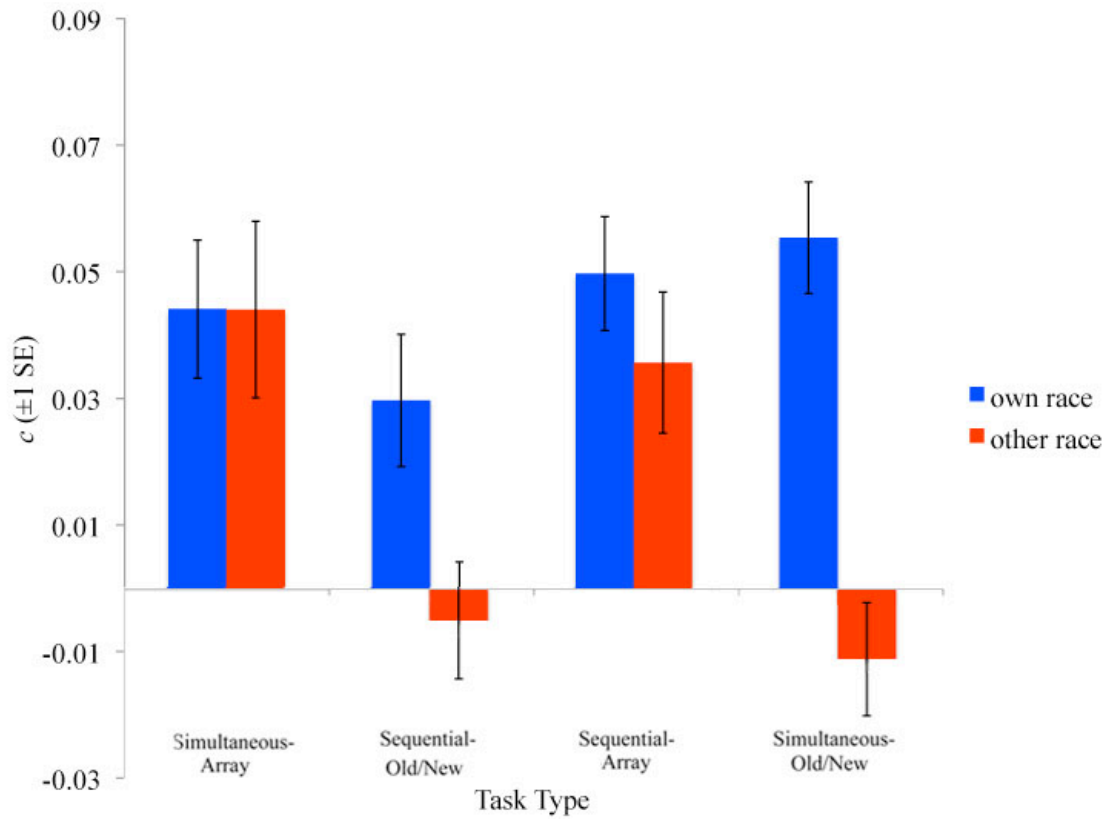
<sup>2</sup> An additional 40 participants were tested in the simultaneous-array condition. After viewing arrays for 16s ( $n = 20$ ) recognition of other-race faces was not above chance. After viewing arrays for 40s ( $n = 20$ ) recognition of own- and other-race faces did not exceed that of participants in the 24s group. Given that our goal was not to investigate the effect of presentation time and that only one control group studied faces in arrays (simultaneous-old/new group) we are only reporting data for the 24s presentation time.

test array contributed to the participant's overall  $d'$  value. To examine the effects of face race, familiarization method and testing method on accuracy, we conducted 2 (face race: Caucasian, Asian) x 2 (familiarization method: simultaneous, sequential) x 2 (testing method: array, old/new) mixed ANOVAs with  $d'$  and  $c$  as the dependent variables.

$d'$ . Single sample  $t$ -tests indicated that all  $d'$  means were significantly different from zero,  $ps \leq .007$ . As shown in Figure 2, Own-race faces ( $M = .99$ ,  $SE = .07$ ) were recognized more accurately than other-race faces ( $M = .47$ ,  $SE = .06$ ),  $F(1,76) = 35.14$ ,  $p < .001$ ,  $\eta_p^2 = .32$  (see Figure 2). Accuracy was higher when faces were presented sequentially ( $M = .94$ ,  $SE = .07$ ) than simultaneously ( $M = .52$ ,  $SE = .07$ ) during familiarization,  $F(1,76) = 18.35$ ,  $p < .001$ ,  $\eta_p^2 = .19$ , but there was no effect of testing method,  $p = .97$ . There was a significant interaction between face race and familiarization method,  $F(1,76) = 4.78$ ,  $p = .03$ ,  $\eta_p^2 = .06$ ; although own-race recognition accuracy was higher than other-race recognition accuracy regardless of whether study faces were presented sequentially ( $M_{own} = 1.29$ ,  $SE_{own} = .10$ ;  $M_{other} = .59$ ,  $SE_{other} = .09$ ) or simultaneously ( $M_{own} = .68$ ,  $SE_{own} = .10$ ;  $M_{other} = .35$ ,  $SE_{other} = .09$ ), the effect was larger after sequential presentation,  $t(39) = 5.81$ ,  $p < .001$ , Cohen's  $d = 1.16$ , than when faces were studied simultaneously,  $t(39) = 2.68$ ,  $p = .01$ , Cohen's  $d = .59$ . No other interactions approached significance,  $ps \geq .62$ .



