An Investigation of the Role of Attention in the Cross-Race Effect: An Ecological Approach

By

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A thesis
submitted in partial fulfillment
of the requirements for the degree
Master of Arts

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BROCK UNIVERSITY
St. Catharines, Ontario

August, 2013

Abstract

The current set of studies was conducted to examine the cross-race effect (CRE), a phenomenon commonly found in the face perception literature. The CRE is evident when participants display better own-race face recognition accuracy than other-race recognition accuracy (e.g. Ackerman et al., 2006). Typically the cross-race effect is attributed to perceptual expertise, (i.e., other-race faces are processed less holistically; Michel, Rossion, Han, Chung & Caldara, 2006), and the social cognitive model (i.e., other-race faces are processed at the categorical level by virtue of being an out-group member; Hugenberg, Young, Bernstein, & Sacco, 2010). These effects may be mediated by differential attention. I investigated whether other-race faces are disregarded and, consequently, not remembered as accurately as own-race (in-group) faces.

In Experiment 1, I examined how the magnitude of the CRE differed when participants *learned* individual faces sequentially versus when they learned multiple faces simultaneously in arrays comprising faces and objects. I also examined how the CRE differed when participants *recognized* individual faces presented sequentially versus in arrays of eight faces. Participants' recognition accuracy was better for own-race faces than other-race faces regardless of familiarization method. However, the difference between own- and other-race accuracy was larger when faces were familiarized sequentially in comparison to familiarization with arrays. Participants' response patterns during testing differed depending on the combination of familiarization and testing method. Participants had more false alarms for other-race faces than own-race faces if they learned faces sequentially (regardless of testing strategy); if participants learned faces in arrays, they had more false alarms for other-race faces than own-races faces if they were tested with sequentially presented faces. These results are consistent with the perceptual expertise model in that participants were better able to use the full two seconds in the sequential task for own-race faces, but not for other-race faces.

The purpose of Experiment 2 was to examine participants' attentional allocation in complex scenes. Participants were shown scenes comprising people in real places, but the head stimuli used in Experiment 1 were superimposed onto the bodies in each scene. Using a Tobii eyetracker, participants' looking time for both own- and other-race faces was evaluated to determine whether participants looked longer at own-race faces and whether individual differences in looking time correlated with individual differences in recognition accuracy. The results of this experiment demonstrated that although own-race faces were preferentially attended to in comparison to other-race faces, individual differences in looking time biases towards own-race faces did not correlate with individual differences in own-race recognition advantages. These results are also consistent with perceptual expertise, as it seems that the role of attentional biases towards own-race faces is independent of the cognitive processing that occurs for own-race faces.

All together, these results have implications for face perception tasks that are performed in the lab, how accurate people may be when remembering faces in the real world, and the accuracy and patterns of errors in eyewitness testimony.

Acknowledgements

First, I would like to thank my supervisor, Dr. Cathy Mondloch, for her expertise and support throughout the duration of my thesis project. I would also like to thank my committee members Dr. Gordon Hodson and Dr. Angela Evans for their valuable insight and feedback throughout this project's duration.

Second, I would like to thank the members of the Face Perception lab (past and present), but specifically Lindsey Short, Matt Horner and Valentina Proietti for your insight, knowledge and many laughs we had together.

Finally, I would like to thank my husband, James Semplonius, for his support during this process, and his enthusiasm for the work I have completed.

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General Introduction

When studying face recognition, a phenomenon that is frequently mentioned is the cross-race effect (e.g., Ackerman et al., 2006; McKone, Brewer, MacPherson, Rhodes & Hayward, 2007; Shriver, Young, Hugenberg, Bernstein & Lanter, 2008). The cross-race effect simply means individuals recognize own-race faces better than other-race faces (McKone et al., 2007; Meissner & Brigham, 2001; Sporer, 2001).

The cross-race effect is an interesting phenomenon. Although it may seem to be a theoretical phenomenon used only in the face perception literature, it does have crucial real-life implications, one of which is false incarceration. As reviewed in Behrman and Davey (2001), eyewitnesses tend to correctly identify cross-race suspects to a lesser extent than own-race suspects. Additionally, false alarm rates—incorrect recognition of a completely novel face—tend to be higher for other-race faces than own-race faces in recognition tasks (e.g., Ackerman et al., 2006). Therefore, although other-race suspects are correctly identified to a lesser extent than own-race suspects, it is possible that other-race suspects may more often be falsely accused as perpetrators of a crime simply due to the nature of what drives the cross-race effect. If more other-race suspects are being incorrectly chosen as previously viewed at the scene of a crime, then there is a critical link between eyewitness testimony and false incarceration.

Not only is the cross-race effect prevalent in the eyewitness literature, but it is also a phenomenon people may experience on a daily basis. Whether the experience is derived from attending an ethnically diverse school or travelling internationally, the cross-race effect is evident and can also lead to potentially awkward social situations. For example, imagine sitting on a city bus on your way to campus and chatting with a person who differs in race from yourself—potentially a common occurrence. When trying to recognize that individual on campus later on, you may have a difficult time picking him/her out of the crowd. This should hopefully drive home the fact that the cross-race effect is something we experience quite frequently.

Typically, the cross-race effect has been attributed to two factors: perceptual expertise and social categorization; however, these have often been viewed as separate domains and only recently have both factors been taken into account as contributors to the cross-race effect. According to the perceptual expertise model, perceivers are better at processing (i.e., are more sensitive to differences among) own-race faces in comparison to other-race faces because they have more experience viewing own- than other-race faces. According to the social categorization model, own-race faces are more socially relevant and therefore are processed at an individual level which aids in later recognition, whereas other-race faces are less socially relevant and therefore are processed at a categorical level thereby hindering later recognition.

Development of Perceptual Expertise

As adults we are experts at face processing (Maurer, Le Grand & Mondloch, 2002) but this expertise is not something that is evident from birth. The cross-race effect is, in part, due to perceptual narrowing in infancy and how the visual system is set up early in life (e.g., Kelly et al., 2005; Kelly et al., 2007).

Throughout infancy, humans perceptually narrow to the type of stimuli with which they have the most experience (e.g., faces; Pascalis et al., 2005) and as a result of this narrowing process they are better at recognizing or discriminating between own-race faces in comparison to other-race faces (e.g., Kelly et al., 2005; Kelly et al., 2007). In infant studies, recognition of familiar faces is measured using novelty preferences. Novelty preferences are demonstrated by infants’ longer looking time at novel faces when both a familiar and a novel face are presented simultaneously. Kelly et al. (2007) found that at 3 months of age, infants display preferences for novel faces of various races, while at 9 months of age they display novelty preferences for only own-race faces. This evidence strongly suggests there is a broad processing system present at birth and that this system narrows with visual experience (Nelson, 2001).

Pascalis, de Haan and Nelson (2002) found similar results but were interested in how humans perceptually narrow in terms of recognition for faces of different species. They found that at 6 months of age infants looked at the novel face for longer periods of time for both own-race human faces and monkey faces while at 9 months of age infants looked longer at the novel face only for human faces and could not discriminate between familiar/novel monkey faces (Pascalis et al., 2002). In addition to these findings Pascalis et al. (2005) found that if infants were given experience with monkey faces between the 6- and 9-month testing sessions, they retained the ability to discriminate between familiar and novel monkey faces at nine months of age.

Both of these studies demonstrate the importance of experience with stimuli infants come into contact with most frequently. Expertise with own-race human faces continues to develop as contact continues (i.e., Kelly et al., 2005; Kelly et al., 2007; Mondloch, Le Grand & Maurer, 2002) although the perceptual system is very plastic in childhood and experience with other-race faces can reduce/eliminate the magnitude of the cross-race effect (Bar-Haim, Ziv, Lamy & Hodes, 2006; Goodman et al., 2007) or even reverse the effect (Sangrigoli, Pallier, Argenti, Ventureyra & de Schonen, 2005).

In contrast to how infants' ability to discriminate between familiar and novel faces is measured, adults' expertise in face processing is demonstrated by their ability to use holistic processing, to detect differences between individual features and their sensitivity to spacing within a face (Maurer et al., 2002). Faces that adults come into contact with most frequently (here, own-race faces) tend to be processed holistically or as a gestalt/whole (Michel, Rossion, Han, Chung & Caldara, 2006; Tanaka, Kiefer & Bukach, 2004; but see Mondloch et al., 2010). Two tasks that serve as markers of holistic processing are part/whole tasks and composite face tasks. These tasks are outlined in Mondloch et al. (2010). In part/whole tasks, participants are shown a target face and then either a pair of faces (*whole condition:* one identical face, one face with a different feature) or a pair of features (*part condition:* one familiar feature, one different feature). Participants indicate which face/feature was identical to the target (e.g., which nose was the target's nose?). Holistic processing is evident when accuracy is higher in the whole condition than the part condition, a pattern that is stronger for own-race faces than other-race faces (especially amongst Caucasian participants; Mondloch et al., 2010; Tanaka et al., 2004). In composite face tasks, participants see a target face and then a composite face comprised of the same upper half paired with a different lower half or a composite face comprised of different upper and lower halves than the target face (i.e., an entirely different face). Participants respond whether the top half of the composite face was the same as the target face. On some trials the top and bottom halves are aligned (utilizes holistic processing) while on other trials they are misaligned (disrupts holistic processing). Because faces are processed holistically, the bottom half of the face influences the perception of the top half of the face when the top and bottom halves of the face are aligned. Therefore, holistic processing is evident when accuracy is lower on the aligned trials than the misaligned trials (for the trials in which the upper half of the test face matched the top half of the target face). The discrepancy between accuracy for aligned and misaligned trials is called the *composite face effect* and should be larger for own-race faces than other-race faces. This demonstrates that holistic processing was used in the familiarization phase for own-race faces and to a lesser extent for other-race faces (i.e., Michel et al., 2006; reviewed in Mondloch et al., 2010). This use of holistic processing allows adults to more efficiently and effectively process own-race faces in comparison to other-race faces.

We also tend to be more sensitive to featural differences in own-race faces than other-race faces as is indicated by better own-race performance than other-race performance in scrambled face tasks (Hayward, Rhodes, & Schwaninger, 2008) and featural swap tasks (Mondloch et al., 2010). In scrambled face tasks, participants are familiarized with regular faces and are presented with scrambled features in the recognition task. Participants must indicate whether or not they have previously seen the scrambled face (e.g., Hayward et al., 2008). In featural swap tasks, participants are shown a target face and then a test face with a different feature on the face and must indicate whether the faces were the same or different. For both tasks, participants tend to be more accurate for own-race faces than other-race faces indicating better own-race featural processing (Hayward et al., 2008; especially for Caucasian participants, Mondloch et al., 2010).

We also tend to be more sensitive to the spacing between features as is evident through better performance for own-race faces than other-race faces in blurred face tasks

(Hayward et al., 2008) and feature spacing tasks (Mondloch et al., 2010; all tasks reviewed in Mondloch et al., 2010). In blurred tasks, participants are shown a series of target faces in the familiarization stage, and are shown a series of blurred faces in the testing phase (blurring eliminates featural information leaving only spacing information). Participants must indicate whether or not they recognize the faces from the familiarization phase (Hayward et al., 2008). In feature spacing tasks, participants are shown a target face and then a test face that differs in the spacing between facial features from the target face on some trials and is identical on others. Participants must indicate whether the faces are the same or different. For both tasks, participants tend to be more accurate with own-race faces in comparison to other-race faces (Hayward et al., 2008; for Caucasian participants, Mondloch et al., 2010).

Therefore, according to perceptual expertise models, markers of expert processing (holistic processing, featural processing, and sensitivity to feature spacing) are weaker for other-race faces than own-race faces, and as a result other-race faces are recognized less accurately than own-race faces.

One way to conceptualize the expertise adults develop for own-race faces is Valentine's face space model (1991). In the middle of face space is an average face comprised of all the faces with which one comes into contact (Valentine, 1991). Surrounding the average face is a series of vectors representing facial dimensions on which faces vary. For example, these vectors could represent nose width or distance between the eyes. Valentine (1991) proposes that own-race faces are in the center of face space and are maximally differentiated by certain dimensions whereas other-race faces are clustered in the periphery, far away from own-race faces. Other-race faces differ from the average face in the same way (e.g., face shape) making it more difficult to differentiate between individual other-race faces (Valentine, 1991).

This perceptual expertise is demonstrated in Humphrey, Hodsell and Campbell's (2005) study in which Caucasian and Indian participants viewed two scenes comprising multiple people (both own- and other-race) that were identical in all ways but one. Participants were instructed to find the change between two pictures. The changes included either a face change, a body change or one background item change. Both groups of participants detected body changes equally as fast regardless of the race of the body, but they detected own-race face changes more quickly than other-race faces changes. Humphrey et al. (2005) concluded that because changes to both own- and other-race bodies were detected equally both own- and other-race individuals were attended to. Faster detection of own-race face changes indicates that participants were simply more sensitive at detecting own-race face changes; this would support the theory of perceptual expertise for own-race faces. However, when Hirose and Hancock (2007) ran a very similar study but with eyetracking technology, they found that Caucasian participants detected changes in own-race faces more quickly than other-race face changes, yet Indian participants' superior own-race face change detection was only marginal. It must, however, be mentioned that all participants were living in a predominantly Caucasian area (Scotland, UK) and experience must be taken into account as well.

Combining all the previous information on perceptual narrowing in infancy, the role of experience, development of expertise and the relationship to recognition and change detection of own- and other-race faces demonstrates that perceptual expertise is a crucial factor underlying the cross-race effect. However, the cross-race effect is not entirely explained by expertise because the way we socially categorize own- and other-race faces is also important.

Social Cognition

The social cognitive approach differs from the perceptual expertise approach in that rather than attributing differences in processing (sensitivity to featural or spacing differences) to expertise, the level of processing is an outcome of whether the face is processed at an individual level (“That’s Joe”) or at a categorical level (“That person is Asian”). Individual-level processing is utilized for in-group faces, whereas categorical-level processing is utilized for out-group faces (e.g., Maclin & Malpass, 2001; Shriver et al., 2008). However, a consequence of processing faces at a categorical level is impaired recognition.

One way of demonstrating this categorization is the pop-out effect. Triesman and Gormican (1988) found that looking for a “feature-positive” item amongst “feature negative” items is much quicker than looking for a “feature-negative” item amongst “feature-positive” items. For example, people are quicker at locating a tilted line amongst straight lines than they are at locating a straight line amongst tilted lines. Levin (1996) suggested that other-race faces carry a “race-feature” (e.g., “this face has dark/light skin”) that own-race faces do not have. Therefore, in a visual search task involving own- and other-race faces, one would expect an other-race face (“race feature-positive”) to be found more quickly in arrays of own-race faces (“race feature-negative”) than an own-race face in an array of other-race faces. In fact, these are just the results that Levin (1996, 2000) found.

The pop-out effect resulting from visual search tasks demonstrates an other-race face advantage in terms of reaction time. Another task that also demonstrates an advantage for other-race faces (in contrast to the disadvantage found in recognition tasks) are categorization tasks. Categorization tasks are tasks in which participants are shown a face and they must categorize it as a certain race. For these types of tasks, reaction time is used to evaluate how quickly faces are categorized. Ge et al. (2009) created a categorization task in which participants had to categorize faces as either Caucasian or Chinese. Ge et al. (2009) also had a recognition (individuation) task in which participants passively viewed faces and then had to recognize the faces later on. Ge et al. (2009) found that own-race faces are recognized more quickly than other-race faces while other-race faces are categorized more quickly than own-race faces. Ge et al. (2009) also found that for Asian and Caucasian participants, those who individuated own-race faces more quickly than other-race faces also categorized own-race faces more slowly than other-race faces. These results indicate that other-race faces are categorized more quickly than own-race faces and this may relate to how much time is spent on other-race faces when encoding them and the level at which they are processed.

One problem with manipulating in-group and out-group categorization for both own- and other-race faces simultaneously (i.e., Shriver et al., 2008) is that any results may be confounded between the two factors. In other words, one cannot be sure that changes in recognition are simply due to the social in/out-group status and not to the role race plays. For example, Caucasian observers have more *experience* with Caucasian faces than Asian faces and Caucasian faces are part of the *social in-group* whereas Asian faces are part of the social out-group. To eliminate this issue one must control for perceptual expertise and manipulate the in-group/out-group status for *only* own-race faces. Bernstein, Young and Hugenberg (2007) found that when you change the social group to which own-race faces belong (i.e., manipulate university affiliation of face stimuli to be a member of one's own university versus a member of a rival university) the recognition of own-race, university out-group faces is impaired when compared to own-race, university in-group recognition (Bernstein et al., 2007). This demonstrates that although perceptual expertise is crucial to face recognition, social in-group and out-group status are able to trump expertise and make social group the more salient feature individuals use to process faces (see also Bernstein et al., 2007; Short & Mondloch, 2010; Shriver et al., 2008).

In the literature, perceptual expertise and social categorization have historically been portrayed as "competitors" to explaining the cross-race effect. Both perceptual expertise and social cognition provide explanations for the cause of the cross-race effect. Although both models were initially conceptualized as mutually exclusive models of the other-race effect, a more integrative approach has been developed most recently. Like Hugenberg, Young, Bernstein and Sacco (2010) and Young and Hugenberg (2012), I do not think that the perceptual expertise and social categorization models are mutually exclusive; rather, both models provide valuable insight as simultaneous contributors to the cross-race effect. Work by Cassidy, Quinn and Humphreys (2011) has demonstrated that other-race in-group faces are processed more configurally than other-race out-group faces meaning that social group does, in fact, moderate the manner in which faces are processed. These interactions between perceptual mechanisms and the social group status of a face demonstrate that both models have legitimate and important roles to play in the cross-race effect and both processes are fairly malleable. Both perceptual expertise and social categorization are critical to my thesis work, but the purpose of my research was to investigate another third contributing factor: the role of attention to own- and other-race faces.

Differential Attention

According to Smith and Kosslyn (2007, p. 103) attention is the ability to simultaneously enhance some information and repress other incoming information. The information that is enhanced is processed further, whereas the information that is repressed is disregarded. In regards to face perception then, greater attention to own-race faces than other-race faces means that own-race faces would be further processed whereas other-race faces would not be.

Social categorization may influence the allocation of attention. Faces are either in- or out-group members and group membership may influence the amount of attention (e.g. how much time one allocates to a face or how many times one visits a face) spent on each face. Consequently attention to faces of one's own race versus faces of a different race may vary. Previous studies tend to display faces individually or in pairs, but this methodology does not allow participants to allocate attention to competing stimuli that vary in social group membership. This means that the results of these studies may not demonstrate a realistic representation of how faces are processed in a natural setting. In other words, attention to faces may differ when faces are presented in a context (e.g., a crime scene) or when multiple faces are presented to participants.

Relating to attention, Rodin (1987) even went so far as to suggest that participants disregard faces that are less relevant to their lives (e.g., faces of a different age group, less attractive female faces for male participants). Rodin (1987) found that when adults were given multiple photographs to look at and were asked to form impressions of the people they saw, participants tended to remember faces that were more relevant to their lives even if the participants had been directed to attend to different faces. Participants also remembered own-age faces better than other-age faces both when the faces were presented as stimuli and in real life encounters—particularly for the young adult group. Relating to the cross-race effect, own-race faces would be the social in-group, whereas other-race faces would be part of the social out-group. Therefore, based on Rodin's (1987) suggestion, people should attend more to own-race faces than other-race faces.

The issue remains that although cognitive disregard may be vital to how faces are categorized and remembered, much of the information currently presented on the cross-race effect is almost always obtained by presenting participants with faces displayed in the familiarization phase either individually or in pairs. When faces are displayed individually, there is less opportunity for cognitive disregard to be evident as attention can only be given to that one face. Subsequently, the magnitude of the cross-race effect found in the lab, although a robust effect, may be even smaller than we would expect to find in subjective encounters experienced when travelling, or even in a more realistic lab setting when natural viewing strategies are used.

Experiment 1

The purpose of Experiment 1 was to modify the methodology of standard recognition tasks used to examine the cross-race effect. Typically, recognition tasks have two phases. In the familiarization phase participants are shown a series of sequentially displayed individual faces: half own-race faces and half other-race faces. In the testing phase, participants are shown those same faces again amidst a larger array of faces such that half of the faces presented are familiar while the other half is novel. Participants respond to each individual face with either an “old/new” or “yes/no” response. Occasionally participants also provide information on how certain they are of their decision. Alternatively, two faces may be presented in the testing phase and participants must choose which face was previously shown to them.