*Figure 2:* Mean  $d'$  for both own- and other-race faces as a function of familiarization and testing methods.



*Figure 3:* Mean criterion for both own- and other-race faces as a function of learning and testing methods.

c. Single sample *t*-tests showed that *c* means were significantly greater than zero in all conditions,  $ps < .02$ , with two exceptions: other-race faces in the two groups completing the old/new recognition task,  $ps > .20$ . Participants' response biases were more conservative overall for own-race faces ( $M = .05$ ,  $SE = .01$ ) than other-race faces ( $M = .02$ ,  $SE = .01$ ),  $F(1,76) = 31.10$ ,  $p < .001$ ,  $\eta_p^2 = .29$  (see Figure 3). Although significant, these biases are quite small in absolute terms. There was no effect of familiarization method,  $p = .54$ , no interaction between face race and familiarization method,  $p = .39$ , and no interaction between familiarization and testing method,  $p = .64$ . There was a main effect of testing method; participants were more conservative in the array task ( $M = .04$ ,  $SE = .01$ ) than the old/new task ( $M = .02$ ,  $SE = .01$ ),  $F(1,76) = 8.35$ ,  $p = .005$ ,  $\eta_p^2 = .10$ . The two-way interaction between face race and testing method,  $F(1,76) = 17.72$ ,  $p < .001$ ,  $\eta_p^2 = .19$ , and the three-way interaction between race, familiarization method and testing method,  $F(1,76) = 4.90$ ,  $p = .03$ ,  $\eta_p^2 = .06$ , were both significant. Follow-up analyses revealed that participants were more conservative for own- than other-race faces in all conditions,  $ps < .02$ ,  $\eta_p^2$ s  $\geq .14$ , except one: simultaneous-array,  $p = .99$ .

### Discussion

Experiment 1 was designed to test two hypotheses: a) that the ORA would be larger when faces were studied simultaneously rather than sequentially, and b) that the ORA would be larger when a line-up (array) versus an old/new recognition test was used during the test phase. Surprisingly, neither hypothesis was supported.

As predicted, recognition accuracy was higher when faces were studied individually than when they competed for attention with each other and with household

objects. However, contrary to our hypothesis, the ORA was larger when participants studied faces individually. Our finding that own-race faces benefitted more from sequential presentation (or were more impaired by simultaneous presentation) than other-race faces, indicates that the traditional methodology of studying the ORA may enhance recognition of own-race faces, thus overestimating, rather than underestimating, the magnitude of the ORA.

Our hypothesis of a larger ORA when faces were studied simultaneously rather than individually was based on social cognitive models of the ORA. According to these models, other-race faces should receive less attention than own-race faces (Humphreys et al., 2005; Rodin, 1987) and be processed at the categorical rather than the individual level (Ge et al., 2009; Hugenberg et al., 2010; Levin, 2000; Shriver et al., 2008). These effects should be enhanced when competition for attention is high. In contrast, our findings suggest that when faces are studied under optimal conditions (individually), own-race faces benefit more than other-race faces. (Alternatively, they incur a greater cost when competing for attention.) This finding is consistent with perceptual expertise accounts whereby holistic processing and sensitivity to differences among faces in feature shape and spacing are reduced for other-race faces compared to own-race faces (e.g. Hayward et al., 2008; Mondloch et al., 2010; Tanaka et al., 2004). However, the reduced ORA after studying faces simultaneously suggests that the processing styles associated with expertise (even for own-race faces) are weaker when faces compete for attention with other faces and household objects than when faces are presented in isolation (i.e., the processing styles may be exaggerated in traditional task paradigms). The influence of study method was smaller for other-race faces, suggesting that our ability to remember



other-race faces may not be constrained by competition for attention, but rather by perceptual expertise and/or social cognitive factors that operate independently of attentional competition.

Contrary to our hypothesis, the test procedure had little effect on the ORA. It had no influence on  $d'$  and a minimal effect on  $c$ . Although the uncertainty created by our line-up test was much less than that experienced in daily life or in police line-ups in which the perpetrator of the crime may be absent, our data suggest that increasing uncertainty with line-up tasks that include multiple targets does not enhance the ORA.

Two limitations of Experiment 1 preclude drawing strong conclusions. First, the familiarization arrays lacked ecological validity; second, we did not measure allocation of attention during the study phase and so do not know the extent to which presenting faces in arrays reduced total amount of time spent looking at faces or altered the allocation of attention among own- versus other-race faces. Experiment 2 was designed to address these limitations.

## **Experiment 2**

Experiment 2 was designed to investigate the allocation of attention to own- versus other-race faces when viewing faces in naturalistic scenes and the relationship between allocation of attention and subsequent recognition. Participants viewed eight scenes; half of the faces in each scene were Caucasian and half were Asian. We hypothesized that participants would look preferentially towards own-race faces and recognize them more accurately.

In addition, we manipulated task instructions to determine whether the magnitude of the ORA would increase when participants were not specifically instructed to

memorize faces. In many studies investigating the ORA, participants are instructed to remember the faces (e.g., Chiroro, Tredoux, Radaelli, & Meissner, 2008; Hayward et al., 2008; Rhodes et al., 2009), judge attractiveness (Stahl, Wiese, & Schweinberger, 2010) or categorize own- and other-race faces based on age (Wiese, 2012). Experiments outside the realm of face perception have shown that task instructions influence allocation of attention and subsequent recall. Kaakinen, Hyönä and Viljanen (2011) showed participants pictures of home interiors and instructed them to study the pictures from either a burglar or homeowner perspective, or in preparation for a memory test. Participants in the homeowner and burglar perspectives looked more at perspective-relevant items and remembered them better than perspective-irrelevant items (see also DeAngelus & Pelz, 2009). We reasoned that the ORA might be minimized when participants are anticipating a recognition test; such task conditions may encourage participants to spend more time attending to other-race faces. Thus, in Experiment 2 we explicitly manipulated participants' goals while faces were viewed in complex scenes. Half of the participants were told to remember the people and half were told to form an impression of people in each scene. To determine whether participants' allocation of attention was influenced by task instructions, we presented the scenes on an eye tracker. We hypothesized that relative to participants in the impressions group, participants in the memory group would look more at faces, less at bodies and background scenes, and show reduced preferential attention to own-race faces. We also hypothesized that participants in the memory group would have higher recognition accuracy overall and a smaller ORA than participants in the impressions group.

We also measured the specificity of recall. Studies investigating the ORA typically treat recognition as all or none, although in a few studies participants were asked to indicate their confidence (e.g., Gilchrist & McKone, 2003; Pezdek, O'Brien, & Wasson, 2012; Wright et al., 2001; Wright, Boyd, & Tredoux, 2003). Horry and Wright (2008) specifically asked participants to indicate in which context they had learned each face and found better context recollection for own- than other-race faces. Given the importance of eye witnesses remembering the context in which faces were encountered (*I recognize that face but did I see him at the scene of the crime?*), a secondary goal was to measure the influence of face race and task instructions on participants' ability to recall the scene in which recognized faces had been encountered as well as other details about the individual (e.g., what the person was wearing). We hypothesized that participants' recognition of own-race faces would be based on recollection (i.e., that they would recall more details) whereas their recognition of other-race faces would be based on a sense of familiarity (i.e., that they would recall fewer details).

### Method

**Participants.** Caucasian undergraduate students from Brock University ( $n = 40$ , 9 male,  $M_{\text{age}} = 19.10$  years, range = 18-22 years) participated in this study. All participants gave informed consent, indicated minimal experience with people of Asian ethnicity, and received either course research credit or a small honorarium. An additional six participants were excluded because of program malfunction ( $n = 2$ ), experimenter error ( $n = 1$ ), or the eye tracker failing to detect gaze direction for both eyes at least 80% of the time during familiarization ( $n = 3$ ).

**Materials.** The familiarization and testing tasks were programmed using Tobii Studio version 3.2. The tasks were run on a Tobii T60 XL (0.1 degree precision, 24 inch screen, 60 Hz sample rate, 1440 x 900 pixel resolution) eye-tracking system. The face stimuli from Experiment 1 were used in Experiment 2. The test arrays were identical to those used in Experiment 1 except that Asian faces were shown in the top row in half of the arrays and in the bottom row for the other half.

During familiarization, faces were presented in the context of six color photographs of naturalistic scenes (i.e., a busy street, a fair) displayed at a resolution of 1280 x 900 pixels (see Figure 1b). Each scene contained either four or six people (half Caucasian, half Asian) who were central to the scene and were looking straight ahead (targets); the faces of other people were either turned away from the camera or blurred. We used Adobe Photoshop version CS5 to superimpose new faces onto the bodies of targets; the size of each face was adjusted to maintain realistic proportions (size ranged from 0.25% to 0.96% of the screen; across scenes, the percentage of the screen that own- and other-race faces occupied was equated). Two versions of each scene were created such that the locations of Caucasian and Asian faces were reversed. We also added objects (e.g., a garbage can, a kite) to each scene so that any detection of scenes having been altered would not specifically draw participants' attention to faces.

### **Procedure**

The procedure had clearance from Brock University's Research Ethics Board. After providing informed consent, participants were seated approximately 65cm from the eyetracking system, completed a 5-point calibration, and then were given the task instructions.

Half of the participants were instructed to remember the people in each scene (memory group), whereas the other half of participants was told to form impressions of the people (impressions group). Each scene was presented for 40s (four targets) or 60s (six targets); this allowed each face to receive 10s of viewing time if attention was restricted to faces and equally distributed among them. The order in which scenes were presented was randomized for each participant. The test phase was identical to the array test used in Experiment 1 except that each face was numbered and participants stated the number associated with each familiar face.