As mentioned above, it is possible that the traditional method of examining the cross-race effect results in an inaccurate representation of the expected effect found in subjective encounters and situations such as false incarceration. This may be due to two factors: 1) the way participants encode or learn faces; and 2) the way participants recognize faces.

When participants learn faces individually there is no competition for attention as participants are given the same length of time to encode every face. This is different from how attention is allocated in real life as we typically encounter multiple people at a time and allocate attention to what is most important for the interaction/context (e.g., Rodin, 1987). This aspect of encoding is taken away when faces are presented individually and any preexisting attentional biases to own-race faces would be minimized.

Secondly, when participants are asked to recognize faces presented individually or to choose between two faces, the probability of answering correctly is approximately 50%. When we encounter people in a crowd and decide which individual we talked to previously, the chance of correctly identifying the individual in that situation is not 50%; in fact, much more uncertainty is introduced in accurately identifying a face (Mondloch et al., 2010).

Therefore, there were three manipulations in Experiment 1. The first manipulation was to have participants learn multiple own- and other-race faces (eight faces total) surrounded by household items presented in complex arrays thereby increasing competition for attention. Recognition accuracy was subsequently compared between the array familiarization method and a sequential familiarization method in which faces were presented individually and sequentially.

The second manipulation was designed to create more uncertainty in the testing phase. In Experiment 1 participants were asked to identify familiar faces from arrays of eight faces. Each of the testing arrays had different combinations of familiar and novel, own- and other-race faces so participants could not guess the number of faces to recognize in each trial. Performance on the array testing method was compared to performance on a sequential testing method.

The third manipulation was designed to evaluate whether the amount of time participants had to learn faces in array familiarization method moderated how well participants performed when tested in the array testing method. In particular, I evaluated whether recognition accuracy increased when the arrays were presented for more time, and whether this increase was seen more for other-race faces than own-race faces. It was expected that increasing presentation time would increase recognition accuracy, especially for other-race faces.

The familiarization and testing method manipulations allowed the differences in the magnitude of the cross-race effect to be evaluated based on differences in task structure. As the array familiarization and testing methods are more similar to how faces are typically encountered on a daily basis, the cross-race effect resulting from the array familiarization and testing methods may more closely resemble the cross-race effect found in real-life because in the real world faces compete for attention with each other and with objects. Therefore, the cross-race effect was predicted to be larger in the array task than in the sequential task.

Experiment 2

Experiment 2 was conducted by using realistic scenes rather than faces scattered amongst household items. Because Experiment 1 had no eye-tracking data, one purpose of Experiment 2 was to examine attentional allocation in complex stimuli and whether differences in scanning strategies are apparent for own- and other-race faces. A second purpose was to evaluate whether or not individual differences in looking time for faces correlate with better recognition of faces in the testing task. The final purpose was to examine whether different task instructions influenced how participants scanned the stimuli in addition to influencing participants' recognition accuracy.

The complex stimuli used in Experiment 2 were digital, colour photographs taken by the researcher. These photos were altered by superimposing both own- and other-race heads (e.g., Caucasian and Asian faces) onto the bodies of people in the scenes. To take away from the unnatural aspect of heads being "pasted" onto bodies, a series of distracter objects were included as well to ensure not only the heads looked slightly unrealistic. Due to the nature of the scenes' composition—each scene comprised half own- and half other-race faces—allocation of attention could be examined by using the Face Perception Lab's Tobii Eyetracking System.

Using eyetracking data allowed me to examine allocation of attention to own- and other-race faces, own- and other-race bodies and distracter objects in the scenes.

Additionally, the eyetracking data allowed me to calculate individual own-race looking time biases (i.e., how much more time was spent on own-race faces than other-race faces) and correlate those values with individual own-race recognition accuracy advantage scores (i.e. own-race *d'* – other-race *d'*).

Finally, task instructions were manipulated as well. One group of participants was instructed to remember the target individuals because they would have to identify them later, while a second group of participants was instructed to form impressions of people. By using these subtle manipulations, differences in recognition accuracy as well as differences in scanning strategies were obtained and could be attributed to the task participants were performing during the familiarization phase. Overall, Experiment 2 allowed for information on differential scanning patterns and these patterns' relationship to later recognition to be evaluated.

Experiment 1

Introduction

As mentioned previously, the cross-race effect is attributable to both perceptual expertise and social categorization. However, a third factor that may contribute to the presence of the cross-race effect in face recognition tasks is how attention (see Page 11) is allocated to faces of our own race versus faces of a different race. Examining the cross-race effect with an additional third perspective results in a well-rounded perspective and will provide valuable information relating to actual behaviour during recognition tasks.

People tend to disregard faces that are socially "unimportant" and will focus more attention on faces that may have more relevant information or may serve a more important role for the situation in which they find themselves (Rodin, 1987). Rodin (1987) suggests that we disregard people who may not be important for an upcoming interaction and therefore, we attend elsewhere. One caveat, however, involves facial expressions. Ackerman et al. (2006) found the typical cross-race effect when Caucasian participants viewed neutral Caucasian and African American faces. However, when participants were shown angry faces, angry African-American faces were recognized more accurately than angry Caucasian faces. This indicates that the recognition outcome is moderated by the context or expression of the faces present in the task.

Rodin (1987) explains that due to cognitive disregard and categorization we cannot easily discriminate between other faces that have also been disregarded (consistent with Levin, 1996, 2000). Additionally, the disregard cue of "other race" has been found throughout the literature (Brigham & Malpass, 1985 as cited in Rodin, 1987). When the context is neutral (e.g. not threatening as in Ackerman et al., 2006) one would expect participants to look at own-race faces more frequently or for longer periods of time than other-race faces. It is expected that the amount of time spent on faces should influence later recognition. Therefore, because own-race faces are attended to more than other-race faces, own-race faces should be recognized more accurately than other-race faces.

Attentional allocation. In regards to where people tend to allocate attention, we know that attention is typically directed at the eyes and heads (or faces) of people in contrast to bodies and background items (i.e., Birmingham, Bischof & Kingstone, 2008a, 2008b; DeAngelus & Pelz, 2009). In social contexts faces provide valuable information that one can use to understand the social situation (Birmingham et al., 2008a). Therefore, I would expect: 1) faces to be attended to more than objects; and 2) own-race faces to be attended to more than other-race faces.

Using an eyetracking system, Birmingham et al. (2008a) presented participants with scenes containing either one person or three people. The scenes were categorized by the authors as either active (e.g., reading a book) or inactive (e.g., sitting). Birmingham et al. (2008a) found that, regardless of task instruction (e.g., “look” group, “look and describe” group and “look and describe social attention” group), participants looked most at peoples’ eyes. This effect was larger when the scenes were classified as active scenes rather than inactive scenes (despite the very low level of activity even in active scenes), and had three people present rather than only one person.

One important note to make is that Birmingham et al.’s (2008a, 2008b) stimuli, although life-like, are not very interesting. There is not much difference between sitting doing nothing (inactive) and sitting reading a book (active). Additionally, the stimuli were very plain (e.g., people sitting in a white room at a table with a file cabinet behind them), so attention would naturally have been allocated to the people in the scenes. In other words, because the stimuli were plain, the only interesting items to look at were the people. However, even though the stimuli used were not interesting, attention was still allocated to faces, particularly the eyes, more than any other region in the scene, including bodies. The key point from Birmingham et al.'s (2008a, 2008b) studies is that participants had to allocate their attention in tasks involving more complex stimuli than is typically used in face perception tasks.

Although eyetracking results demonstrate how people may scan the world around them, eyetracking data does not help answer the question of participants' cognitive processing of the stimuli. In other words, they were looking at the pictures, but what were they *doing* when looking at the pictures?

One way to examine what participants are doing when looking at stimuli is by using change detection tasks. These are tasks in which participants are shown two identical stimuli one at a time, but the second stimulus has a slight modification that the participants must find as quickly as possible. Hirose and Hancock (2007) tested both Caucasian and Indian participants and asked them to find changes in the photographs presented to them. Changes were either made to an own-race face, an other-race face, an own-race body, an other-race body or a background item.

Hirose and Hancock (2007) found that all participants tended to look at the Caucasian faces first and fixated on them more often than the Indian faces. In terms of change detection, Caucasian participants were quicker at detecting own-race face changes than other-race face changes whereas this own-race face change detection advantage was only marginally significant for Indian participants. The attentional bias could be due to the fact that participants were living in a predominantly Caucasian location (Scotland, UK) and people with high levels of other-race experience tend to recognize other-race faces with higher accuracy than those with lower levels of experience (Wright, Boyd & Tredoux, 2003). Increased recognition accuracy for other-race faces is also found if the other-race face is a part of the majority group (e.g., suggested in Bukach, Cottle, Ubiwa & Miller, 2012; Wright et al., 2003).

Hirose and Hancock's (2007) study also only gave results based on a change detection task, so performance may differ during a recognition task. One reason may be that because the instructions for the tasks differ, attention may be allocated in ways that are more appropriate for the task. For example, if participants are instructed to detect a change, attention may be allocated more equally, whereas if participants are freely viewing the stimuli, natural attentional biases may be present.

Regardless of the criticisms about the previous studies, the main issue is that the researchers allowed participants to allocate their attention to different areas of the screen. Although this methodology has been used to examine gaze patterns and look for changes in stimuli, this kind of methodology, to my knowledge, has not been used to examine the cross-race effect in terms of recognition biases.

Current Study

The purpose of Experiment 1 was to alter the standard methods of testing own- and other-race recognition. Recognition tasks have two phases: the familiarization phase and the testing phase. Half of the faces seen in each phase are own-race faces while the other half comprises other-race faces. In the familiarization phase, participants typically see one face displayed at a time and the testing phase is comprised of all the faces in the familiarization phase plus another equally sized set of novel faces. Participants then respond to each individually presented face in the testing phase with a “yes/no” or “old/new” response, or indicate which face is familiar when faces are presented in pairs. Although this task results in a robust cross-race effect, there are some methodological issues.

Firstly, Mondloch et al. (2010) state that although standard lab tasks focus on only one aspect of processing—usually perceptual expertise *or* social categorization—preferably both should be taken into account so that researchers can ask different questions in the laboratory. In a perfect world, both would be tested together so the models can be evaluated together.

Secondly, the magnitude of the cross-race effect may be underestimated simply due to the manner by which participants learn the stimuli. In the laboratory participants are typically asked to remember the faces they see in the task (Mondloch et al., 2010; Tanaka & Pierce, 2009). This means that performance in the recognition task may result in enhanced recognition of faces compared to conditions under which they are not specifically motivated to recognize faces, an effect that may be largest for other-race faces. If recognition accuracy is overestimated in the typical familiarization method, then the cross-race effect would be small compared to the size of the cross-race effect resulting from natural viewing strategies.

Thirdly, the manner in which participants recognize faces may also lead to the magnitude of the cross-race effect being smaller than expected. Participants typically respond using a “yes/no” response or choose the familiar face from a pair of faces. This manner of recognition induces approximately a 50/50 percent chance of being correct—far from the uncertainty that is evident in real life situations.

Although these techniques do result in robust findings of the cross-race effect throughout the literature, the traditional way of studying own- and other-race face recognition is not at all similar to how faces are learned and remembered in the real world. Therefore, the purpose of Experiment 1 is not to contradict the previous theoretical perspectives, but to investigate a more realistic and ecologically valid research method and the effects on the magnitude of the cross-race effect.

Familiarization phase. To do so, I first altered the way participants learned faces. In the traditional method of testing, participants are familiarized with sequentially presented faces. This method allows participants to spend equal amounts of time learning each face (e.g., two seconds for every face, regardless of race). Although this familiarization method results in better own-race face recognition than other-race faces, in the *real world* we do not see individual heads appearing in front of us for two seconds. Rather, we see complex stimuli around us! One must decide *where* to look, *what* to look at, and determine what is most important to the situation.

If participants are shown more complex stimuli, they are no longer forced to view each face for the same period of time—they must allocate their attention to what they deem important (as seen in Rodin, 1987). In Experiment 1 some participants were shown complex arrays containing multiple faces in the familiarization phase. Each array was made up of eight faces (half own-race, half other-race) and the faces were scattered amongst common household objects such as spoons, candles, and children’s toys.

Having multiple objects to attend to would result in participants having to elect where to allocate their attention, similar to in the real world. Proponents of the social categorization theory would suggest that participants may quickly categorize the other-race faces present in the complex array and take the time to individuate own-race faces (Ge et al., 2009; Maclin & Malpass, 2001; Shriver et al., 2008). Rodin's (1987) findings are consistent with this hypothesis as participants are expected to attend more to own-race faces than other-race faces.

This kind of attentional allocation would result in participants choosing to spend more time looking at own-race faces, and very little time focusing on other-race faces. The array familiarization method should then induce a larger cross-race effect than the sequential familiarization method because other-race faces may be initially disregarded and own-race faces would be observed first. If more time is spent on own-race faces in comparison to other-race faces, presumably recognition accuracy for own-race faces should be better than other-race face accuracy as well (e.g., Lovén et al., 2012).

Because no previous study has presented faces in the context of complex arrays during familiarization a second goal was to determine whether recognition accuracy increased with longer presentation times. If more time spent learning faces results in better recognition, then the magnitude of the cross-race effect should decrease with longer presentation times. The increase in recognition should be seen more for other-race faces than own-race faces because other-race faces would be attended to after own-race faces. Due to more own-race attention than other-race attention, participants may have time to go back and study the faces they may have initially disregarded.

Testing phase. The second methodology change was to alter the manner in which participants' recognition was tested. Traditionally, participants are shown either one or two faces and must either respond "old/new" to the individual face, or pick which face they recognize when presented with two faces simultaneously. This methodology means participants know the chance of correctly identifying a face is around 50% while in the real world much more uncertainty is introduced. When learning someone's face, regardless of the context of learning, that person will most likely have to be recognized in a group setting.

To alter the testing phase, participants were shown arrays of eight faces (half own-, half other-race faces). Each testing array had an unpredictable combination of familiar and novel own- and other-races faces. Participants were simply asked to indicate for each array which faces they had previously seen. This testing method results in greater uncertainty as the chance of being correct in each array is not 50/50; rather the chance of being correct in each array is unpredictable.

With increasing uncertainty, the magnitude of the cross-race effect should increase as participants would naturally have better processing of own-race faces in the familiarization phase and should therefore perform better in own-race face recognition while other-race face processing and recognition may be impaired. Additionally, with increasing uncertainty, one should expect higher false alarm rates, especially so for other-race faces. This higher rate of false alarms would in turn decrease recognition accuracy and induce a larger cross-race effect.

Control tasks. Performance of participants who were familiarized and tested with faces in arrays (array-array task) was compared to that of participants who completed a traditional task (sequential-sequential task) in which they were familiarized and tested with sequentially presented faces. Two additional control tasks were created to parse out the effects of the altered familiarization and testing methods on the magnitude of the cross-race effect. In the Control 1 (sequential-array) task, participants were familiarized with sequentially presented faces and were tested with faces presented in arrays. In the Control 2 (array-sequential) task participants were familiarized with faces presented in arrays and tested with sequentially presented faces.

Furthermore, as contact and experience with people of other-races can influence performance on recognition tasks (see Rhodes et al., 2009; Tanaka et al., 2004; Wright et al., 2003) participants were given a questionnaire to assess amount of contact with people of Asian ethnicity.

Overall, the purposes of Experiment 1 were: 1) to examine whether giving participants more time to study the complex arrays increases recognition performance and, in turn, decreases the magnitude of the cross-race effect; 2) to examine whether the method by which participants learned faces (i.e., by allowing participants to decide where to allocate attention) influences recognition accuracy and the magnitude of the cross-race effect; and 3) to examine whether increasing uncertainty during recognition influences recognition accuracy and increases the magnitude of the cross-race effect.

Our first hypothesis was that with increasing presentation time of arrays, the magnitude of the cross-race effect should decrease as participants may spend the additional time attending to faces they may not have initially attended to. To test this hypothesis I compared performance across three groups of participants who were familiarized and tested with faces in arrays; the familiarization arrays were presented for

16, 24, or 40 seconds. Our second hypothesis was that increased attentional competition when being familiarized with faces presented in arrays would lead to a larger cross-race effect than the effect in the sequential task. Our third hypothesis was that increased uncertainty when being tested with faces presented in arrays would lead to a larger cross-race effect than when being tested faces presented sequentially. To test Hypotheses 2 and 3 I compared accuracy across four groups of participants: 24s array-array, sequential-sequential, Control 1 (sequential-array) and Control 2 (array-sequential).

Methods

Participants. Participants included in this study were Caucasian (self-identified) undergraduate students from Brock University (n = 120, 101 female, M_{age} = 19.57 years). A total of 129 participants were tested but 9 were excluded due to participation in a conflicting study (n = 6), experimenter error (n = 1), program malfunction (n = 1) or perseverated by pressing only one response key during the recognition task (n = 1). All participants gave informed consent and were compensated for their time by receiving either course research credit (one credit) or a $12 honorarium.

Stimuli. The stimuli used in both the familiarization and testing phases of the study were neutral expression, front-facing colour photographs of young adult Caucasian faces acquired from the Center for Vital Longevity Face Database (Minear & Park, 2004) and Asian faces acquired from the Face Perception Lab database at Brock University in St. Catharines, Ontario, Canada. There were 32 faces used per race (half male, half female) totaling 64 faces. Half of the faces were shown in the familiarization phase and all 64 faces were used in the testing phase. In each phase, half of the faces were male, and half of the faces were Caucasian while the other half was Asian. In addition to the faces, the familiarization phase stimuli in the array task included common household objects scattered amongst the faces.

Across the six conditions in Experiment 1, the same stimuli were used in the familiarization and testing phases, and the stimuli sizes were equal across tasks as well. The face sizes in the familiarization phases were approximately 3.9cm tall and the face sizes in the testing phases were approximately 8.9 cm tall.

Tasks. In Experiment 1, each participants was assigned to one of three task types resulting in a between-subjects design: 1) the array-array task (three groups; either 16, 24 or 40 second presentation); 2) the sequential-sequential task; and 3) the control tasks (Control 1 (sequential-array) or Control 2 (array-sequential)). In each condition's familiarization phase, participants were presented with 16 Caucasian and 16 Asian faces, and in each condition's testing phase, participants were presented with 32 Caucasian and 32 Asian faces. All of these tasks were programmed in SuperLab 4.5. Initially, data were collected for only four groups—three groups who participated in the varied presentation time array-array tasks and the sequential-sequential task. To parse out the influence of the array and sequential familiarization and testing methods on recognition accuracy, data were collected for the two control groups resulting in a design that is not completely randomized.[1] I elected to test the control groups last because I based the array presentation time for the Control 2 task based on the recognition accuracy of the timed arrays (i.e., I wanted to be sure to use a group that would perform above chance).

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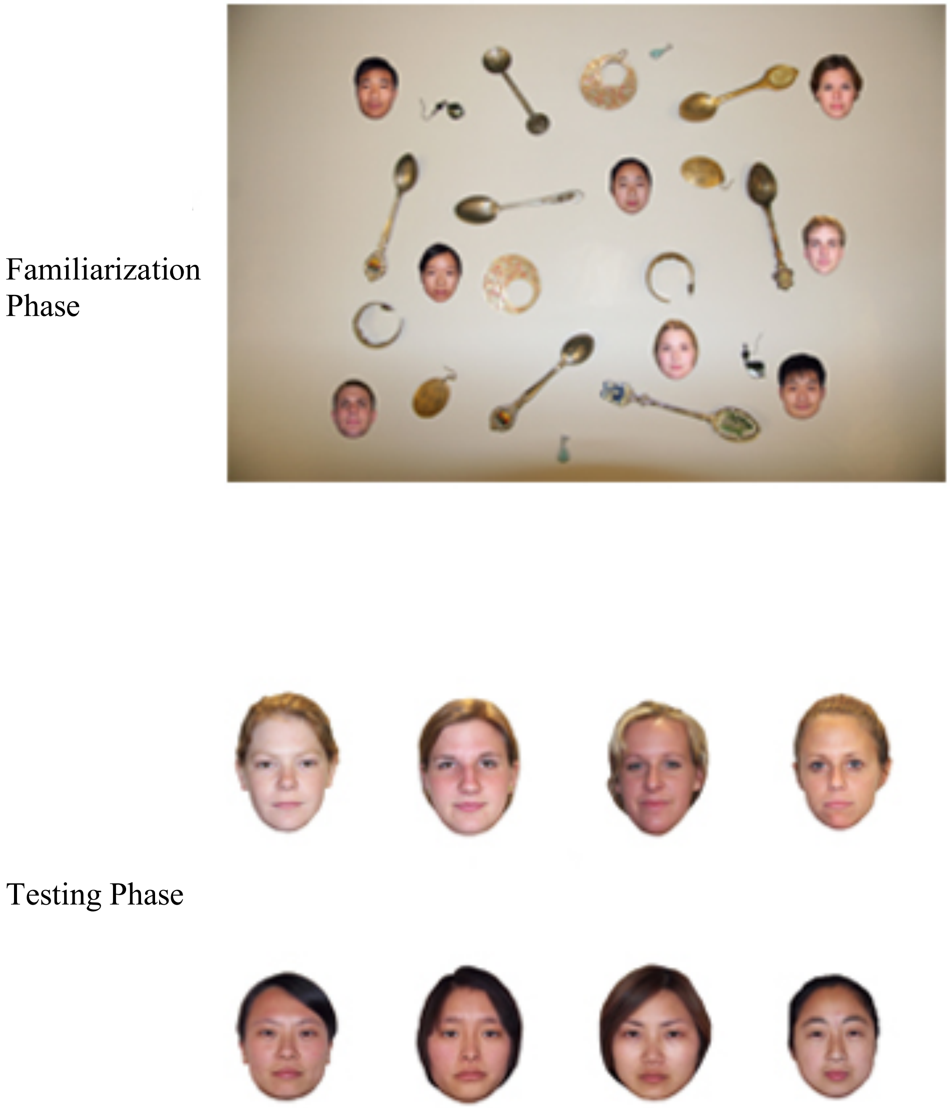
[1] This methodology is similar to DeAngelus and Pelz (2009) in that 17 of their participants performed a "free-view" task, and only one participant performed a "3 minute" view task to be used as a replicator of a previous study.

Array task. In the familiarization phase of the array-array task, participants were shown five complex arrays. Four of the complex arrays comprised both household objects and eight faces (half Caucasian, half Chinese, half male, half female). This totaled 32 faces presented in the familiarization phase. The fifth complex array contained only household items and was always displayed last. The complex arrays were presented in a randomized order for 16, 24 or 40 seconds each depending on the group to which each participant was assigned. To control for the possibility that a face's location on the screen would influence latency to first fixation or the duration of looking, two versions of each complex array were created such that the locations of Asian and Caucasian faces were reversed.

In the testing phase of the array-array task, participants were shown eight arrays of eight faces each. Four of the arrays comprised female faces and four comprised male faces; the top row of faces was always Caucasian and the bottom row was always Asian. Overall, half of the faces in the testing phase were familiar (i.e., had been presented in the complex arrays) while the other half was novel; this gave a total of 64 faces in the testing phase. Each array had an unpredictable amount of familiar and novel, own- and other-race faces. For example, each row of own- or other-race faces could have had one, two, or three familiar faces. Each participant saw the same set of arrays, but the number of familiar faces varied across arrays so participants could not guess how many faces they should be recognizing in each array.

The testing arrays were presented in a random order (randomized by SuperLab 4.5) and each for unlimited time. Participants pointed to the faces they recognized and told the experimenter to move on to the next array once they were finished with the current array. Participants had to point to the faces rather than record the responses themselves so that each participant did not have to be trained how to properly record their responses before the testing session. Having the experimenter record response ensured that scoring was kept consistent. An example of the array task can be seen in Figure 1.



Familiarization Phase

Testing Phase

Figure 1. An example of the array-array task. The familiarization phase picture is at the top and the testing phase is at the bottom of the figure.

Sequential-sequential task. The sequential-sequential task faces were the same faces used in the array-array task. The difference, however, was that this task was set up in the standard recognition task format. In the familiarization phase, each face was presented individually and sequentially for 2 seconds with a 500ms fixation point displayed in-between faces. The faces were presented in a different random order for each participant.

In the testing phase, participants saw the same 64 faces used in the array testing method, but each face was presented individually and sequentially. Each face remained on the screen until participants pressed a key (Z or X) indicating whether the face was familiar or novel (key usage was counterbalanced). After responding, the next face appeared in the center of the screen. An example of the sequential-sequential task can be seen in Figure 2.

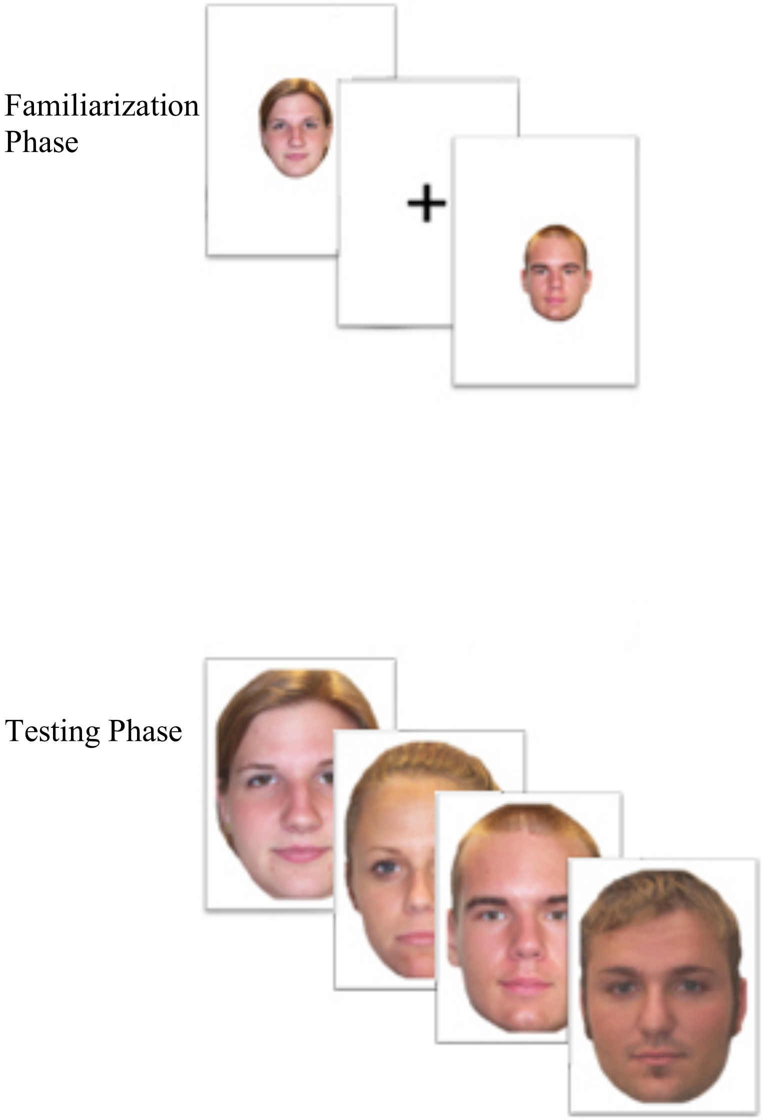


Figure 2. An example of the sequential-sequential task. The familiarization phase pictures are at the top of the figure, and the testing phase is at the bottom of the figure. Participants would respond “old” or “new” to each test face that appeared on the screen.

Control tasks. There were two control tasks created to control for the effect of familiarization and testing methods. In the Control 1 (sequential-array) task, the faces were presented sequentially during familiarization and in arrays during testing while in the Control 2 (array-sequential) task, the faces were presented in 24-second arrays during familiarization and sequentially during testing. All methodology and stimuli for the control tasks (i.e., faces, randomization) was exactly the same as what was used in the array and sequential tasks. Examples of the control tasks can be seen in Figures 3 and 4.

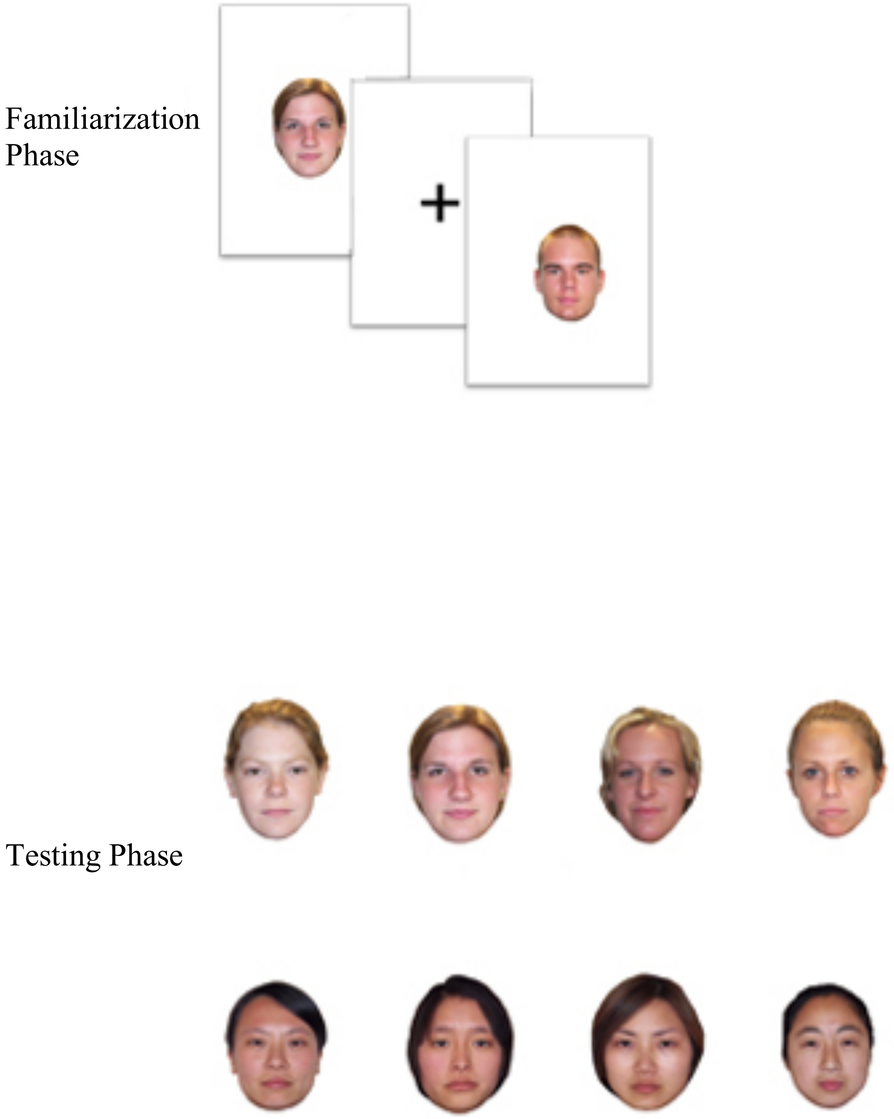


Figure 3. An example of the Control 1 (sequential-array) task that included the sequential familiarization method and the array testing method.

Familiarization
Phase

Testing Phase

Figure 4. An example of the Control 2 (array-sequential) task that included the 24-second array familiarization method and the sequential testing method.

Procedure. Participants were seated approximately 60cm away from a 24” LG computer monitor and participated in the array task (one of the 16, 24 or 40-second tasks), the sequential task, or one of the control tasks. At the beginning of the array familiarization phase, participants were told, “You are about to see five pictures, each of which has several objects. You will have (16, 24, or 40) seconds to look at each picture. Try to remember as much as you can about what you see,” while for the sequential familiarization phase, participants were told, “You will be shown a series of faces that will appear sequentially on the screen. Please pay close attention to all of the faces and try to remember as much as you can.” After receiving these instructions, participants began the familiarization phase.

After the end of the familiarization phase, participants in the array testing task were then told, “You are about to see 8 arrays. In each array, some of the faces will be ones you have seen, and some will be new faces. I need you to tell me which faces are the ones you saw before. Once you have pointed to all the faces you recognize, tell me when you are done,” while participants in the sequential testing task were told, “You will be shown a series of faces that will appear sequentially on the screen. Some of the faces are ones you have seen before and some of the faces are new. Please respond with the ‘Z’ (or ‘X’) key for faces you have seen before. Please respond with the ‘X’ (or ‘Z’) key for faces you have not seen before.” Participants in the array test pointed to the faces they recognized and the experimenter recorded responses on a score sheet. Participants in the sequential test used the Z and X keys on the keyboard to indicate whether the face was familiar or novel (counterbalanced between participants).

To assess the amount of contact or experience each participant had with people of Asian ethnicity, participants were given a contact questionnaire to fill out. Using the responses from the questionnaire allowed me to confirm that the sample was a low-experience group (as is expected in St. Catharines) and to examine whether or not experience with people of Asian ethnicity correlated with other-race recognition accuracy. After completing the questionnaire, participants were debriefed about the purposes of the study. The questionnaire can be found in Appendix 2.

Results

The raw data from every task were used to compute hits and false alarms. Hits were calculated by counting the number of faces correctly identified as being previously seen and false alarms were calculated by counting the number of times a novel face was indicated as previously seen. Hits and false alarms were calculated for Caucasian and Asian faces separately. Using signal detection theory, each participant's hits and false alarms were used to calculate d-prime (*d'*). *d'* is calculated by taking a standardized score of the probability of false alarms and subtracting that number from the standardized score of the probability of hits ($d'=Z(p(H))-Z(p(FA))$).

d' represents the recognition accuracy of participants in terms of how well they correctly identify faces while taking into account how many times they incorrectly recognize a novel face. For example, *d'* would be higher for participants who had more hits than false alarms, *d'* would be zero for participants who had the same amount of hits and false alarms as they do not demonstrate any recognition, and *d'* would be negative for participants who have more false alarms than hits. Lower *d'* values for other-race faces tend to be driven by increased false alarm rates for those faces (reviewed in Meissner &

Brigham, 2001). Although there is a large range of possible *d′* values, typical *d′* values are up to two (Keating, 2005).

Criterion values were also calculated. Criterion is calculated by adding the standardized score of both hits and false alarms and multiplying the result by -.05 (-.05*(Z(p(H))+Z(p(FA))). The resulting number is an indicator of each participant's response bias. A criterion value of zero would indicate no response bias, while a negative criterion indicates a liberal response bias and a positive criterion value indicates a conservative response bias (Stanislaw & Todorov, 1999). Liberal strategies mean participants are more likely to indicate recognition of faces that appear regardless of whether the face is familiar or novel while a conservative strategy means participants are less likely to indicate recognition of any face that appears. Therefore, lower criterion values correspond with more false alarms and hits as participants displayed a liberal response bias and higher criterion values correspond participants who had fewer false alarms and hits and displayed a conservative response bias.

As the initial tasks conducted were the timed array tasks and the sequential task, the first analysis evaluated whether the different presentation times had an effect on recognition accuracy. Based on this analysis I used one group (24s array presentation) to compare to the sequential-sequential task, the Control 1 (sequential-array) task and the Control 2 (array-sequential) task. The timing of the familiarization array in Control 2 was matched to that of the array-array group.

Effect of presentation time. One question in Experiment 1 was whether increasing presentation time of the familiarization arrays increased recognition accuracy and if the increase was seen more for other-race faces than own-race faces. Single sample *t*-tests confirmed that all *d′* values were significantly greater than zero (indicating recognition accuracy was above chance levels), ps$\leq$.007, except for the *d′* value for other-race faces in the 16 second task, p=.28.

To examine whether performance in the array-array task varied as a function of presentation time a 2 (face race: own, other) x 3 (study time: 16, 24, 40 seconds) mixed ANOVA was conducted. The ANOVA revealed a main effect of race, $F_{(1, 57)}$=14.48, p<.001, η_p^2=.20, such that own-race face recognition accuracy (*M*=.62, *SE*=.07) was better than other-race face recognition accuracy (*M*=.28, *SE*=.07).There was no effect of presentation time, p=.26, and no interaction between race and presentation time, p=.99. The mean *d′* values can be seen in Figure 5. These findings demonstrate that, contrary to the hypothesis, changing the length of presentation time did not affect recognition accuracy, and other-race face recognition did not increase more than own-race face recognition with longer presentation time.

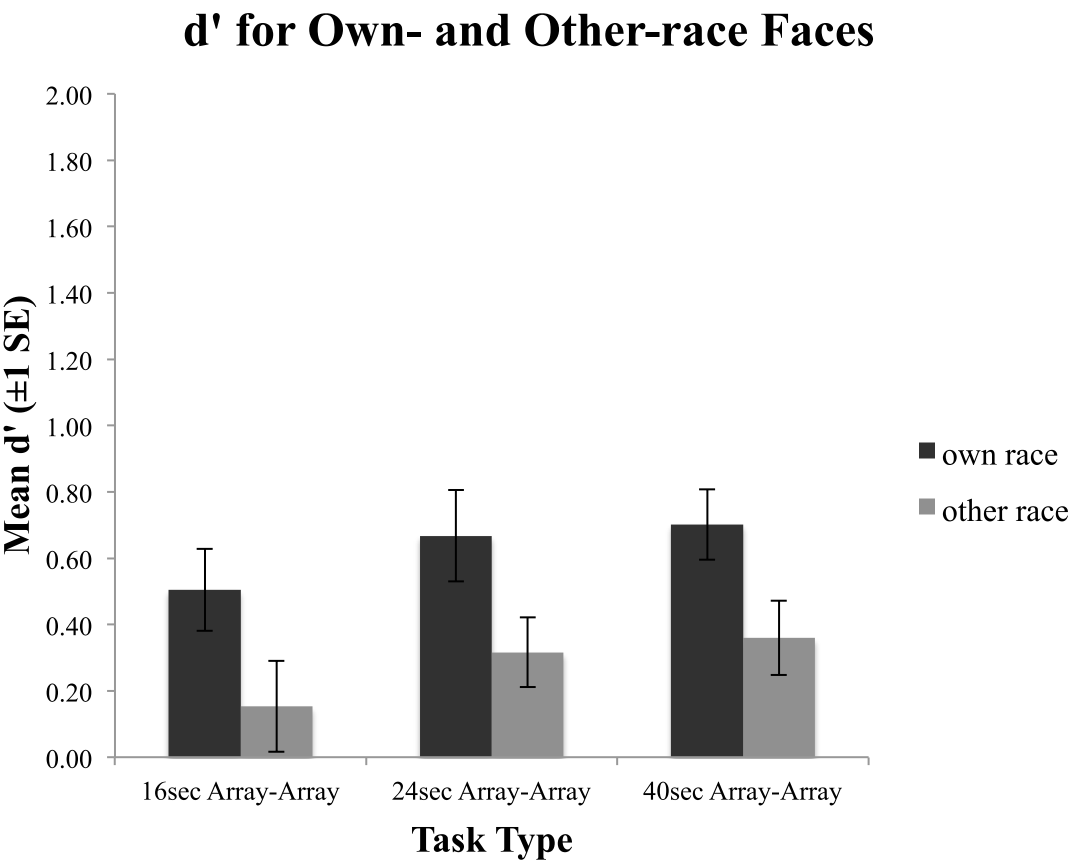


Figure 5: Mean *d'* values for both own- and other-race faces as a function of complex array presentation time.

Effect of familiarization and testing methods. The second set of analyses was conducted to evaluate the effect of familiarization and testing methods on recognition accuracy (*d′*), criterion, hits and false alarms for own- and other-race faces. Because the 16-second group did not perform above chance levels in terms of recognition accuracy for other-race faces and to avoid inducing participant boredom with the 40-second presentation, I chose to use the 24-second array task as the array time used in the array familiarization method for the Control 2 (array-sequential) group. I was then able to compare performance on the original 24-second array-array task, the sequential-sequential task, and the two control tasks.