After completing the recognition task, participants' detailed recognition accuracy for faces was assessed by presenting each target face individually (fixed order). Participants were told that these faces had been presented during familiarization, and that their task was to indicate: 1) whether they could remember seeing the face; 2) which scene the person was from; and 3) any other details about the person (e.g., what clothes they were wearing, what they were doing, etc.). Participants wrote down their responses on a score sheet.

### **Results**

All participants indicated minimal contact with Asian people with 37 of the 40 participants having zero ( $n = 26$ ) or one ( $n = 11$ ) Asian friend.

We defined areas of interest (AOIs) on own- and other-race faces (heads including hair), bodies (entire body excluding the head) and the background scene (any part of the scene that was not heads or bodies). This allowed us to obtain the mean visit count and the mean total visit duration for each AOI group (i.e., how many times and for how long did participants visit own- and other-race faces and bodies).

**Analyses.** We conducted 2 (race: Caucasian, Asian) x 2 (task instruction: memory, impressions) mixed ANOVAs to examine the effects of race and task instructions on visit count, total visit duration,  $d'$ ,  $c$ , and detailed face recognition accuracy. We also conducted an independent samples  $t$ -test to determine whether time spent looking at the background scene varied with task instructions. A moderated regression was conducted to examine whether the relationship between the own-race looking time bias and the own-race recognition advantage was moderated by task instructions or the interaction between looking time advantages and task instructions.

**Visit count.** The number of visits to faces was influenced only by face race: Own-race faces ( $M = 77.73$ ,  $SE = 4.07$ ) were visited more times than other-race faces ( $M = 71.18$ ,  $SE = 3.71$ ),  $F(1, 38) = 9.10$ ,  $p = .005$ ,  $\eta_p^2 = .19$ . There was no effect of task instructions,  $p = .27$ , and no interaction between face race and task instructions,  $p = .45$ . Attention to bodies was influenced by both face race and task instructions: Own-race bodies were visited more times ( $M = 49.63$ ,  $SE = 3.36$ ) than other-race bodies ( $M = 44.53$ ,  $SE = 2.58$ ),  $F(1, 38) = 6.31$ ,  $p = .016$ ,  $\eta_p^2 = .14$ , and the impressions group looked more at bodies ( $M = 52.88$ ,  $SE = 3.99$ ) than the memory group ( $M = 41.28$ ,  $SE = 3.99$ ),  $F(1, 38) = 4.23$ ,  $p = .047$ ,  $\eta_p^2 = .10$ . There was no interaction between face race and task instruction,  $p = .64$ .

**Total visit duration.** Total time spent looking at faces was influenced by both face race and task instructions: Own-race faces ( $M = 71.38$ s,  $SE = 4.57$ s) were visited for more time than other-race faces ( $M = 62.86$ s,  $SE = 4.73$ s),  $F(1, 38) = 8.23$ ,  $p = .007$ ,  $\eta_p^2 = .18$ ; the memory group ( $M = 81.88$ s,  $SE = 6.24$ s) visited faces for more time than the impressions group ( $M = 52.36$ s,  $SE = 6.24$ s),  $F(1, 38) = 11.20$ ,  $p = .002$ ,  $\eta_p^2 = .23$ . There

was no interaction between task instructions and face race,  $p = .28$ . Time spent looking at bodies was not influenced by face race or task instructions or an interaction between the two,  $ps > .10$ . The impressions group ( $M = 142.16s$ ,  $SE = 9.82s$ ) spent more time looking at the background scene than the memory group ( $M = 95.68s$ ,  $SE = 9.69s$ ),  $t(38) = 3.37$ ,  $p = .002$ , Cohen's  $d = 1.09$ , confirming the effectiveness of our task instructions.

$d'$ . Single sample  $t$ -tests showed that  $d'$  values were significantly greater than zero for both task instruction groups for both own- and other-race faces, all  $ps < .002$ . Own-race faces ( $M = 1.25$ ,  $SE = .09$ ) were recognized more accurately than other-race faces ( $M = .69$ ,  $SE = .11$ ),  $F(1, 38) = 27.48$ ,  $p < .001$ ,  $\eta_p^2 = .42$ , and the memory group ( $M = 1.15$ ,  $SE = .12$ ) was more accurate than the impressions group ( $M = .79$ ,  $SE = .12$ ),  $F(1, 38) = 4.75$ ,  $p = .04$ ,  $\eta_p^2 = .11$  (see Figure 4). The predicted interaction between face race and task instruction did not approach significance,  $p = .22$ .