Hit rates. A 2 (face race: own, other) x 2 (familiarization method: array, sequential) x 2 (testing method: array, sequential) mixed ANOVA was conducted to analyze hit rates for own- and other-race faces. Figure 6 shows the means for hit rates. The results of the ANOVA demonstrated there was no effect of race, p=.71, but there was a main effect of familiarization method, $F_{(1,76)}$=9.63, p=.003, η_p^2=.11, such that the sequential method resulted in higher hit rates (M=9.11, SE=.36) than the array method (M=7.54, SE=.36). There was a main effect of testing method, $F_{(1,76)}$=9.02, p=.004, η_p^2=.11, such that the sequential method resulted in higher hit rates (M=9.09, SE=.36) than the array method (M=7.56, SE=.36). There was a marginal interaction between race and familiarization method, p=.06, and no three-way interaction between race, familiarization and testing method, p=.11. There was a significant two-way interaction between race and testing method, $F_{(1,76)}$=10.96, p=.001, η_p^2=.13.

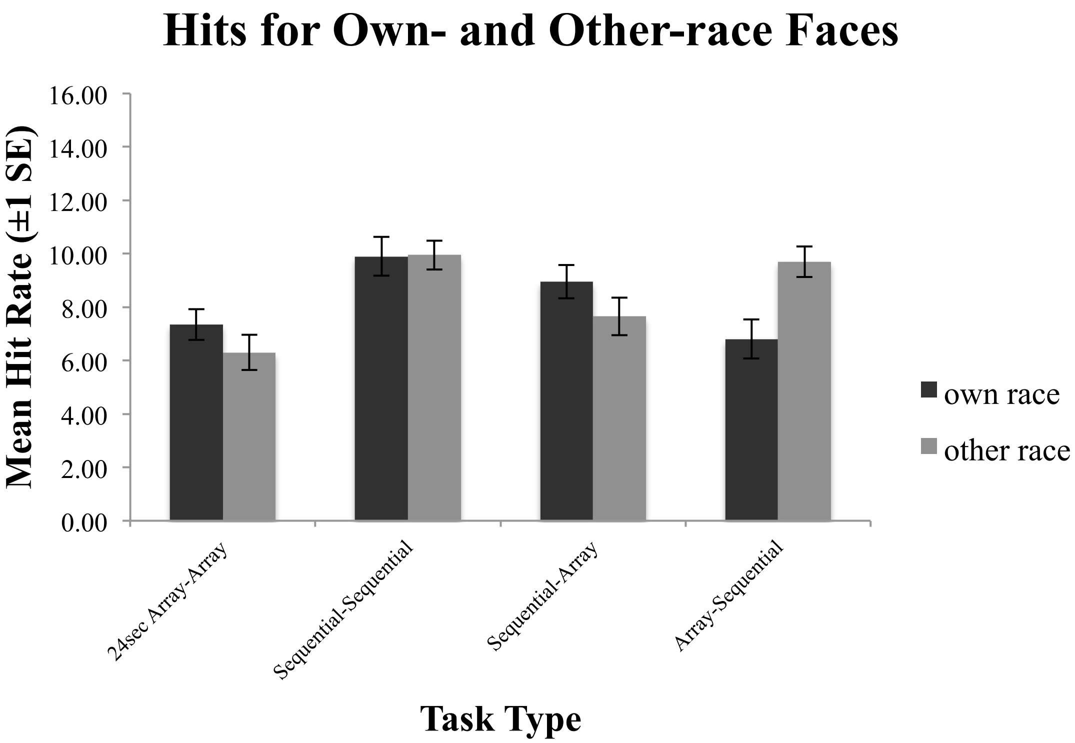


Figure 6: Mean hit rates for both own- and other-race faces as a function of familiarization and testing methods.

To follow up the significant race by testing method interaction, paired samples *t*-tests[2] were conducted to evaluate how own- and other-race hits differed as a function of testing method. When faces were tested sequentially the difference between own- and other-race hits was significant, $t_{(39)}$=-2.12, *p*=.041, such that other-race hits were higher than own-race hits (*M*=9.83, *SE*=.39 and *M*=8.35, *SE*=.56, respectively). In contrast, when faces were tested in arrays, the difference between own- and other-race hits was also significant, $t_{(39)}$=2.69, *p*=.01, but own-race hits were higher than other-race hits (*M*=8.15 *SE*=.44 and *M*=.6.98, *SE*=.49, respectively). Therefore, this interaction indicates other-race hits were higher when faces were recognized sequentially, whereas own-race hits were higher when faces were recognized in arrays. Although there were more hits for other-race than own-race faces when faces were tested sequentially, analysis of false alarm rates indicates that this does not reflect superior recognition of other-race faces.

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[2] All *t*-tests are two-tailed unless otherwise noted.

False alarm rates. A 2 (face race: own, other) x 2 (familiarization method: array, sequential) x 2 (testing phase: array, sequential) mixed ANOVA was conducted to analyze false alarms. The means for false alarm rates can be found in Figure 7.

The results of the ANOVA demonstrated there was a main effect of race, $F_{(1,76)}=74.67, p<.001, \eta_p^2=.50$, such that other-race faces had higher false alarm rates ($M=5.93$, $SE=.34$) than own-race faces ($M=3.26$, $SE=.27$), a main effect of testing method, $F_{(1,76)}=5.87, p=.018, \eta_p^2=.07$, such that the sequential method results in higher false alarm rates ($M=5.24$, $SE=.38$) than the array method ($M=3.95$, $SE=.38$), and no main effect of familiarization method, $p=.17$. Whereas there was no interaction between race and familiarization method, $p=.44$, there was a two-way interaction between race and testing, $F_{(1,76)}=13.04, p=.001, \eta_p^2=.15$, and a three-way interaction between race, familiarization method and testing method, $F_{(1,76)}=4.62, p=.035, \eta_p^2=.06$**.** To follow up the three-way interaction, two 2 (face race: own, other) x 2 (testing method: array, sequential) mixed ANOVAs were conducted for each method of familiarization (array, sequential) to evaluate how the interaction between race and testing differed depending on how participants were familiarized with the faces.

When participants were familiarized with sequentially presented faces there was a main effect of race, $F_{(1,38)}=42.40, p<.001, \eta_p^2=.53$, such that false alarms were higher for other-race faces ($M=5.68$, $SE=.46$) than own-race faces ($M=2.78$, $SE=.34$), a main effect of testing, $F_{(1,38)}=5.63, p=.023, \eta_p^2=.13$ such that when participants were tested with sequentially presented faces false alarms were higher ($M=5.03$, $SE=.48$) than when they were tested with faces presented in arrays ($M=3.43$, $SE=.48$). There was no race by testing interaction, $p=.32$.

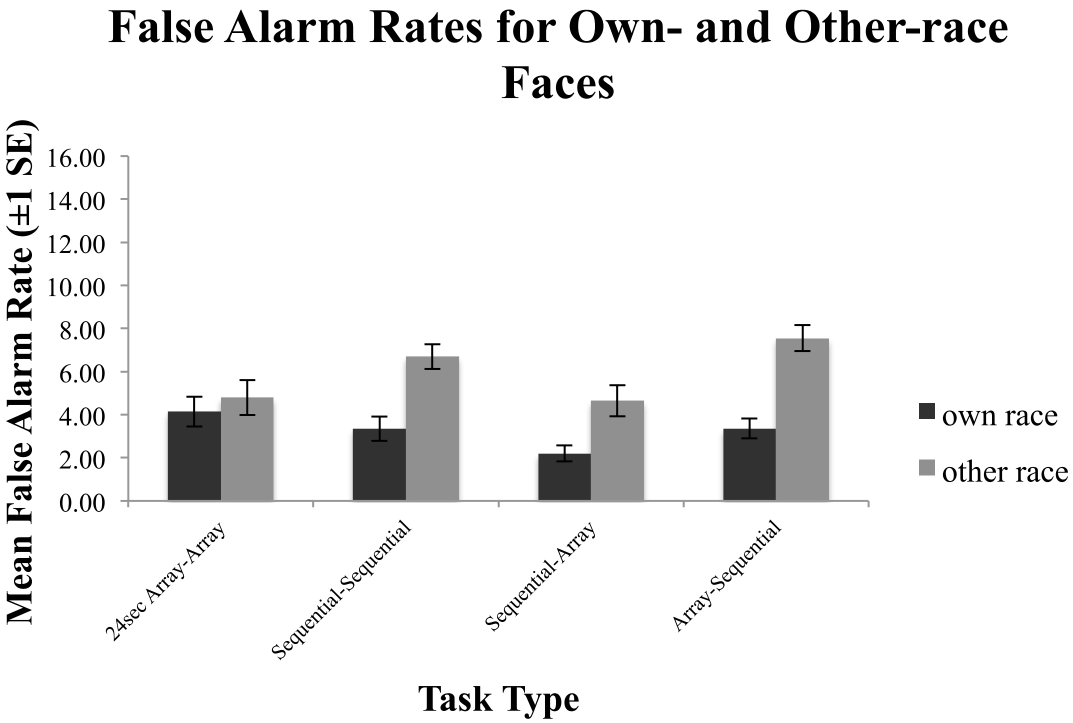

Figure 7: Mean false alarm rates for both own- and other-race faces as a function of familiarization and testing methods.

When participants learned faces in arrays there was a main effect of race, $F_{(1,38)}$=32.42, p<.001, η_p^2=.46, such that false alarms were higher for other-race faces (M=6.18, SE=.50) than own-race faces (M=3.75, SE=.42), no main effect of testing, p=.24, but there was a two-way interaction between race and testing method, $F_{(1,38)}$=17.37, p<.001, η_p^2=.31. To follow up the significant two-way interaction between race and testing within the array familiarization method, paired sample t-tests were conducted to evaluate whether own- and other-race false alarms were different within each testing method. For the participants who were familiarized with faces in arrays and were tested on faces in arrays, there was no difference between own- and other-race false alarms, p=.19, but for participants who were familiarized with faces in arrays and were tested with sequentially presented faces, there was a difference between own- and other-race false alarms, $t_{(19)}$=-5.98, p<.001, such that other-race false alarms were higher than own-race false alarms (M=7.55, SE=.60 and M=3.35, SE=.46 respectively). Thus, in addition to increasing hit rates for other-race faces, presenting faces sequentially during the testing phase increased false alarms for other-race faces.

Recognition accuracy (d'). Single sample *t*-tests were conducted to evaluate whether all *d'* means were significantly different from zero (chance). For all groups, *d'* values were significantly greater than zero, all ps$\leq$.007.

To determine whether own- and other-race recognition accuracy (*d'*) varied as a function of the familiarization and testing method, a 2 (face race: own, other) x 2 (familiarization method: array, sequential) x 2 (testing method: array, sequential) mixed ANOVA was conducted. The graph for *d'* can be seen in Figure 8. The results of the ANOVA demonstrated there was a main effect of race, $F_{(1,76)}$=35.14, p<.001, η_p^2=.32, such that own-race face recognition accuracy (M=.99, SE=.07) was higher than other-race face recognition accuracy (M=.47, SE=.06). There was no effect of testing method, p=.97. There was a main effect of familiarization method, $F_{(1,76)}$=18.35, p<.001, η_p^2=.19, such that familiarization in the sequential method resulted in higher recognition accuracy (M=.94, SE=.07) than familiarization in the array method (M=.52, SE=.07). Although there was no two-way interaction between race and testing, p=.72, and no three-way interaction between race, learning and testing, p=.97, the significant main effects

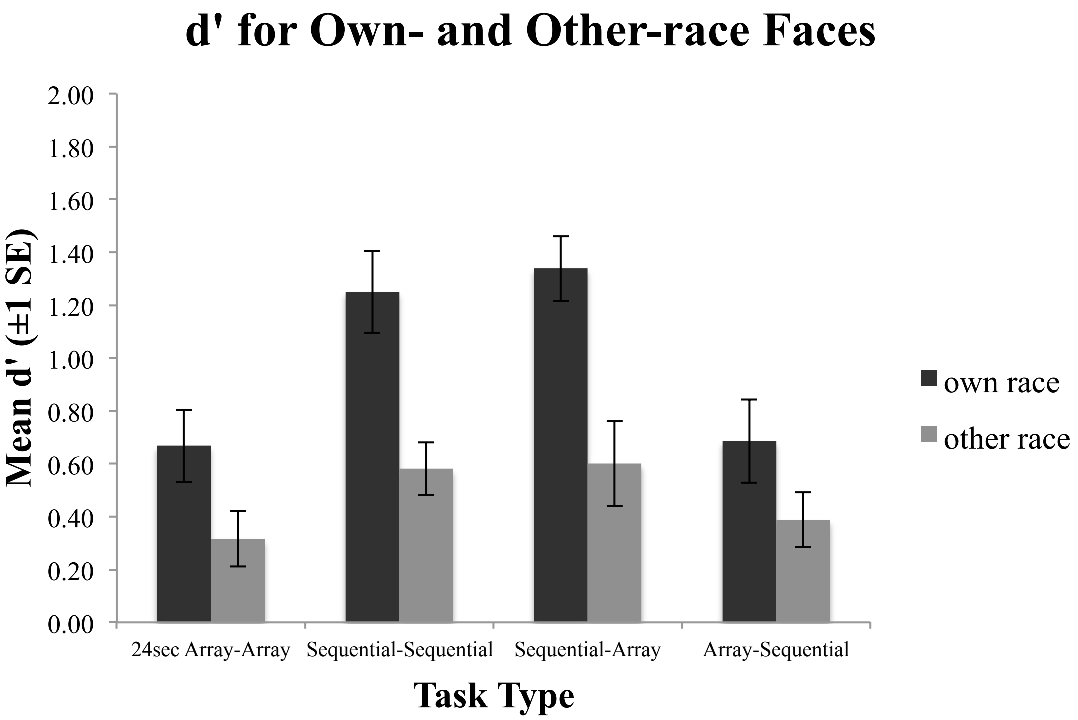

Figure 8: Mean recognition accuracy (*d')* for both own- and other-race faces as a function of familiarization and testing methods.

were qualified by a two-way interaction between race and familiarization method, $F_{(1,76)}$=4.78, p=.032, $\eta_p{}^2$=.06.

To follow up the two-way interaction, paired samples *t*-tests were conducted to evaluate how own- and other-race *d′* differed as a function of familiarization method. When faces were presented sequentially during familiarization, the difference between own- and other-race *d′* was significant, $t_{(39)}$=5.81, p<.001, Cohen's *d*=1.17, such that own-race recognition accuracy was higher than other-race recognition accuracy (*M*=.1.29, *SE*=.10 and *M*=.59, *SE*=.09, respectively) and when faces were familiarized in arrays, the difference between own- and other-race *d′* was also significant, $t_{(39)}$=2.68, p=.011, Cohen's *d*=.61, such that own-race recognition accuracy was higher than other-race recognition accuracy (*M*=.68 *SE*=.10 and *M*=.35, *SE*=.07, respectively). However, the significant interaction between race and familiarization method and the larger effect size in the sequential familiarization method (*d* = 1.17) in comparison to the smaller effect (*d* = .61) size in the array learning method (i.e., Cohen, 1988, 1992; Jackson, 2008), indicate that the difference between own- and other-race face recognition is larger when faces were familiarized sequentially compared to the difference when they were familiarized in arrays. These results are evident in Figure 8.

Criterion. Single sample *t*-tests were conducted to evaluate whether all criterion means were significantly different from zero (no bias). Criterion means were significantly greater than zero indicating a conservative bias, all *p*s≤.02, except for the other-race criterion in the sequential-sequential, *p*=.59, and the array-sequential task, *p*=.23.

A 2 (face race: own, other) x 2 (familiarization method: array, sequential) x 2 (testing method: array, sequential) mixed ANOVA was conducted to analyze criterion. The means for criterion can be found in Figure 9. The results of the ANOVA demonstrated there was a main effect of race, $F_{(1,76)}$=31.10, *p*<.001, η^2=.29, such that criterion values were more conservative for own–race faces (*M*=.05, *SE*=.01) than other–race faces (*M*=.02, *SE*=.01), a main effect of testing method, $F_{(1,76)}$=8.35, *p*=.005, η_p^2=.10, such that criterion values were more conservative in the array testing method (*M*=.04, *SE*=.01) than the sequential testing method (*M*=.02 *SE*=.01), a two-way interaction between race and testing method, $F_{(1,76)}$=17.72, *p*<.001, η_p^2=.19, and a three-way interaction between race, familiarization method and testing method, $F_{(1,76)}$=4.90, *p*=.03, η_p^2=.06. There was no main effect of learning, *p*=.54, no two-way interaction between race and learning, *p*=.39, and no interaction between testing and learning, *p*=.64. To follow up the significant three-way interaction, two 2 (face race: own, other) x 2 (testing method: array, sequential) mixed ANOVAs were conducted within each method of familiarization (array, sequential) to evaluate how the interaction between race and testing differed depending on how participants were familiarized with faces.

When participants were familiarized with sequentially presented faces there was a main effect of race, $F_{(1,38)}$=10.92, *p*=.002, η_p^2=.22, such that criterion was more conservative for own-race faces than other-race faces (*M*=.04, *SE*=.01, and *M*=.015, *SE*=.01 respectively), a main effect of testing method, $F_{(1,38)}$=6.36, p=.016, η_p^2=.14 such that when participants were tested with faces sequentially criterion was less conservative (*M*=.012, *SE*=.01) than when they were tested with faces presented in arrays (*M*=.043, *SE*=.01). There was no race by testing interaction, p=.17.

When participants were familiarized with faces presented in arrays there was a main effect of race, $F_{(1,38)}$=21.11, p<.001, η_p^2=.36, such that criterion was more conservative for own-race faces than other-race faces (*M*=.05, *SE*=.01 and *M*=.016, *SE*=.01 respectively), no main effect of testing method, p=.11, but there was a two-way interaction between race and testing method, $F_{(1,38)}$=21.02, p<.001, η_p^2=.36. To follow up the significant two-way interaction between race and testing method within the array familiarization method, paired sample *t*-tests were conducted to evaluate whether own- and other-race criterion differed within each testing method. For the participants who were familiarized with faces in arrays and were tested on faces in arrays, there was no difference between own- and other-race criterion, p=.99, but for participants who were familiarized with faces in arrays and were tested on faces presented sequentially, there was a difference between own- and other-race criterion, $t_{(19)}$=5.66, p<.001, such that own-race criterion was more conservative than other-race criterion (*M*=.06, *SE*=.01 and *M*=-.01, *SE*=.01 respectively).

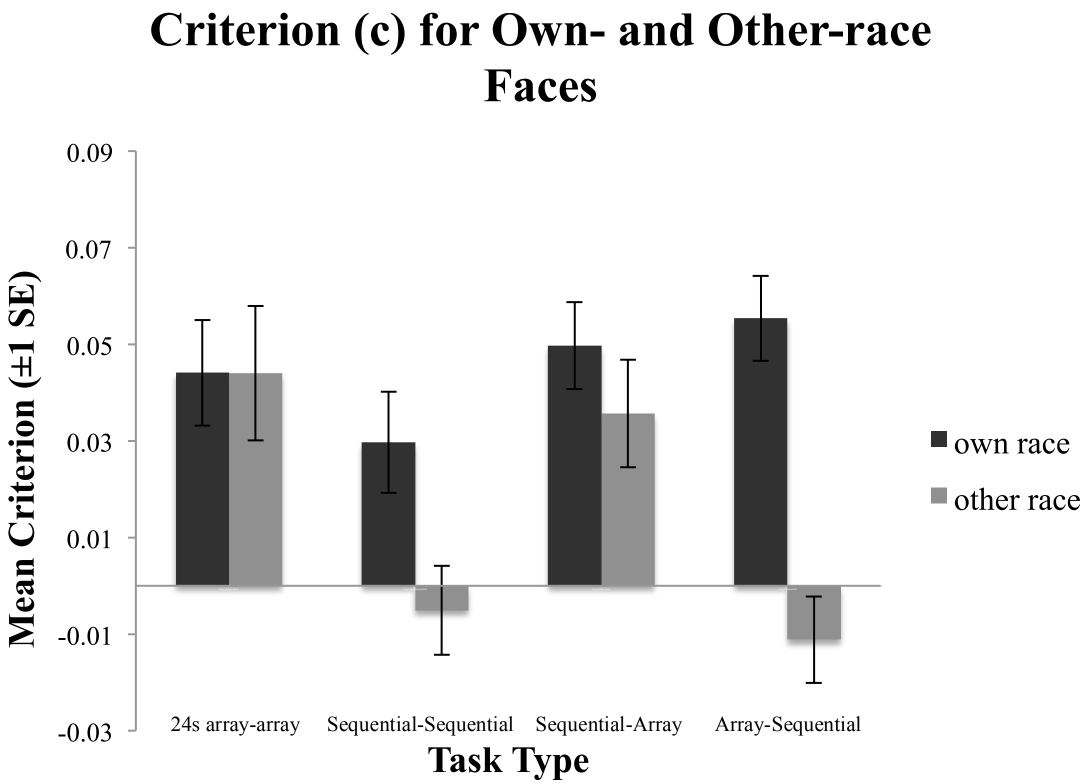

Figure 9: Mean criterion for both own- and other-race faces as a function of learning and testing methods.

Questionnaire data. Experience with people of various races can influence performance on recognition tasks (i.e., see Rhodes et al., 2009; Tanaka et al., 2004; Wright et al., 2003). Due to the location of this study, I expected that the sample would have small amounts of experience with people of Asian ethnicity, as St. Catharines is a relatively racially homogenous community (Statistics Canada, 2011). Meaningful contact or motivation to individuate other-race faces is also very important in terms of type of experience (i.e., if the contact is meaningful, one may be more motivated to individuate an other-race face rather than categorize it; Hugenberg et al., 2010) so I examined how many participants had friends of Asian ethnicity in their top ten friends. Of the 119 participants that filled out questionnaires, out of their ten closest friends, 87 reported having zero Asian friends, 22 reported having one Asian friend, eight reported having two Asian friends and only two participants reported having 4 friends. The low number of personal friends makes it less likely that individual differences in performance are correlated with differences in experience.

Experience with people of Asian ethnicity was evaluated by averaging questions one, four, five, eight, nine and eleven from the contact questionnaire (Cronbach's alpha = .905) (see Appendix 2 for the questions). Only one participant did not fill out the questionnaire, so correlational data was performed with the remaining 119 participants. Two of the 119 participants only answered five of the six questions and therefore their average experience was out of five and not six. Correlations were run with and without those two participants and the results gave the same story in both cases, so the two participants were included in the final analysis. When average experience was correlated with d' for other-race faces, there was no significant relationship for any of the six groups, all rs<.21, ps>.40.

Discussion

The main purpose of Experiment 1 was to make a standard recognition task more ecologically valid. This was achieved by altering the manner in which participants were familiarized and tested in a face recognition task. The first alteration involved showing participants arrays of stimuli comprised of both faces and popular household items. This allowed participants to decide where to allocate their attention, which was hypothesized to decrease face recognition overall and to increase the magnitude of the cross-race effect. The second alteration involved showing participants arrays of eight faces and instructing them to pick out which faces they had previously seen. Using the array method induced more uncertainty in the recognition phase and this was expected to increase the magnitude of the cross-race effect.

In Experiment 1 there were three hypotheses: 1) with longer presentation time of the familiarization arrays recognition accuracy should increase, especially for other-race faces; 2) increased attentional competition in the familiarization arrays would induce a larger cross-race effect; and 3) the testing arrays would create more uncertainty thereby creating a larger cross-race effect.

Although a cross-race effect was evident in all conditions, not one of the above hypotheses was supported by the data. In relation to the first hypothesis, increased presentation time was expected to influence recognition accuracy and this increase in recognition accuracy would be greater for other-race faces than own-race faces.

However, this hypothesis was not supported as there was no effect of presentation time and increased presentation time did not interact with other-race face recognition accuracy.

In relation to the second hypothesis, own-race faces were recognized more accurately than other race faces; however, the cross-race effect was larger when participants learned faces sequentially than when they learned faces in arrays. In other words, the difference between own- and other-race face recognition was larger when faces were familiarized sequentially than when faces were familiarized in arrays.

These results relate directly to the perceptual expertise hypothesis. Adults are better able to use holistic processing for own-race faces than other-race faces (Michel et al., 2006) and they are more sensitive to both featural and spacing differences in own-race faces than other-race faces (Hayward et al., 2008; Mondloch et al., 2010).

In Experiment 1, when participants had optimal conditions for learning faces (e.g., two seconds for each face) recognition performance increased greatly for own-race faces and to a lesser extent for other-race faces. These results are consistent with the perceptual expertise hypothesis. It is apparent that perceptually, participants' learning strategy differed for own-race faces in comparison to other-race faces. With participants' full attention given to only one face, it could be that participants were able to use holistic processing, featural processing and spacing sensitivity for own-race faces and, even with two full seconds, were unable to utilize the same learning strategies for other-race faces. However, the large advantage for own-race face recognition that was evident when participants were given two full seconds to learn a face decreased when attention was divided amongst multiple stimuli. In other words, participants may not have used the same perceptual strategies that were employed in the sequential learning method for own-race faces when the same faces were learned in complex arrays.

In contrast to the perceptual expertise model, proponents of the social-cognitive model suggest that own-race faces are individuated (rather than categorized like other-race faces) and this allows one to obtain details at an individual level rather than at a group level, aiding in later recognition of an own-race face. In Experiment 1 it was expected that when both own- and other-race faces competed for attention, own-race faces would be individuated and attended to before other-race faces, and other-race faces would be categorized and disregarded, leading to an increased magnitude of the cross-race effect. When competition for attention was high (the array task) participants' recognition accuracy for own-race faces was higher than other-race face recognition accuracy. Although this result is consistent with the social-cognitive model, the magnitude of the cross-race effect was not larger in the array task than in the sequential task as was hypothesized. Therefore, although there was some evidence for the social-cognitive model, the results of Experiment 1 are more consistent with the perceptual expertise model.

In relation to the third hypothesis, there was no effect of testing phase on recognition accuracy; neither own- nor other-race recognition was impaired when uncertainty was increased by presenting faces in arrays. However, testing phase did shift participants' response bias when they recognized other-race faces depending on how the faces had been familiarized. When participants were familiarized with sequentially presented faces, participants had more false alarms and were less conservative for other-race faces than own-race faces. However, when participants were familiarized with faces presented in arrays and were tested with sequentially presented faces, participants had more false alarms and were less conservative for other-race faces.

Overall, the cross-race effect was evident in all conditions, but was largest when participants learned faces sequentially—contrary to what was hypothesized. Furthermore, the size of the cross-race effect was not influenced by either testing method or presentation time. Participants' recognition accuracy was best when given two full seconds to learn faces and this was especially evident for own-race faces. It may be that having two full seconds to learn a face maximizes participants' ability to use perceptual expertise. In the array familiarization method this strategy may not have been used as the difference between own- and other-race recognition was smaller than the difference in the sequential familiarization method.

Experiment 1 had two limitations, the first of which is ecological validity. The characteristics of the array tasks did not really reflect how faces are encountered in the real world, potentially influencing why some of the expected hypotheses were not supported. The complex arrays used in the learning phase were still not ecologically valid. Although the stimuli *were* more complex than what is typically seen in the face recognition literature, one never sees floating heads surrounded by thumbtacks and gluesticks. Therefore, it is possible that the small magnitude of the cross-race effect in the array task is not an actual representation of the cross-race effect in real life.

Secondly, participants' strategies during the learning phase are unknown. Presenting stimuli in arrays was expected to increase the size of the cross-race effect because own-race faces, due to their social in-group status (e.g., Maclin & Malpass, 2001; Shriver et al., 2008) and relevance (Rodin, 1987), should be attended to first while other-race faces should be attended to secondarily. As a result of increased attention to own-race faces, own-race face recognition was expected to be better than other-race face recognition. However, because only recognition accuracy was collected, it is unknown whether or not better recognition accuracy for own-race faces than other-race faces in the complex array task was attributable to increased attention to own-race faces *in addition to* participants' expertise in processing own-race faces. By using only accuracy data, participants' gaze patterns and fixations are unknown and so it is unclear whether participants did, in fact, attend preferentially to own-race faces. Participants frequently mentioned after the task that they had been counting paper clips and trying to remember the colour of all the candles in the scenes. Therefore, it is possible that less attention was given to the faces as participants were motivated to remember everything they saw.

Even if participants did tend to look at faces more often than the objects, it is not possible to gauge whether participants looked at own-race faces for longer periods of time than other-race faces. With only accuracy data, it is difficult to attribute the cross-race effect to attentional allocation; therefore, Experiment 2 was created to: 1) examine the cross-race effect with stimuli that are more realistic; and 2) to evaluate attentional allocation.

Experiment 2

Introduction

In Experiment 1 it was found that the difference between participants' recognition accuracy for own- and other-race faces was largest when faces were learned sequentially rather than when faces learned in arrays. These results indicate that, contrary to our hypothesis, the cross-race effect was larger when faces were learned sequentially in comparison to when faces were learned in arrays. When familiarization and testing methodologies were evaluated, it was found that the manner in which participants were tested on faces did not affect recognition accuracy, although it did affect the strategy participants used when recognizing faces.

Again, these results may be due to the limitations addressed in Experiment 1: the heads in the complex arrays were still disembodied, were not to scale with the surrounding items, and the pictures were still unrealistic. Therefore, these limitations could have resulted in an unrealistic representation of the cross-race effect. Additionally, a major limitation of Experiment 1 was the lack of eye-tracking data to supplement accuracy data. Although accuracy data indicate a reliable cross-race effect, another way to examine the effect is by using eyetracking technology and evaluating how participants allocate attention when there is attentional competition.

Many studies are now using eyetrackers to examine attentional allocation to various types of stimuli. The related topics that have been examined in terms of in-group and out-group faces (or own- and other-race faces) are preferential looking to faces depending on race or group membership, attentional allocation to different faces, and the effect of task instructions on recognition accuracy and scanning strategies of the participant. Additionally, eyetracking has been useful in demonstrating that the processing of other-race faces is more effortful than the processing of own-race faces (Wu, Laeng & Magnussen, 2012). However, the majority of these studies have been conducted in order to examine change detection in stimuli (Hirose & Hancock, 2007), preferential looking (e.g., Bean et al., 2012; Lovén et al., 2012) and effect of task instruction (e.g., DeAngelus & Pelz, 2009; Kaakinen, Hyönä & Viljanen, 2011) while not many studies, to my knowledge, have used complex stimuli to examine recognition of own- and other-race faces.

Preferential looking. When using eyetracking data to obtain information on participants' eye movements, it is possible to decipher where participants are allocating attention. The manner in which participants allocate attention can be addressed by two questions: 1) what captures attention; and 2) how long do they spend looking? These research questions have been addressed by examining what face races tend to "grab" attention and by evaluating how much time tends to be spent on faces. However, to my knowledge, neither phenomenon has been applied to a recognition paradigm that uses complex stimuli in the learning and recognition phases.

What captures attention? The first question can be addressed by examining what participants tend to look at *first*. Bean et al. (2012) were interested in whether being highly motivated to appear unprejudiced affects allocation of attention to other-race faces when compared to a group of participants who had lower motivation to appear unprejudiced. In Bean et al.'s (2012) study, the Caucasian participants were given a questionnaire to evaluate whether they were highly concerned about appearing prejudiced or not (high or low motivation was the factor by which participants were grouped) and then participated in a recognition task. In the learning phase, participants saw individual

European American, African American and South Asian faces displayed on the screen. Additionally, participants saw filler pictures of household objects. In the recognition phase, participants saw pairs of faces and had to indicate whether both faces were new, both were old or if one was old and one was new; this was done for both face pairs and objects pairs (Bean et al., 2012).

By using pairs of pictures, Bean et al. (2012) were able to examine where participants allocated attention during the task. Their primary analysis was based on location of first fixation. Participants who were highly motivated to appear unprejudiced fixated on the African American faces before the Caucasian faces when this combination was presented together whereas participants who were not highly motivated to appear unprejudiced did not show this pattern (Bean et al., 2012). However, while not significant, there was a trend of initial own-race face fixations in these participants (Bean et al., 2012). These findings demonstrate that in natural viewing own- and other-race faces *may* be looked at equally, while individual differences in motivation seem to change participants' scanning patterns.

Length of looking time. In addition to evaluating what grabs participants' attention, one can also examine how *long* participants spend observing faces of different races. Lovén et al. (2012) found that when participants viewed pairs of faces (male and female, own- and other-race) participants tended to spend longer amounts of time examining own-race faces than other-race faces (especially for female faces). Additionally, the results from a surprise memory test indicated that the longer looking time was correlated with better recognition (Lovén et al., 2012).

These studies demonstrate that participants' gaze patterns can definitely be influenced by motivation (e.g., to appear unprejudiced; Bean et al., 2012) and length of time spent observing a face correlates to better recognition of that face later on as well. Overall, these results seem to indicate that 1) attention matters and 2) motivation can influence scanning patterns. If natural motivation is an indicator of a change in scanning patterns then, most likely, inducing motivation or altering task instructions should also influence scanning patterns of participants.

Effect of task instruction. The instructions participants are given have a direct relationship with performance on tasks. In fact, when participants are told about the cross-race effect, the results of a subsequent recognition task reveal that the cross-race effect is reduced and sometimes even eliminated (Hugenberg, Miller & Claypool, 2007). This indicates that the magnitude, the existence even, of the cross-race effect is very malleable. Perhaps giving different instructions changes the way participants allocate their attention in a task.

DeAngelus and Pelz (2009) conducted a study in which participants viewed a famous painting and eyetracking patterns were recorded. Participants were shown a series of paintings during the task. In the first 10 pictures, the painting of interest (Repin's "They Did Not Expect Him") appeared allowing the researchers to obtain "freeview" eyetracking information. Throughout the rest of the task, participants saw Repin's painting six more times. Each time the painting appeared participants were given one of six questions they had to answer. After they finished answering the question, they pressed a button and a new painting appeared. The six questions were: 1) Estimate the financial state of the family; 2) Estimate the age of the people; 3) Guess what previous activity was occurring before the man entered the scene; 4) Remember what people were wearing; 5) Remember where the people were; and 6) Estimate the length of absence of the man entering the scene (DeAngelus & Pelz, 2009).

DeAngelus and Pelz (2009) found that although faces tended to be fixated on at a high level regardless of task instruction, the scanning patterns did differ depending on instruction type. For example, when participants were instructed to guess the previous activity of the family, there were more fixations on the table, piano and the sheet music in the painting, while participants tended to examine all regions in the picture when asked to remember the positions of the individuals displayed. Again, although faces seemed to be important to participants, scanning strategies differed depending on the instructions given.

Kaakinen et al. (2011) also observed the effect of task instruction or viewing perspective on scene viewing strategies. Participants were told to examine pictures of house interiors from the perspective of a burglar, a potential homeowner, or in preparation for a memory task. Each photo comprised viewing task relevant and irrelevant objects. In other words, household objects that were relevant to a burglar (e.g., jewelry) or a potential homeowner (e.g., toilet type/location) were present (Kaakinen et al., 2011). When viewing the pictures, participants in the burglar or homeowner perspective groups tended to fixate on salient and perspective-relevant items and looked longer and more frequently on perspective-relevant items. Additionally, by the second fixation, participants were already attending to perspective-relevant objects indicating a very quick effect of task instruction.

After viewing the scenes, participants were given a free-recall test and an object recognition test. Participants remembered more task-relevant objects than task-irrelevant objects (Kaakinen et al., 2011). These findings indicate that task instructions are very important not only for participants' scanning strategies, but also for recognition performance in recognition tasks. Both of these studies show that task instructions influence how participants scan stimuli and how participants' perspective can influence the recognition of objects, specifically objects that are relevant to the viewer.

Current Study

The purpose of Experiment 2 was to further examine questions resulting from the conclusions of Experiment 1. Because the unexpected results of Experiment 1 could have been due to the unrealistic stimuli used, one purpose of Experiment 2 was to examine the cross-race effect with more realistic stimuli that still allowed participants to decide where to allocate their attention. Finally, with the use of eyetracking technology, Experiment 2 enabled me to examine participants' allocation of attention to both own- and other-race faces.

Therefore, the familiarization stimuli in Experiment 2 were scenes comprised of own- and other-race faces that were superimposed onto bodies in a real photograph. An example of the stimuli can be seen in Figure 10.

Figure 10: An example of the familiarization stimuli from Experiment 2.

Participants viewed multiple scenes in the familiarization phase and afterwards were given a face recognition task, an object recognition task and a detailed memory face recognition task. The recognition arrays were similar to the recognition arrays used in Experiment 1, however, each face in each array was labeled one through eight to allow participants to verbally indicate which faces were familiar to them.

Experiment 2 had three hypotheses: 1) own-race faces would be observed more frequently and for longer times than other-race faces in addition to being recognized more accurately (e.g., Lovén et al., 2012; Wu et al., 2012) and with more detail than other-race faces; 2) task instructions would alter scanning strategies when observing scenes; and 3) task instructions would affect performance on the recognition task.

In regards to the first hypothesis, I expected own-race faces to be observed more often and for longer periods of time based on evidence from Lovén et al. (2012) and the social categorization theory. Because other-race faces are categorized quickly (Ge et al., 2009) participants may not take the time to individuate them, therefore, time spent fixating on other-race faces would be shorter. In addition, I expected that participants would have better detailed memory for own-race faces in comparison to other-race faces.

The second hypothesis relates to scanning strategies changing depending on task instruction. One group of participants was told to remember the faces they would see while the other group was simply told to form impressions of people in places. The memory group was predicted to have increased fixations on faces similar to DeAngelus and Pelz's (2009) memory tasks while the impressions group may look more at bodies and objects than the memory group, similar to DeAngelus and Pelz's (2009) freeview task.

The third hypothesis is that task instruction would alter performance on the recognition task. I hypothesized that the memory group would have increased overall recognition and a reduced cross-race effect relative to the impressions groups because they were instructed to remember all faces. By instructing participants to remember all of the faces, participants may be motivated to individuate *each* face regardless of race.

The impressions group was expected to demonstrate a more realistic expression of the cross-race effect, as natural viewing strategies would be evident in comparison to the memory group. Participants would not be expecting to be asked to remember all of the faces presented so they should spend more time on own-race faces than other-race faces resulting in increased recognition accuracy for own-race faces, and decreased recognition accuracy for other-race faces (compared to the memory group). I also expected the impressions group to have better recognition of distracter objects in the scene as they were expected to attend more to the scene than the memory group.

To investigate these questions, 2 (race: own-race, other-race) x 2 (task instruction: memory, impressions) mixed ANOVAs were conducted on visit count and total visit duration for faces and bodies, and the same analysis was used to analyze d', hits, false alarms, criterion and detailed memory for faces. To analyze whether task instruction influenced visit counts and total visit duration for objects, independent samples *t*-tests were conducted on visit count, total visit duration and d' for distracter objects. To determine whether participants' object specificity differed depending on task instructions, a 2 (false alarm type: lure, new) x 2 (task instruction: memory, impressions) mixed ANOVA was conducted on object false alarm types. To determine whether task instruction influenced the relationship between own-race looking time biases and own-race recognition advantages (own-race *d′* – other-race *d′*), a moderated regression was conducted in which the own-race recognition advantage was regressed onto own-race looking time biases, task condition (memory, impressions) and the interaction between looking time advantages and task condition. This analysis enabled me to examine whether or not the relationship between own-race looking time advantages and own-race recognition advantages differed as a function of task instruction.

Methods

Participants. Participants included in this study were Caucasian undergraduate students from Brock University (final n = 40, 9 male, M_{age} = 19.10 years). A total of 58 participants were tested but 18 were excluded due to program error or malfunction (n = 14), experimenter error (n = 1) or participants' scene learning task looking time was less than 80% (n = 3) (i.e., participants were only included if the eyetracker was able to locate both the left and right eye simultaneously during *at least* 80% of the task). All participants gave informed consent and were compensated for their time by receiving either one course research credit (1) or a $12 honorarium.

Equipment. Experiment 2 was run using Tobii Studio version 3.2. The tasks were run on a Tobii T60XL (0.1 degree precision, 24 inch screen, 60 Hz sample rate, 1440x900 pixel resolution) eyetracking system.

Stimuli. The face stimuli used in both the learning phase and face recognition phase of Experiment 2 were the same identities used in Experiment 1. The object recognition phase had the same format as the face recognition arrays, but the faces were substituted with familiar and novel objects. The familiar objects were the objects that had previously been added to the scenes. The novel objects included objects that were the same category as familiar objects (e.g., a bush was the same category as a familiar tree) or were completely new objects (e.g., a pair of shoes). The same strategy was used in Kaakinen et al.'s (2011) study. The use of different novel items allowed object specificity to be analyzed. Each object was labeled 1 through 8 allowing participants to respond verbally rather than pointing at the familiar objects. For the detailed face recognition task, each familiar face was standardized to 250pixels from chin to hairline and was displayed on the Tobii monitor. Each face was presented individually and the order of faces was fixed to ensure later scoring of the written responses could be conducted. However, the order of the faces was varied such that Caucasian and Asian, male and female faces were equally distributed across the task.