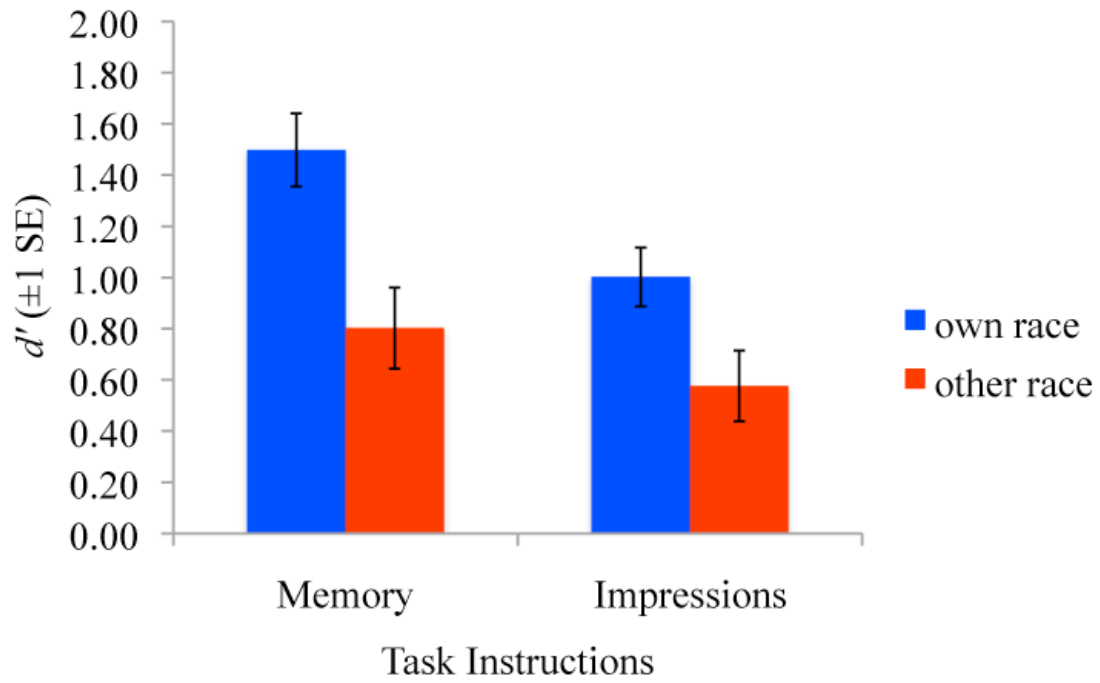
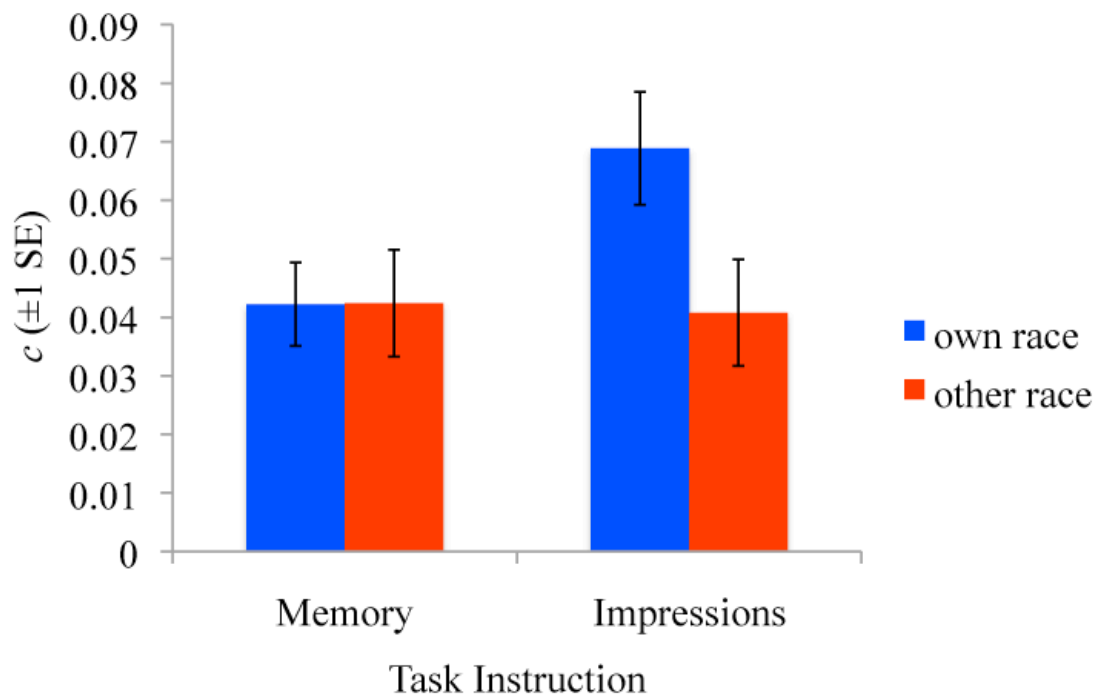


Figure 4. Mean  $d'$  for both own- and other-race faces as a function of task instruction





*Figure 5.* Mean criterion for both own- and other-race faces as a function of task instruction.