Learning phase. The stimuli used in the learning phase were six colour photographs taken by the researcher. Each picture's size was 1280pixels wide, and averaged 912pixels high; on the eyetrackers, however, each picture was displayed at 1280x900 pixels. The colour photographs were taken at various locations throughout the researcher's travels and included places like busy street scenes and athletic events.

Each photograph was altered in Adobe Photoshop CS5. These alterations included fixing brightness and clarity of pictures, superimposing heads onto the bodies of people in the pictures and the addition of various distracter items in the scenes. The faces that were added onto the bodies were the same faces used in the learning phase of Experiment 1. The same faces were used in order to keep continuity across both studies and therefore changes in the results could not be due to difference in faces used. The size of the faces differed slightly to ensure the head fit the body on to which it had been superimposed (sizes ranged from 0.25% of the screen to 0.96% of the screen). See Figure 10 for an example of the scene stimuli.

Each scene contained either four or six faces that were to be later recognized. All other faces of people in the scenes were either profile shots, or the faces were blurred out. Each scene was presented for either 40 or 60 seconds. Presentation time was contingent upon the number of faces in the scene. For example, scenes with four faces were presented for 40 seconds while scenes with six faces were presented for 60 seconds. These presentation times allowed each face to, theoretically, receive 10 seconds of attention if attention would be equally distributed. Finally, each scene contained half Caucasian and half Asian faces.

Because the quality of the superimposed faces differed slightly from the resolution of the scenes used, distracter objects that fit the scene contexts were added. Some examples of the objects are newspapers, a garbage can, or sports equipment.

Crucially, two versions of the scene stimuli were created such that in the second version, each Caucasian face was switched to an Asian face, and each Asian face was switched to a Caucasian face. Additionally, the faces did not appear in the same scenes twice. These two versions ensured that results of the study could not be due to placement of the face on the screen, as any effect would be wiped out with these changes. Finally, all the scenes were presented in a Tobii randomized order.

Face recognition phase. The stimuli used in the recognition phase were the same array recognition stimuli used in Experiment 1. However, two crucial changes were made. The first change was to label each face in each array with a number (one through eight). This change was made to allow participants to verbally indicate which faces they recognized. The second change was that two versions of the recognition arrays were created. One version had Caucasian faces in the top row and Asian faces on the bottom row, while the second version had Asian faces on the top row and Caucasian faces on the bottom row. These two versions, again, allowed face position to not be a factor in recognition biases.

Participants were tested in various combinations of both versions for both the learning and recognition phases. For example, participants could be tested in learning scenes version 1 and recognition arrays version 1; scenes version 1 and arrays version 2; scenes version 2 and arrays version 2; and scenes version 2 and arrays version 1. An equal number ($n = 10$) of participants were tested in each combination of the task. Figure 11 is an example of the face recognition arrays.

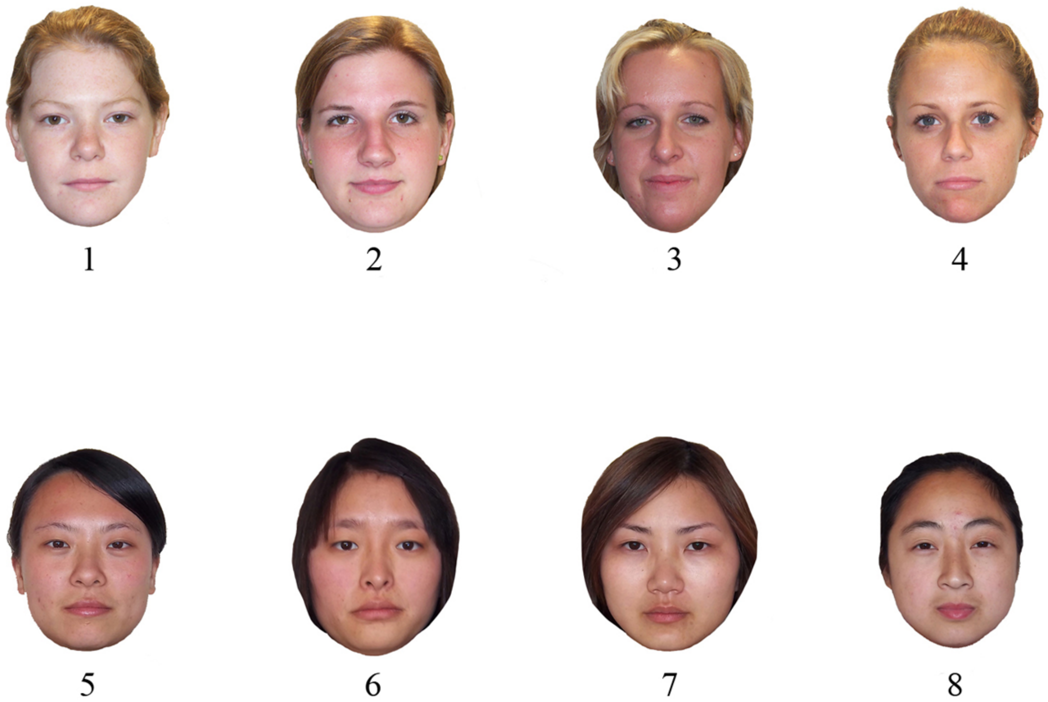

Figure 11. An example of the face recognition arrays from Experiment 2.

Object recognition phase. Participants were shown arrays of eight objects. These object arrays were designed to be comparable to the face arrays. Each array had an unpredictable combination of familiar and novel objects. Some of the novel objects were similar in category to the familiar objects (e.g., a novel bush was the same category as a familiar tree) while other novel objects were completely unrelated to familiar objects (e.g., a pair of shoes). During the task, participants were simply asked to indicate for each array, which objects were familiar to them. Figure 12 depicts an object recognition array.

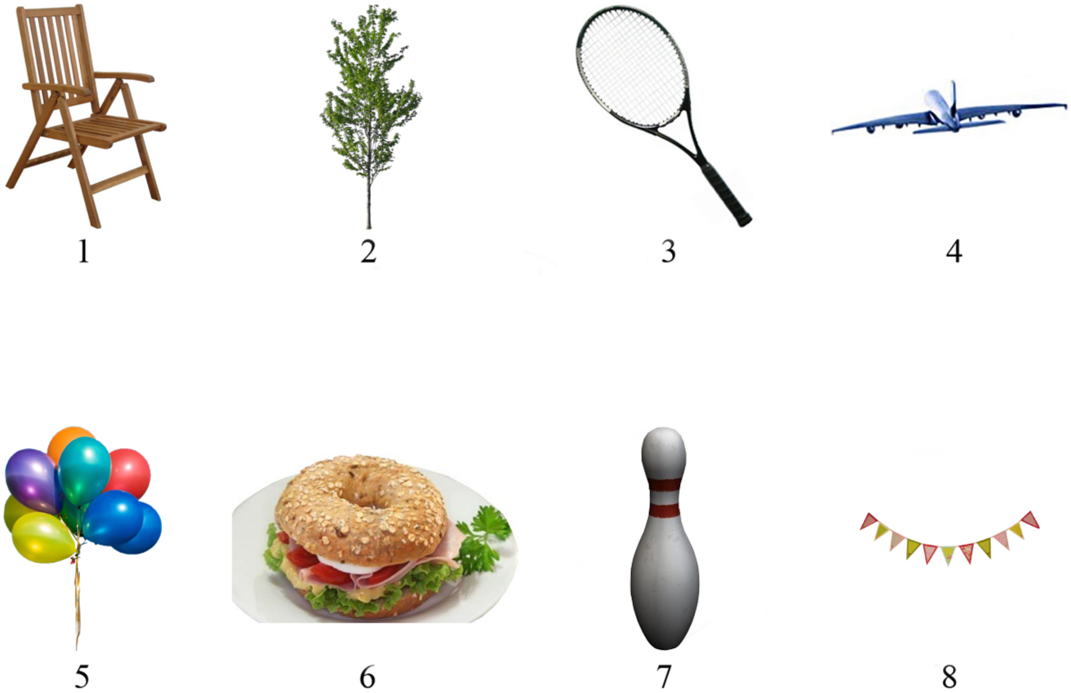

Figure 12. An example of the object recognition arrays used in Experiment 2.

Detailed recognition phase. Participants were shown all of the faces that had appeared in the scenes at the very beginning of the task. For each of the 32 faces, participants were asked to indicate: 1) whether or not they remembered actually seeing the face; 2) if they could remember what scene the person was from; and 3) any other details about the person (e.g., what clothes they were wearing, what were they doing, etc.). Participants wrote down their responses on a score sheet and continued through the task at their own pace by pressing the spacebar on a keyboard to move through the task.

Task instructions. Experiment 2 comprised two different tasks. One group of participants was the *memory* group. Before seeing the stimuli, these participants were told, “When we are out in the world we encounter a variety of people in difference scenes. We’re interested in HOW WELL WE REMEMBER THE PEOPLE WE ENCOUNTER. You are going to see a series of scenes, each of which includes several people. After viewing the scenes I will ask you to IDENTIFIY the people you saw”.

The second group of participants was the *impressions* group. Before seeing the stimuli these participants were told, “When we are out in the world we encounter a variety of people in difference scenes. We’re interested IN THE IMPRESSIONS PEOPLE FORM OF OTHERS. You are going to see a series of scenes, each of which includes several people. After viewing the scenes I will ask you SOME QUESTIONS ABOUT the people you saw”.

In the recognition phase, both groups of participants were told, “You will now be shown eight arrays of faces. In each array some of these faces will be faces that were previously shown to you during the scenes, whereas other faces will be completely new. Your job is to indicate which faces are familiar to you. To indicate your response, say out loud the number corresponding to the face that you recognize. Each face is labeled with a number, so simply say that number out loud". The same set of instructions was used for the object recognition task, but the word "face" was substituted with "object".

Procedure. Participants were seated approximately 65cm away from the Tobii Eyetracking system. The 65cm distance was used as it results in optimal calibration with the Tobii system. Participants were then calibrated using a five-point calibration. After completing calibration, participants were given the instructions for the familiarization phase (either memory or impressions instructions). Participants then viewed the scene stimuli; the scene viewing took approximately five and a half minutes to complete. Each scene was presented for either 40 seconds (four faces) or 60 seconds (six faces) to allow for 10 seconds of viewing time for each face. This view time would occur if participants elected to attend only to faces and to attend to each face equally, regardless of race.

After completing the scene viewing, participants were re-calibrated and then given the instructions for the recognition task. After the instructions, participants verbally indicated which faces they recognized and the experimenter recorded the responses on a score sheet. After completing the face recognition task, participants were re-calibrated and completed an object recognition task (set up in the same recognition arrays as the faces) and then completed a detailed recognition task in which participants were shown all the faces presented in the scenes. Participants were asked to indicate for each face whether or not they actually remembered seeing each face and, if so, to indicate which scene the face was in and any details about the person they could remember.

At the end of the task, participants were given a contact questionnaire (same questionnaire as in Experiment 1) to assess the amount of contact with people of Asian ethnicity and after completion were debriefed about the purposes of the study.

Results

Overall data. To analyze the results from Experiment 2, eyetracking data was obtained from the Tobii software. The Tobii software allows the user to create AOIs (areas of interest) that can then be combined into groups. Each face, body and distracter object was labeled as "own-race" or "other-race" (for faces and bodies), and these items were used as AOIs. The Tobii output gives means for the measures needed to analyze any eyetracking data. These means are given for each individual participant and the group as a whole. For example, for own-race faces, Tobii outputs the mean total fixation time and mean visit count for each AOI group. The means given for each AOI group are taken from data across every scene rather than from individual scenes or faces.

Scanning patterns for faces. For future reference, *visit count* is defined as the mean number of times participants visited a specific AOI group (e.g., how many times own- versus other-race faces were visited). *Total visit duration* is the mean of the total amount of time participants spent visiting own- or other-race faces.

To illustrate these concepts, Figure 13 is an example of a visit on a face. The circles represent fixation points, whereas the lines connecting the fixation points are the movement of the eye. The fixation labeled as "1" has not yet reached the face; however, once Fixation 2 occurs, a visit has now started. In this example only one visit has been made to this face. Total visit duration takes into account the amount of time of spent on each fixation point on the face (2 + 3 + 4) *in addition to* any time taken to get from one

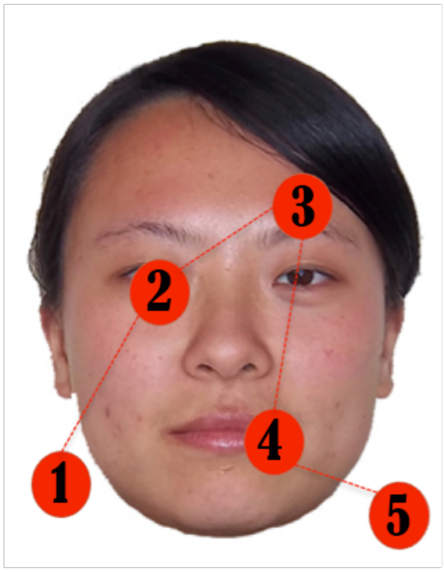

Figure 13: An illustration of potential eyetracking data for a face stimulus. The numbers on the fixation points indicate the order of fixation.

fixation point to another. Once fixation “5” has occurred, the visit to the face has ended. If a participant left the face (point 5) and went back to the face at a later point, this would represent a second visit to the face. Therefore, the total visit count would be two, and the total visit duration would be the amount of time for each visit combined (i.e., visit 1=1 second, visit 2=1.5 seconds, total visit duration=2.5 seconds).

Visit count. A 2 (face race: own, other) x 2 (task instruction: memory, impressions) mixed ANOVA was conducted to examine the effect of task instruction on the average amount of times participants visited own- and other-race faces. Only a main effect of race was evident, $F_{(1, 38)}=9.1$, $p=.005$, $\eta_p^2=.19$, such that own-race faces were visited more times ($M=77.73$, $SE=4.07$) than other race faces ($M=71.18$, $SE=3.71$). There was no effect of task instruction, $p=.27$, and no interaction between task instruction and race, $p=.45$. The mean visit counts can be seen in Figure 14.

Total visit duration. A 2 (face race: own, other) x 2 (task instruction: memory, impressions) mixed ANOVA was conducted to examine the effect of task instruction on the average length of time participants spent visiting own- and other-race faces. A main effect of race was evident, $F_{(1, 38)}=8.23$, $p=.007$, $\eta_p^2=.18$, such that own-race faces had, overall, longer total visit duration ($M=71.38$, $SE=4.57$) than other race faces ($M=62.86$, $SE=4.73$). There was also a significant main effect of task instruction, $F_{(1, 38)}=11.20$, $p=.002$, $\eta_p^2=.23$, such that the memory task group had, overall, longer total visit duration ($M=81.88$, $SE=6.24$) than the impressions group ($M=52.36$, $SE=6.24$). There was no significant interaction between race and task instruction, $p=.28$. The means for total visit duration can be seen in Figure 15.

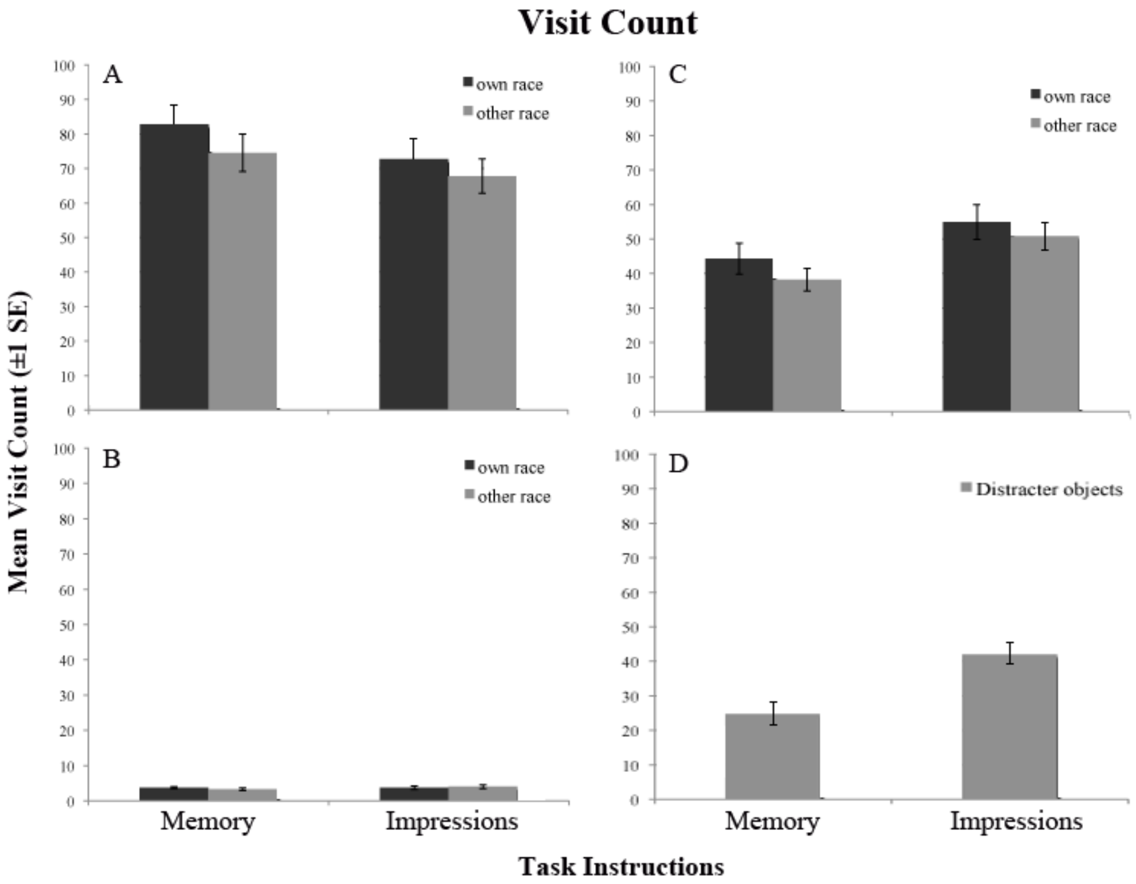

Figure 14. A. Mean visit count for own- and other-race faces as a function of task instruction. B. Mean visit count for own- and other-race faces in the first ten seconds of looking time as a function of task instruction. C. Mean visit count for own- and other-race bodies as a function of task instruction. D. Mean visit count for objects as a function of task instruction.

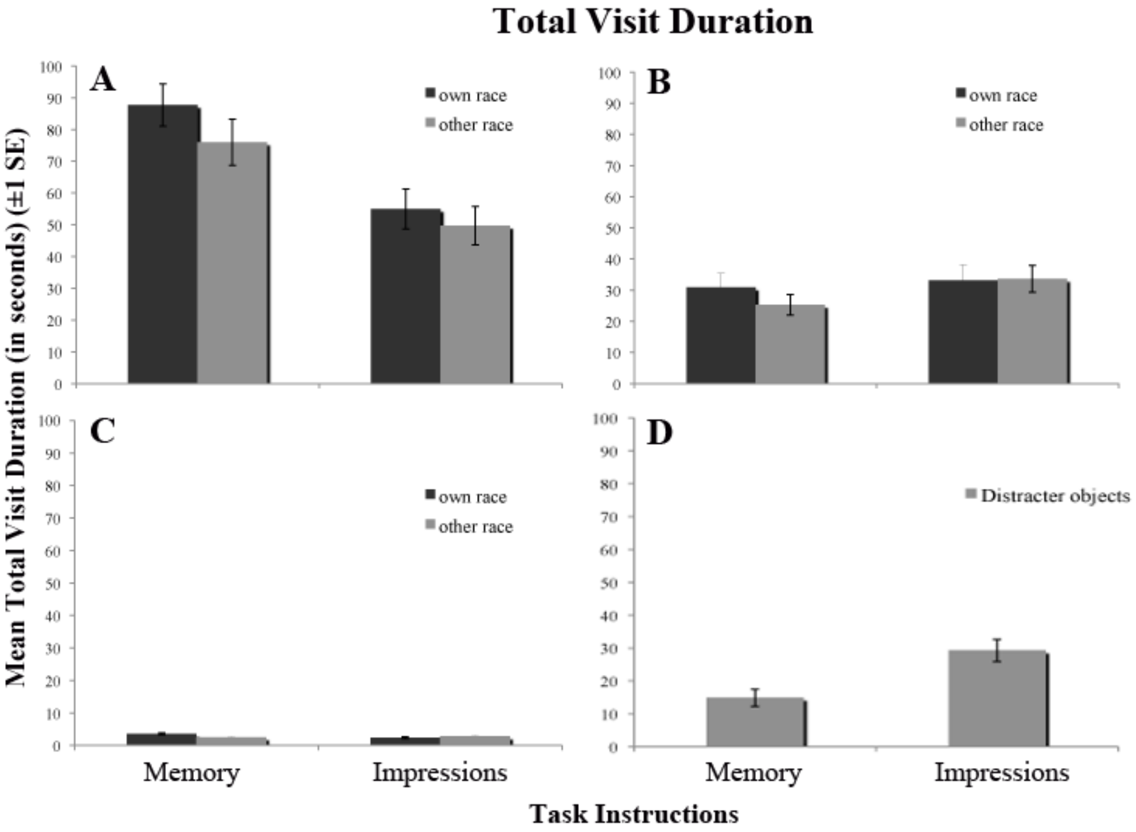

Figure 15. A. Mean total visit duration for own- and other-race faces as a function of task instruction. B. Mean total visit duration for own- and other-race faces in the first ten seconds of looking time as a function of task instruction. C. Mean total visit duration for own- and other-race bodies as a function of task instruction. D. Mean total visit duration for objects as a function of task instruction.

Scanning patterns for faces in the first ten seconds. One issue with analyzing the overall data is that any initial differences in scanning patterns between own- and other-race faces may be reduced by the long presentation time of the scenes. Therefore, to examine if initial biases were stronger than the bias observed over the total presentation time, the first ten seconds of data were analyzed separately.

Visit count. A 2 (face race: own, other) x 2 (task instruction: memory, impressions) mixed ANOVA was conducted to examine the effect of task instruction on the average amount of times participants visit own- and other-race faces. No main effect of race was evident, $p=.81$, there was no effect of task instruction, $p=.48$, and no interaction was evident between task instruction and race, $p=.24$. The means can be found in Figure 14.

Total visit duration. A 2 (face race: own, other) x 2 (task instruction: memory, impressions) mixed ANOVA was conducted to examine the effect of task instruction on the length of time participants spent visiting own- and other-race faces. No main effect of race, $p=.27$, and no main effect of task instruction, $p=.18$, was evident. However, there was a significant interaction between task instruction and race, $F_{(1, 38)}=5.73$, $p=.02$, $\eta_p^2=.13$.

Paired samples *t*-tests were conducted to examine whether total visit duration for own- and other-race faces differed within each task instruction. For the impressions group there was no difference between total visit duration for own- and other-race faces, $p=.44$. For the memory group, there was a significant difference between total visit duration for own- and other-race faces, $t_{(19)}=2.90$, $p=.009$, such that own-race faces received longer total visit duration (*M*=3.56, *SE*=.32) than other-race faces (*M*=2.52, *SE*=.26). The means can be found in Figure 15.

Scanning patterns for bodies. It was expected that looking patterns to bodies would be influenced by task instructions. It was expected that own-race bodies would be attended to more than other-race bodies, and the impressions group would pay more attention to bodies than participants in the memory group as bodies may help form an *overall* impression of the person. I also expected an interaction with the difference between attention towards own- and other-race bodies to be larger in the impressions group than the difference found in the memory group.

Visit count. A 2 (body race: own, other) x 2 (task instruction: memory, impression) mixed ANOVA was conducted to examine the effect of task instruction on the mean visit count for own- and other-race bodies. A main effect of race was evident, $F_{(1, 38)}=6.31$, $p=.016$, $\eta_p^2=.14$, such that own-race bodies were visited more often (*M*=49.63, *SE*=3.36) than other-race bodies (*M*=44.53, *SE*=2.58) and a main effect of task was evident, $F_{(1, 38)}=4.23$, $p=.047$, $\eta_p^2=.10$, such that participants in the impressions group had higher visit counts for bodies (*M*=52.88, *SE*=3.99) than the memory group (*M*=41.28, *SE*=3.99). There was no interaction between race and task instruction, $p=.64$. The means can be found in Figure 14.

Total visit duration. A 2 (body race: own, other) x 2 (task instruction: memory, impression) mixed ANOVA was conducted to examine the effect of task instruction on the mean total visit duration for own- and other-race bodies. There was no main effect of race, $p=.19$, no main effect of task, $p=.37$, and no interaction between race and task instruction, $p=.11$. The means can be found in Figure 15.

Scanning patterns for objects. The objects used in these analyses were the distracter objects that had previously been added into the scenes. I expected that participants in the impressions group would pay more attention to objects as they would help form an overall impression of people in places.

Visit count. Independent samples *t*-tests were conducted to examine whether the memory and impressions group differed on mean visit count for distracter items. The results of the *t*-test indicated that the impressions group had higher visit counts (M=42.00, SE=3.60) than the memory group (M=24.70, SE=3.72), $t_{(38)}$=-3.34, p=.002. The means can be found in Figure 14.

Total visit duration. Independent samples *t*-tests were conducted to examine whether the memory and impressions group differed on total visit duration for distracter items. The results of the *t*-test indicated that the impressions group had longer total visit duration (M=29.28, SE=3.34) than the memory group (M=14.90, SE=2.61), $t_{(38)}$=-3.39, p=.002). The means can be found in Figure 15.

Recognition accuracy for faces. In order to examine recognition accuracy for both own- and other-race faces, hits, false alarms, d' and criterion were calculated in the same manner as Experiment 1.

*Hits***.** A 2 (face race: own, other) x 2 (task instruction: memory, impressions) mixed ANOVA was conducted to examine the effect of task instruction on hit rates for own- and other-race faces. There was a marginal effect of race (p=.07), and a significant effect of task instruction, $F_{(1, 38)}$=8.24, p=.007, η_p^2=.18, such that the memory group had more hits (M=8.90, SE=.44) than the impressions group (M=7.13, SE=.44). There was also a significant interaction between race and task instruction, $F_{(1, 38)}=7.03$, $p=.01$, $\eta_p^2=.16$.

To follow up the significant race by task instruction interaction, paired samples *t*-tests were conducted to evaluate whether own-race hits and other-race hits were different within each task. For the memory group, there was a difference between own- and other-race hits, $t_{(19)}=3.60$, $p=.002$, such that own-race hits were higher than other-race hits ($M=9.95$, $SE=.43$ and $M=7.85$, $SE=.56$ respectively). There was no difference between own- and other-race hits for the impressions group, $p=.63$. The means can be found in Figure 16.

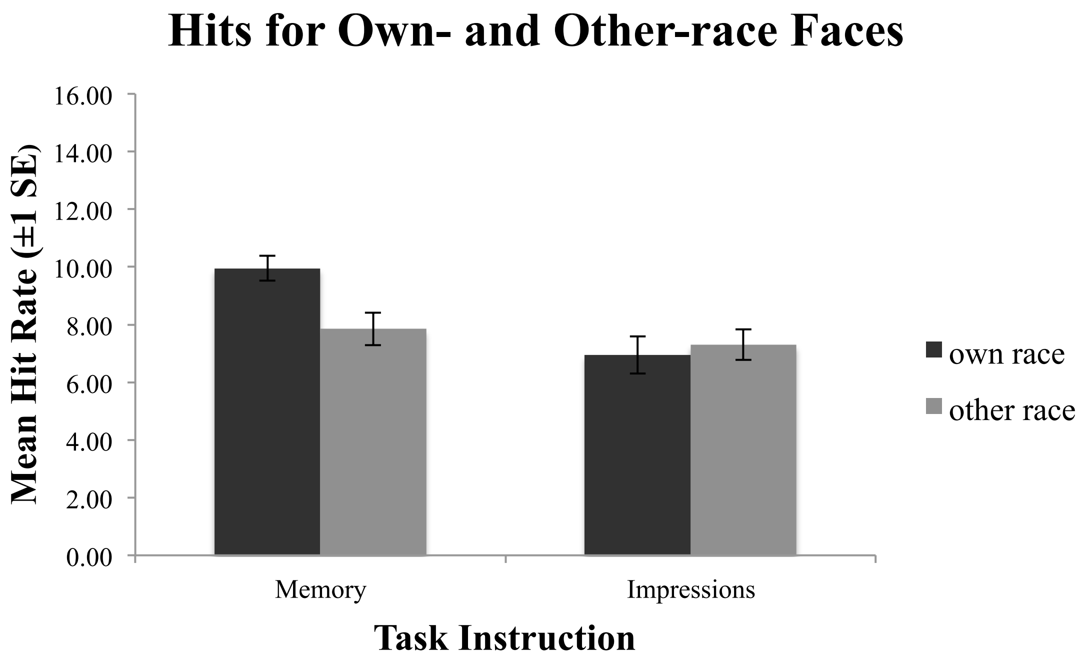

Figure 16. Mean hit rates for both own- and other-race faces as a function of task instruction.

False alarms. A 2 (face race: own, other) x 2 (task instruction: memory, impressions) mixed ANOVA was conducted to examine the effect of task instruction on false alarm rates for own- and other-race faces. There was a significant main effect of race, $F_{(1, 38)}$=17.89, p<.001, η_p^2=.32, such that other-race faces had more false alarms (M=4.13, SE=.45) than own-race faces (M=2.23, SE=.33), no effect of task instruction, p=.76, and no significant interaction between race and task instruction, p=.44.

Recognition accuracy (d'). Single sample t-tests were conducted to evaluate whether d' means for both own- and other-race faces were different from chance (zero) for the impressions and memory groups. All d' means were significantly greater than zero, all ps<.002. A 2 (face race: own, other) x 2 (task instruction: memory, impressions) mixed ANOVA was conducted to examine the effect of task instruction on recognition accuracy for own- and other-race faces. A main effect of race was evident, $F_{(1, 38)}$=27.48, p<.001, η_p^2=.42; own-race faces were recognized more accurately (M=1.25, SE=.09) than other race faces (M=.69, SE=.11). A main effect of task instruction was evident, $F_{(1, 38)}$=4.75, p=.036, η_p^2=.11, such that the memory group had better recognition accuracy (M=1.15, SE=.12) than the impressions group (M=.79, SE=.12). There was no interaction between race and task instruction, p=.22. The means for d' can be found in Figure 17.

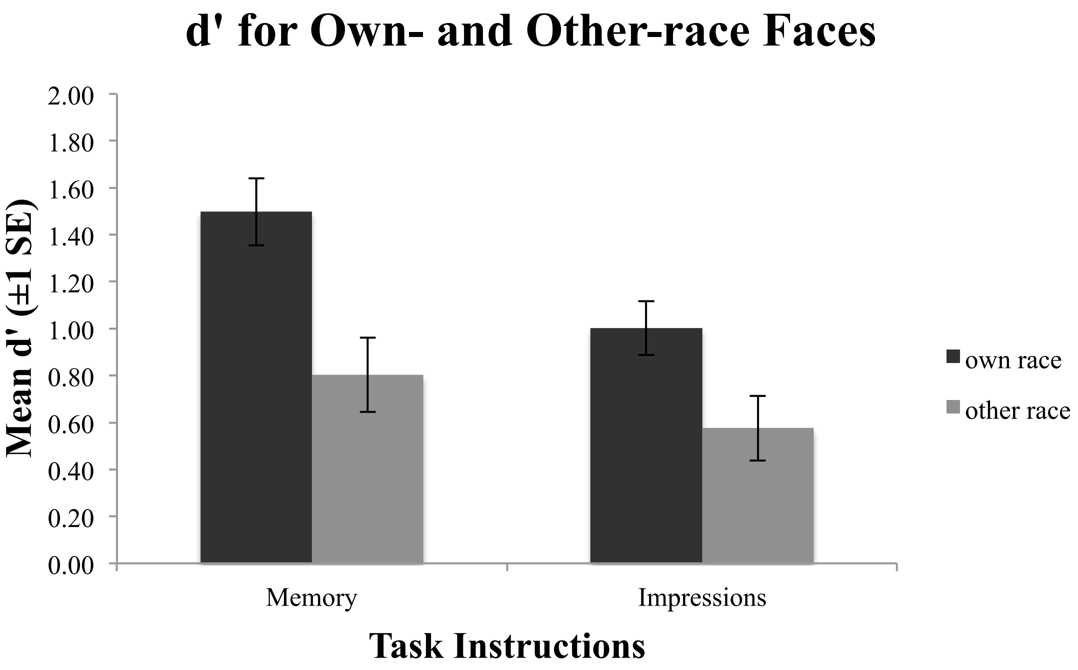

Figure 17. Mean recognition accuracy (*d'*) for both own- and other-race faces as a function of task instruction.

Criterion (response bias). Single samples *t*-tests were conducted to evaluate whether criterion means were significantly different from zero (no bias). Both own- and other-race criterion means were significantly higher than zero indicating a conservative bias, *p*s<.001. A 2 (face race: own, other) x 2 (task instruction: memory, impressions) mixed ANOVA was conducted to examine the effect of task instruction on criterion for own- and other-race faces. There was a marginal effect of race, *p*=.07, no effect of task instruction, *p*=.22, and a marginally significant interaction between race and task instruction, $F_{(1, 38)}$=3.70, *p*=.06, η_p^2=.09. The means can be seen in Figure 18.

The marginally significant interaction was followed up with a paired samples *t*-test to evaluate whether own-race and other-race criterion was different within each task. For the impressions group, there was a difference between own- and other-race criterion, $t_{(19)}$=2.38, *p*=.03, such that own-race criterion was more conservative than other-race criterion (*M*=.07, *SE*=.01 and *M*=.04, *SE*=.01 respectively). There was no difference between own- and other-race criterion for the memory group, *p*=.99. This finding indicates that when participants were trying to remember each faces in the familiarization phase their response strategy or bias was the same for both own- and other-race faces, while participants who simply formed impressions were less conservative when recognizing other-race faces in comparison to own-race faces. This finding is consistent with the increased number of false alarms for other-race faces than own-race faces.

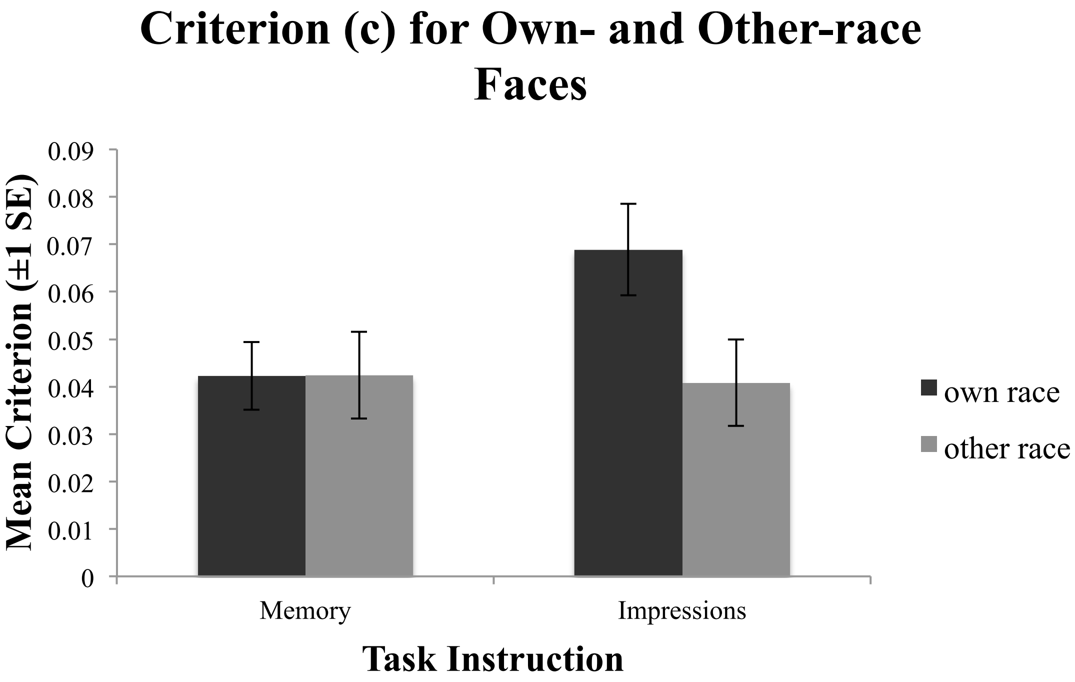

Figure 18. Mean criterion for both own- and other-race faces as a function of task instruction.

Face recognition detail accuracy. For the final portion of the task, participants were asked to indicate for each familiar face whether or not they actually remembered seeing that face, and if so, what scene the face was in and any details about the person. One point was given if the participant remembered the face, one point was given if the participant correctly remembered the scene the face was in, and one point was given if the participant remembered a detail about the person (e.g., what they were wearing or doing). If the participant gave a detail about the person but did not mention the scene, they were still awarded a point for the scene as they had specific recognition of the individual. For a single face the maximum number of points was three and the maximum total score possible for a participant was 96 (a maximum of 48 points for own-race faces and 48 points for other-race faces). Recognition detail was also analyzed in two ways.

A 2 (face race: own, other) x 2 (task: memory, impressions) mixed ANOVA was conducted to examine the effect of task instruction on the accuracy of participants' detailed memory of own- and other-race faces. The results of the ANOVA indicated a main effect of race, $F_{(1, 38)}=17.63$, $p<.001$, $\eta_p^2=.32$, such that own-race faces had higher detailed accuracy ($M=14.48$, $SE=.90$) than other-race faces ($M=10.25$, $SE=.65$). There was a marginal effect of task instruction, $p=.09$, and the interaction between race and task instruction was marginally significant, $F_{(1, 38)}=3.85$, $p=.057$, $\eta_p^2=.09$. The means can be found in Figure 19.

Paired samples *t*-tests were conducted to evaluate whether own- and other-race detailed accuracy differed in each task group. For the impressions group there was no difference in detailed accuracy, $p=.19$, while for the memory group there was a difference between own- and other-race detailed accuracy, $t_{(19)}=5.40$, $p<.001$; own-race detailed accuracy was higher than other-race detailed accuracy (*M*=16.50, *SE*=1.21 and *M*=10.30, *SE*=.90 respectively).

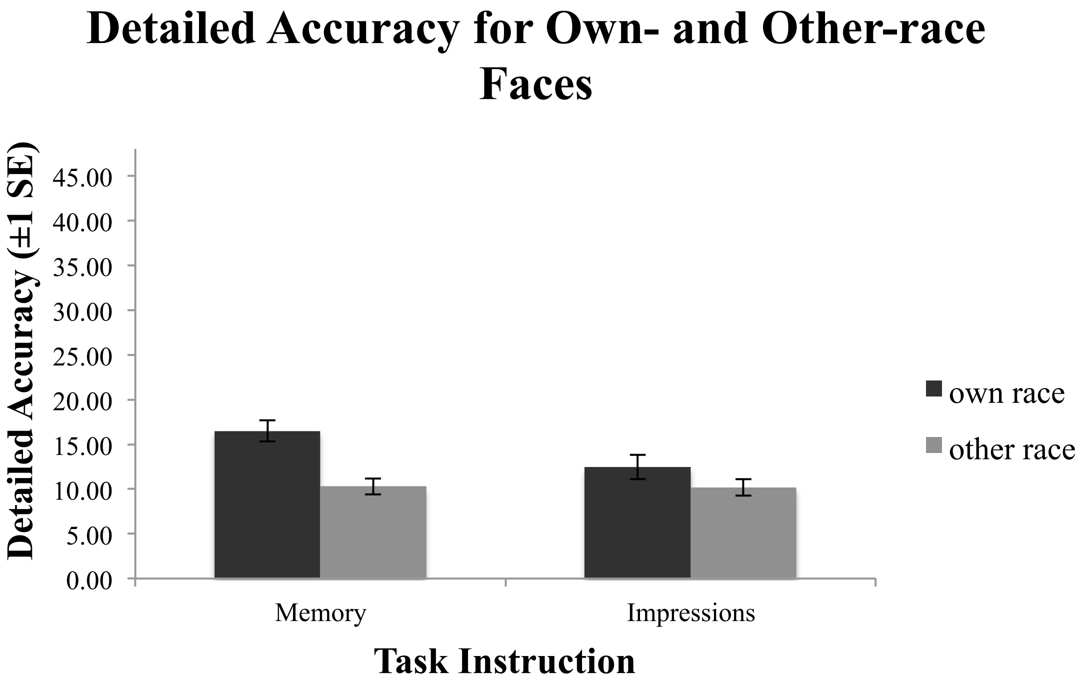

Figure 19. Mean overall detailed accuracy for own- and other-race faces as a function of task instruction.