*c.* Single sample *t*-tests showed that *c* means for both own- and other-race faces were significantly greater than zero in both task instruction groups, all  $ps < .001$ , indicating a conservative response bias. As shown in Figure 5, the effect of face race approached significance,  $p = .07$ ,  $\eta_p^2 = .09$ , there was no effect of task instruction,  $p = .22$ , and the interaction between face race and task instruction approached significance,  $F(1, 38) = 3.70$ ,  $p = .06$ ,  $\eta_p^2 = .09$ . For the impressions group, responses were more conservative for own- ( $M = .07$ ,  $SE = .01$ ) than other-race faces ( $M = .04$ ,  $SE = .01$ ),  $t(19) = 2.38$ ,  $p = .03$ , Cohen's  $d = .75$ , whereas for the memory group, there was no difference,  $p = .99$ .

**Detailed face memory.** We conducted two analyses to determine whether participants' identification of own-race faces was based more on recollection (defined as remembering something about the context in which the recognized face had been viewed) than their identification of other-race faces, which might be based only on familiarity (a sense that the face was familiar without any recollection of the context in which it was encountered). In the first analysis, we divided the number of details remembered (maximum of two per face) by the number of faces that participants claimed to recognize for each face race. Lower scores would indicate identification via familiarity whereas higher scores would indicate identification via recollection. Single sample *t*-tests indicated that the means for the number of details remembered per face were significantly different from zero for both task instruction groups, and for both own- and other-race faces,  $ps \leq .002$ . Participants remembered more details per face for own- ( $M = .43$ ,  $SE = .07$ ) than other-race faces ( $M = .21$ ,  $SE = .04$ ),  $F(1,38) = 15.85$ ,  $p < .001$ ,  $\eta_p^2 = .29$ .

There was no effect of task,  $p = .85$ , and no interaction between race and task instruction,  $p = .46$ .

In a second analysis we coded each face participants claimed to recognize as either “recollected” (the participant correctly recalled the context or another detail) or “familiar” (the participant did not recall any details). We hypothesized that the ORA would be especially evident in recollection (i.e., that participants would recollect more own-race than other-race faces) with a smaller difference or reversal of this pattern for faces categorized as familiar. To test this hypothesis, we conducted two ANOVAs with the number of faces recollected being the dependent variable in one ANOVA and the number faces deemed as familiar being the dependent variable in the other (see Yovel & Paller, 2004). Single sample  $t$ -tests indicated that all recollection and familiarity means were significantly different from zero for both task instruction groups, and for both own- and other-race faces,  $ps \leq .001$ . For the number of faces recollected, there was a significant main effect of face race,  $F(1, 38) = 21.18, p < .001, \eta_p^2 = .36$ ; participants recollected more own- ( $M = 2.85, SE = .39$ ) than other-race ( $M = 1.35, SE = .23$ ) faces. The main effect of task instruction and the face race by task instructions interaction were not significant,  $ps > .40$ . For the number of faces judged as familiar, the main effects of race and task instruction were not significant,  $ps > .10$ , but the face race by task instruction interaction was,  $F(1, 38) = 4.85, p = .03, \eta_p^2 = .11$ . Familiarity rates were higher for own- ( $M = 8.50, SE = .66$ ) than other-race ( $M = 6.90, SE = .60$ ) faces in the memory group,  $t(19) = 2.07, p = .052$ , Cohen’s  $d = .60$ , but not in the impressions group,  $p = .29$ .

**Looking time and accuracy.** A moderated regression was conducted to examine whether the relationship between the own-race looking time bias (centered) and the ORA was moderated by task instructions (dummy coded) or by an interaction between the two predictors. The own-race looking time bias was calculated by dividing the own-race total visit duration by the summed total visit duration for both own- and other-race faces. The own-race recognition advantage was calculated by subtracting other-race  $d'$  from own-race  $d'$ . The overall model was not significant,  $Adjusted R^2 = -.03$ ,  $F(3, 36) = .63$ ,  $p = .60$ . There was no effect of task instruction,  $\beta = .20$ ,  $p = .24$ , no effect of the own-race looking time advantage,  $\beta = -.08$ ,  $p = .76$  and no interaction between task instructions and the own-race looking time advantage,  $\beta = .14$ ,  $p = .56$ .

### Discussion

As predicted, task instructions influenced both looking times and recognition accuracy. Participants in the impressions group attended less to faces and more to bodies and background scenes than participants in the memory group; they also recognized faces less accurately than participants in the memory group. Nonetheless, task instructions did not moderate allocation of attention to own- versus other-race faces or the magnitude of the ORA.

Participants attended preferentially to own-race faces; this preferential attention was reflected in both visit counts and visit duration and is consistent with previous studies showing preferential attention to own-race faces when faces are shown in pairs (Lovén et al., 2012) or in scenes (in a change-blindness task; Humphreys et al., 2005).

Preferential attention to own-race faces is consistent with Rodin's (1987) claim that adults attend preferentially to faces that are socially relevant and with recent evidence that both young and older adults attend preferentially to young adult faces when viewed in scenes containing both young and older adults (Short, Semplonius, Proietti, & Mondloch, revision under review).

Contrary to our hypothesis, preferential attention to own-race faces was not enhanced in the impressions group. The lack of a moderating effect cannot be attributed to our task instructions being ineffective: they influenced total amount of attention given to faces, bodies, and the background scenes (see above). Rather, it appears as though instructing people to remember people does not encourage participants to attend more to other-race faces. Whether differential attention would be augmented if participants were instructed to focus on background scenes (e.g., architecture) is a matter for future research.

Consistent with a large body of work (e.g., Ackerman et al, 2006; McKone et al., 2007; for a review, see Meissner & Brigham, 2001) participants recognized own-race faces more accurately than other-race faces. Although some previous studies (e.g., Ackerman et al., 2006) have reported higher false alarm rates for other-race faces, we found only minimal evidence that participants' criterion was influenced by face race. Contrary to our hypothesis, the magnitude of the ORA was not moderated by task instructions. Furthermore, although own-race faces received more attention and were recognized more accurately than other-race faces at a group level, at the level of individual participants, increased looking time did not predict better recognition accuracy.

The implications of these findings for perceptual expertise and social cognitive models are discussed below (see General Discussion).

The current study provides novel insights about participants' ability to remember the context in which individual faces were encountered. Participants recalled more details about the context in which they previously viewed own-race faces than other-race faces (i.e., in which scene and what the person was wearing/doing in that scene); both groups recollected more own- than other-race faces. These findings suggest that the processes underlying hits for own- versus other-race faces may differ. Bartlett (in press) argues that impaired face recognition in older (compared to younger) adults may be attributable to impairments in the retrieval and analysis of contextual (associative) information and, as a result, an over-reliance on a sense of familiarity rather than recollection per se. Our findings are consistent with evidence that the same processes distinguish recognition of own- versus other-race faces, with other-race face recognition relying more on a sense of familiarity and less on recollection than own-race faces (Horry, Wright, & Tredoux, 2010; Marcon, Susa, & Meissner, 2009). These findings have important implications for eye-witness testimony; it is important that eye-witnesses not only recognize a face as familiar, but that they recognize the specific context in which that face was encountered (at the grocery store/amongst mug shots versus at the scene of the crime). Future research examining the processes underlying hits for own- versus other-race faces is important. Gist-based recall may lead to more lenient criterion in choosing other-race suspects than own-race suspects (Slone, Brigham, & Meissner, 2000) and thus contribute to the high proportion of false incarcerations in cases in which the perpetrator belongs to a different

race than the witness (see Young, Hugenberg, Bernstein, & Sacco, 2012 for implications of the ORA for eyewitness misidentifications).

### **General Discussion**

Our study was designed to test the hypothesis that the ORA would be larger when faces compete for attention with each other and with background stimuli during the study phase and/or when uncertainty is increased during the recognition phase by presenting faces in arrays and varying the number of familiar faces per array. Our findings did not support either hypothesis. Nonetheless, our findings make several novel contributions to the literature. We will briefly comment on three implications in our general discussion: the extent to which faces are special, implications for social cognitive models, and other factors that may limit the magnitude of the ORA in the lab.

**Are faces special?** A vast literature claims that faces are special. This claim is based on ERP and fMRI studies showing patterns of activation that are unique to faces (reviewed in Kanwisher & Barton, 2011), behavioral evidence of specialized processing for faces (e.g., holistic processing, Tanaka et al., 2004; sensitivity to facial features and feature spacing, Hayward et al., 2008, reviewed in Maurer, Le Grand & Mondloch, 2002; norm-based coding, Valentine, 1991), and evidence that adults can recognize hundreds of familiar faces at a glance, despite faces being a homogeneous class of stimuli (reviewed in Maurer et al., 2002, but see McGugin, McKeef, Tong, & Gauthier, 2011, for an example of an alternative view). Our results provide only partial support for the claim that faces are special; faces seem to receive preferential attention but recognition is quite poor, although perhaps better than for other object categories. In Experiment 2, participants allocated more attention to faces than bodies, despite bodies occupying a

larger proportion of each scene. Although participants allocated more attention to background scenes ( $M_s = 95.7s$  and  $142.2s$  for the memory and impressions group, respectively) than to faces ( $M_s = 52.4s$  and  $81.9s$  for the memory and impressions group, respectively), faces occupied only 16% of the area across scenes and thus attracted a disproportionate amount of attention.

Despite attending disproportionately to faces, we were surprised by how low  $d'$  values were, despite our presenting the same image of each face during the study and test phases. Even under ideal study conditions (sequential presentation, Experiment 1) in which faces were presented individually for 2s during the study phase, participants correctly identified only about nine out of 16 own-race faces and falsely identified three of 16 novel faces as familiar. Furthermore, after viewing faces in the context of scenes, participants were unable to recall many details about each face (e.g., the scene in which the face was viewed). Collectively, these results suggest that although recognition accuracy for familiar faces may be very robust (Burton, 2013; Schwaninger, Lobmaier, & Collishaw, 2002), recognition accuracy for faces after a single encounter is quite poor—even when instructed to memorize faces, a finding that is important for social interactions (e.g., for shop keepers attempting to recognize customers) and for eye-witness testimony.

**Implications for models of the ORA.** According to social cognitive models, poor recognition of other-race faces is part of a broader phenomenon whereby faces of out-group members are processed at the categorical level and faces of in-group members are processed at the individual level (Hugenberg et al., 2010). This model is consistent with evidence that in-group faces are recognized more accurately than out-group faces even when perceptual expertise is controlled for (i.e., when all the faces are the same-race;



Bernstein et al., 2007). On the surface, our findings do not provide clear support for social cognitive models. Although participants looked longer at own-race faces than other-race faces in Experiment 2, the difference in looking time was small, with a ratio of 1.14:1s. Indeed, mean time spent looking at individual faces was 4.46s for own-race faces compared to 3.93s for other-race faces and the difference in looking times for own- and other-race faces did not increase when participants were simply asked to form impressions of the people in each scene (which we predicted would increase looking time biases driven by social categorization). Furthermore, individual differences in the own-race looking time advantage were not correlated with individual differences in the magnitude of the ORA. Thus, although category membership influenced looking times, looking times per se do not adequately explain the ORA.

The lack of relationship between looking time and recognition accuracy may not be surprising. Hsiao and Cottrell (2008) reported that the accuracy of face recognition is higher after two fixations than one fixation at test, but that there is no additional improvement with additional fixations. We note, however, Hsiao and Cottrell manipulated the number of fixations during the recognition phase, not during encoding. Likewise, participants can accurately discriminate faces that differ only in feature shape or feature spacing after a 200-ms presentation time (Mondloch, Dobson, Parsons, & Maurer, 2004; Mondloch, Le Grand, & Maurer, 2002), at least when variations of a single identity are presented on each trial and memory demands are minimized. Our results show that variation in time spent encoding individual faces does not predict recognition accuracy or the magnitude of the ORA. Indeed, our results provide additional evidence that what might best distinguish processing of both own- versus other-race faces

and in- versus out-group faces is the efficiency with which they are processed (Bukach, Cottle, Ubiwa, & Miller, 2012; Harrison et al., 2014). Other-race faces may be processed less efficiently for two reasons: observers are less sensitive to the characteristics that distinguish among other-race faces than own-race faces and social categorization may further differentiate the speed with which other-race faces are processed (see Harrison et al. for a discussion).

**Capturing the ORA in laboratory studies.** Our original goal was to investigate three explanations for the relatively small ORA observed in laboratory studies. Our findings, though informative, did not provide an answer to this question, although we eliminated three predominant hypotheses (competition for attention during familiarization, uncertainty during the test phase, and task instructions).

We propose two additional characteristics of laboratory studies that may underestimate the magnitude of the ORA experienced in daily life. First, like most previous studies, we presented the same image of individual faces at study and test (with only image size varying). In the real world we see people from different angles and under different lighting conditions; additionally, individuals display a range of facial expressions. It may be that one's ability to recognize identity across natural variability in appearance is especially challenging when recognizing other-race faces. Burton (2013) points out that tightly controlled stimuli may obscure the very phenomena we are trying to study—identity perception. Jenkins, White, Van Montfort and Burton (2011) provided clear evidence that even for own-race faces, recognizing a face's identity across a set of images that vary naturally is challenging when the identity is unfamiliar; when asked to sort 40 photographs (20 images of each of two identities) into piles such that each pile

included all images of an identity, participants (who were unfamiliar with the identities) perceived an average of 7.5 identities (i.e., made 7.5 piles). We recently found that participants created twice as many piles when sorting other-race faces than own-race faces (Zhou, Laurence, & Mondloch, 2014), a result that is consistent with evidence that recognition of other-race faces is more impaired than own-race faces when point of view is altered (Sporer & Horry, 2011). Future studies should incorporate presenting different images at study and test into our ecologically valid procedure in which faces are studied in the context of naturalistic scenes and later recognized in our modified line-up task.

Second, like virtually every previous study, we intentionally included an equal number of Caucasian and Asian faces in each scene. However, to the extent that the ORA is driven by differential experience with own- versus other-race faces, it may be that the ongoing ratio of own- to other-race faces plays a critical role in the extent to which faces from these two categories are processed differently (e.g., individuated versus categorized). Future studies should examine the influence of the composition of each scene on recognition accuracy (e.g., scenes comprising all own- or all other-race faces, more own- than other-race faces, etc.). Differential attention and subsequent recognition may be enhanced if scenes comprised only one racial group or a single other-race face set amongst several own-race faces. Either of these manipulations may enhance the tendency to process other-race faces at the categorical level and would be more representative of how other-race faces are encountered in racially homogeneous communities.

Acknowledgements and Author's note:

The research was funded by a Discovery Grant and a Discovery Supplement Award [NSERC] awarded to CJM; TS was supported by a Joseph-Armand Bombardier Canada Graduate Scholarship [SSHRC]. Lindsey Short and Sarah Laurence provided helpful comments on a previous version of the paper.

Portions of this work were presented at the annual meeting of Vision Sciences Society (2013) and this work formed the basis of the first author's MA thesis.

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