Figure 19 clearly shows that for detailed memory of faces, accuracy was incredibly low. In fact, when considering *only* the amount of detail (e.g., scene, clothing) accuracy decreases even further. For example, if a participant remembered eight faces out of the 32, for those eight faces they may have only remembered the location for four of the faces, and of those four faces, only one specific detail about a person.

To evaluate the level of detailed recognition of the faces participants actually remembered, proportion scores were calculated by dividing the amount of detail remembered (which scene + a specific detail) by the number of faces remembered. Using this proportion score, a 2 (face race: own, other) x 2 (task: impressions, memory) mixed ANOVA was conducted to evaluate whether participants demonstrated better own-race face detail when *only* specific details were considered. I expected that own-race faces would have higher detailed recognition accuracy than other-race faces and that the impressions group would have higher detailed recognition accuracy than the memory group as more attention to the body was given by those in the impressions group than those in the memory group.

The results of the ANOVA indicated a main effect of race, $F_{(1, 38)}=15.85$, $p<.001$, $\eta_p^2=.29$, such that own-race faces had higher detailed accuracy ($M=.43$, $SE=.07$) than other-race faces ($M=.21$, $SE=.04$). There was no main effect of task, $p=.85$, and no interaction between race and task instruction, $p=.46$.

Looking time and recognition accuracy regression. The final analyses were conducted to evaluate the relationship between individual participants' looking time data and recognition accuracy of own- and other-race faces. To analyze these data, each participant's own-race total visit duration bias was computed along with own-race recognition advantages. To calculate each participant's total visit duration bias, the mean total visit duration for own-race faces was divided by the mean total visit duration for both own- and other-race faces. This calculation results in a proportion for an own-race total visit duration bias. To calculate each participant's recognition bias, other-race *d′* values were subtracted from own-race *d′* values resulting in a *d′* difference score. Higher values for the total visit duration bias indicate that participants spent much more time on own-race faces than other-race faces and higher values for the recognition bias indicate that participants recognized own-race faces much more accurately than other-race faces. These difference scores were calculated to evaluate whether participants with larger total fixation time looking biases also have a larger own-race recognition advantage.

Regression. A moderated regression was conducted to examine whether or not the relationship between the own-race looking time advantage (centered) and own-race recognition advantage varied, or was moderated, by task condition or the interaction between looking time advantages and task condition. Overall, the model was not significant, *Adjusted* R^2=-.03, $F_{(3, 36)}$=.63, *p*=.60, indicating that the relationship between own-race advantage for looking time and recognition was not correlated and did not differ depending on the task instructions. There was no main effect of task, β=.20, *p*=.24, no main effect of looking time advantage, β=-.08, *p*=.76 and no interaction between task and looking time, β=.14, *p*=.56. The correlations between the *d′* difference scores and total visit duration bias proportion can be seen for the memory group in Figure 20 and the impressions group in Figure 21.

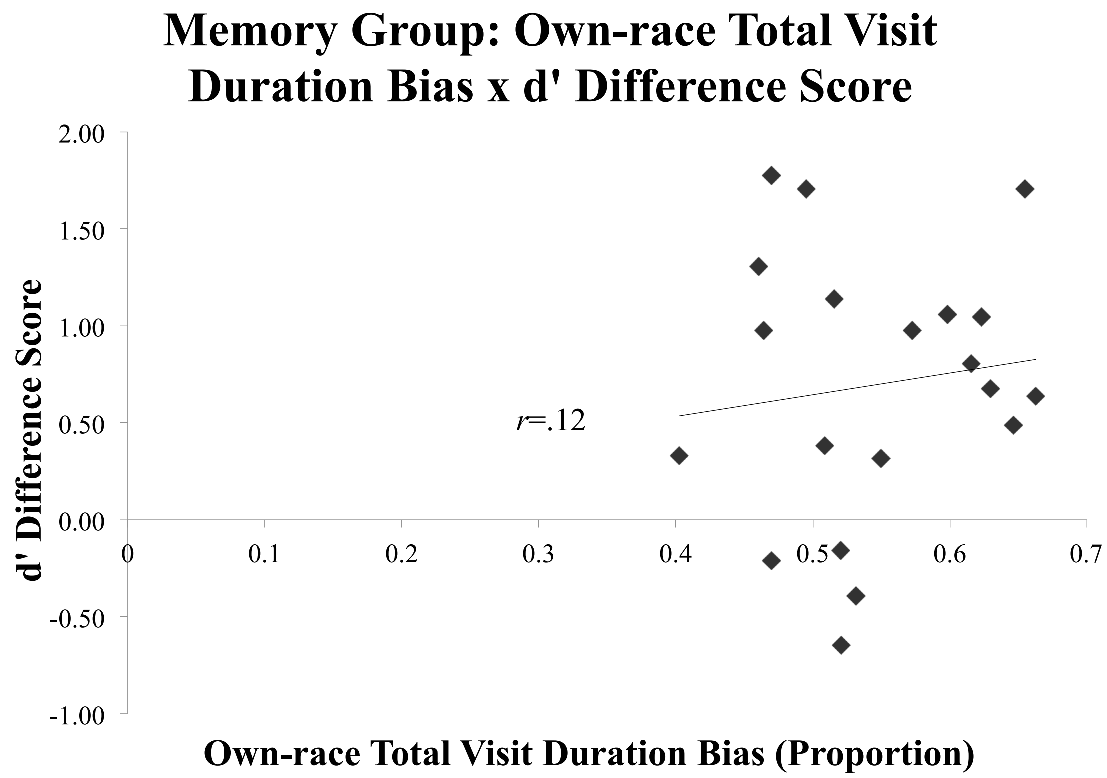

Figure 20: Correlation between own-race total visit duration proportion and *d'* difference scores for participants in the memory group.

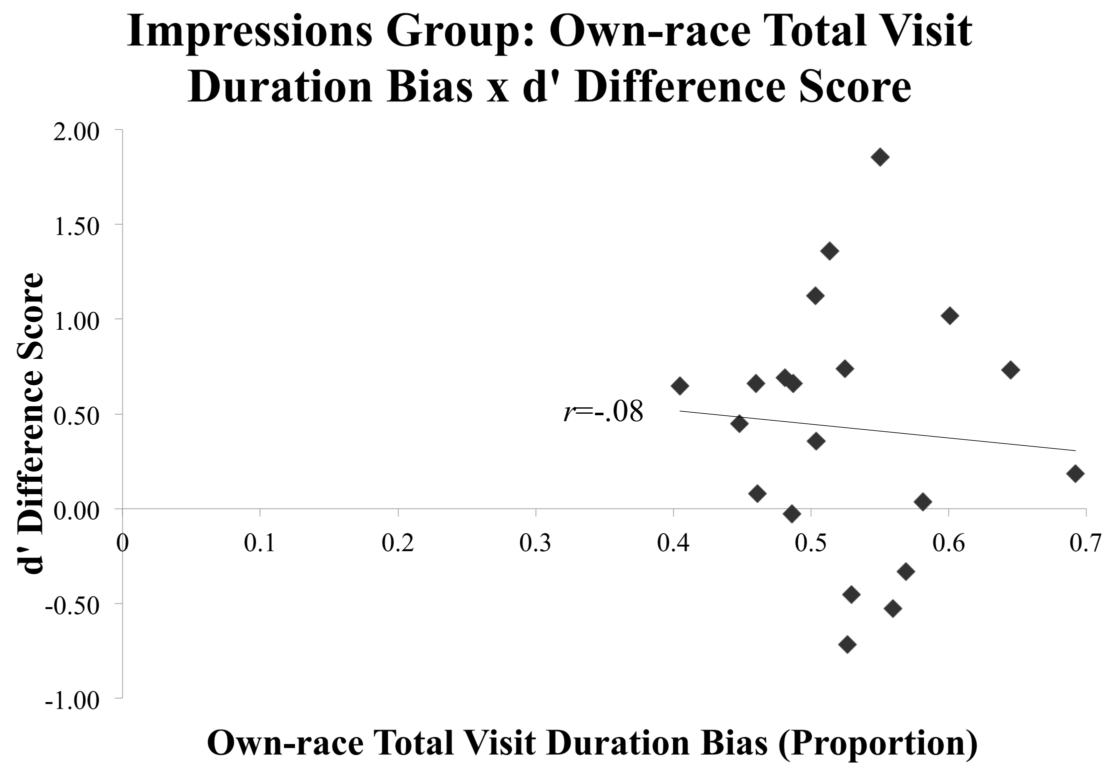

Figure 21: Correlation between own-race total visit duration proportion and *d'* difference scores for participants in the impressions group.

Object recognition. As distracter items were also added to the scenes, it was of interest to examine whether or not participants spent time looking at those items *and* whether or not participants were proficient at object recognition. The impressions group was expected to be more accurate with object recognition as forming an impression requires more information than simply the faces of people in the scene and they spent more time looking at objects than the memory group.

d'. Single sample *t*-tests were conducted to evaluate whether the *d'* means were significantly different from chance (zero). Mean *d'* values for both the memory and impressions group were different from chance, *p*s<.001. To examine whether one group had higher recognition accuracy of the distracter items, an independent samples *t*-test was conducted comparing the *d'* values for the memory and impressions group. Although participants in the impressions group looked longer at objects than did participants in the memory group, there was no significant difference in object recognition accuracy between these groups, *p*=.21.

False alarm types. For the object recognition task, half of the objects in the arrays were familiar objects (ones that had been shown in the scenes) and other half was unfamiliar. Unfamiliar objects were classified as either a lure or a new object. A lure was an object that was in the same category as a familiar object (e.g., the lure for the familiar tree is a bush) while a new object was an item that was unrelated to categories of the familiar objects (e.g., a pair of shoes).

A 2 (false alarm type: lure, new) x 2 (task instruction: memory, impressions) mixed ANOVA was conducted to examine whether one group was more likely to have less specificity of the objects (demonstrated by higher rates of lure identification). The results of the ANOVA indicated there was no main effect of false alarm type, $p=.46$, no main effect of task instruction, $p=.50$, and no interaction between type of false alarm and task, $p=.31$.

Questionnaire data. Experience with people of Asian ethnicity was taken by averaging questions one, four, five, eight, nine and eleven (Cronbach's alpha = .875) (see Appendix 2). When average experience was correlated with recognition accuracy (d') for other-race faces, there was no significant relationship, $r_{(38)}=.15$, $p=.36$. When correlations were performed for each instruction group separately, no significant correlations were found, $r\text{s}<.34$, $p\text{s}>.14$. As in Experiment 1, all 40 participants in Experiment 2 had very low personal experience as 26 participants indicated having zero Asian friends out of their top ten closest friends, 11 participants indicated having one Asian friend in their top ten friends and three participants indicated having two Asian friends in their top ten friends.

Discussion

The main purpose of Experiment 2 was to follow up on the limitations of Experiment 1. To address the limitations, more realistic stimuli were used in the learning phase of the task. This was achieved by superimposing stimulus heads onto bodies in actual photographs. Additionally, a Tobii Eyetracking system was used to obtain participants' scanning data for complex stimuli.

In Experiment 2 there were three hypotheses. The first was that own-race faces would receive attentional priority. This would be evident if participants looked at own-race faces more often and for longer periods of time. The first hypothesis is predicted by the social-cognitive model as own-race faces are part of the participants' in-group and are expected to be processed at an individual level rather than at a group level like other-race faces. Time and effort would be taken to individuate own-race faces in contrast to simply categorizing other-race faces quickly. It was also expected that own-race faces would be recognized more accurately than other-race faces, in part because they receive more attention.

The first hypothesis was supported in that participants did look preferentially at own-race faces. Participants in both instruction groups visited own-race faces more frequently than other-race faces and also spent more time overall on own-race faces than other-race faces. These results are consistent with the social-cognitive model. Additionally, own-race faces were recognized more accurately than other-race faces.

The second hypothesis was that task instruction (memory vs. impressions) would alter performance in several ways. The impressions group was expected to pay less attention to faces than the memory group because although the memory group was specifically told to remember faces, the impressions group was not. The impressions group was also expected to attend more to the bodies and objects than the memory group as the bodies and objects in the scene help to give an overall impression of the person. This hypothesis is based on Birmingham et al.'s (2008a) study in which participants who were told to look at or look at and describe the scenes attended more to bodies, objects and the background than the participants who were simply evaluating the social interactions in the scenes.

Fitting this hypothesis, task instruction did alter performance on the task, which is consistent with DeAngelus and Pelz's (2009) and Kaakinen et al.'s (2011) work. The impressions group looked for shorter periods of time at faces than the memory group, and looked more frequently at bodies and looked longer and more frequently at objects than the memory group.

Although it was expected that own-race faces would be attended to more frequently and for longer periods of time than other-race faces regardless of task instruction, I also expected that the difference in attention for own- and other-race faces would be larger for the impressions group than the memory group. Because the memory group was instructed to remember all of the faces, there would be no advantage to look more at own-race faces than other-race faces while for the impressions group, other-race faces would be categorized quickly and own-race faces would be the focus of attention due to the nature of their social in-group status. This hypothesis was not supported as there were no interactions between visit count and task instruction or between total visit duration and task instruction over the entirety of the stimulus displays. Only in the first 10 seconds did the memory group look more at own-race faces than other-race faces and this was contrary to our hypothesis.

I expected the memory group to be more accurate for faces in comparison to the impressions group, and this is due to the fact that the memory group was told to remember the faces while the impressions group was not. Furthermore, I expected own-race faces to be recognized more accurately than other-race faces. However, I hypothesized that the magnitude of the cross-race effect would be larger in the impressions group than the memory group as more attention would have been given to own-race faces than other-race faces.

This hypothesis was partially supported as participants did recognize own-race faces more accurately than other-race faces. Not only was own-race face recognition more accurate than other-race face recognition accuracy, but participants' specific detailed memory for own-race faces was more accurate than the specific detailed memory for other-race faces strongly suggesting participants attended to own-race faces with a different level of detail than they did for other-race faces. Additionally, the memory group did have better overall face recognition than the impressions group. However, contrary to what was expected, there was no significant interaction between race and task instruction. The impressions group was better at recognizing own-race faces than other-race faces but the difference in recognition accuracy was not larger than the difference in the memory group.

The third hypothesis was that increased looking time for own-race faces should correlate with higher recognition accuracy (e.g., individual differences for own-race looking time advantages should correlate with own-race recognition advantages). Presumably, time spent encoding a face should aid with later recognition as Lovén et al. (2012) found.

The third hypothesis was not supported as the regression results demonstrated that there was no relationship between the own-race face looking time advantage and the own-race face recognition advantage (and task instruction did not moderate this potential relationship) meaning that even when participants spent more time looking at own-race faces than other-race faces, this did not result in even better own-race face recognition (i.e., in a larger own-race recognition advantage). These results are contrary to Lovén et al.'s (2012) study where increased looking time was correlated with better recognition accuracy. However, own-race faces were, overall, attended to more than other-race faces and were also recognized more accurately than other-race faces. Therefore, these findings demonstrate that better recognition accuracy for own-race faces was associated with increased attentional allocation to own-race faces. It would seem logical, then, to predict that for an individual, a larger difference in looking at own-race faces than other-race faces should correlate with better recognition accuracy for own-race faces than other-race faces. However, at the individual level, this relationship is not significant.

These results lead to an interesting proposition: own-race faces do receive more attention than other-race faces (consistent with the social-cognitive model) and this reflects a bias to attend to own-race faces. However, this attentional bias towards own-race faces is not driving the difference in recognition accuracy at an individual level. Rather, the difference in recognition accuracy may reflect differential expertise for own- and other-race faces and this expertise is independent from the individual differences in attentional allocation. These results and implications for Experiment 2 will be presented more fully in the general discussion.

General Discussion

The cross-race effect is a common phenomenon found in the face perception literature. This effect is demonstrated when participants demonstrate better recognition accuracy for own-race faces than other-race faces (McKone et al., 2007; Meissner & Brigham, 2001; Sporer, 2001). Typically, the cross-race effect has been attributed to perceptual expertise and social cognition but one of the purposes of my thesis was to examine the role of attentional allocation in the cross-race effect.

Proponents of the perceptual expertise model suggest that own-race faces will be recognized more accurately than other-race faces because people have more experience with them and, hence, more expertise for own-race faces (e.g. Kelly et al., 2005; Kelly et al., 2007; Michel et al., 2006; Pascalis et al., 2005; Valentine, 1991). Meanwhile, proponents of the social cognitive model propose that when faces are encoded, other-race faces (or out-group faces) are processed at a categorical level while own-race faces (in-group faces) are processed at the individual level (e.g. Hugenberg et al., 2007; Levin, 1996, 2000; Shriver et al., 2008). When expertise is controlled for (e.g. when participants view only own-race faces) categorizing an own-race face as an out-group member reduces recognition accuracy in comparison to the recognition accuracy for own-race, in-group faces (Bernstein et al., 2007), presumably because the out-group face is processed at a categorical level (i.e., ‘she is one of *them*’). Encoding a face at an individual level rather than a group level therefore aids in later recognition (e.g. Maclin & Malpass, 2001; Shriver et al., 2008). A third factor that may contribute to the cross-race effect is attentional allocation. Based on the literature, it seems that more attention is allocated to faces that are relevant to the individual (Rodin, 1987) (although this may be limited to neutral contexts, (see Ackerman et al., 2006 and Young & Hugenberg, 2012) and increased attention to certain faces aids in subsequent recognition (Lovén et al., 2012). The results of my research have implications for each of these approaches.

Perceptual Expertise

Perceptual expertise is an important factor in accurately recognizing a face. In Experiment 1, participants who were familiarized with sequentially presented faces had better recognition accuracy compared to participants who were familiarized with faces presented in arrays. In addition, the difference between own- and other-race recognition was largest when participants were familiarized with sequentially presented faces rather than faces presented in arrays. Based on those results it is apparent that having two seconds to learn faces maximizes the ability to recognize a face, and this was especially evident for own-race recognition accuracy. Because the same benefit was not apparent for other-race faces, *perceptually*, the process must be different. Participants were able to reap the benefits of time, but only for faces with which they had the most expertise.

This conclusion is further supported by the individual correlation data. In Experiment 2 there was no correlation between the own-race looking time advantage and the own-race recognition advantage. Again, this should lead one to consider that the amount of time spent observing faces is not what is crucial, but the encoding process is what is important. It is possible that in-group faces receive more attention, as predicted by the social cognitive model, but that differential attention may not underlie the own-race recognition advantage. At an individual level, the cross-race effect cannot be predicted by looking time meaning the key factor remaining is the individual encoding process. This is consistent with Ge et al.'s (2009) work demonstrating that the faster one is at recognizing an own-race face (i.e. the larger the own-race recognition advantage) the slower one is at categorizing of an own-race face (i.e. the larger the other-race categorization advantage) suggesting that the initial learning process is incredibly important in later recognition.

Future directions. In Experiment 2, typical methods of testing perceptual expertise were not used. To directly test whether expertise underlies the cross-race effect there are a few manipulations that could be used in the scene task. One way to measure expertise would be to evaluate markers of configural processing. Using the scenes, an inversion task could be used. In an inversion task, the faces in the scenes would be upside down. Inverting faces tends to disrupt both holistic processing and sensitivity to differences among faces in feature spacing (i.e., Collishaw & Hole, 2000; reviewed in Maurer et al., 2002; Yin, 1969); therefore, it would be expected that in a later recognition task, own-race face recognition would be more impaired by inversion than other-race face recognition (Sangrigoli & de Schonen, 2004) because own-race face learning relies on both featural spacing and holistic processing (Hayward et al., 2008; Michel et al., 2006).

Holistic processing could be evaluated by using a composite face task. In the study phase, participants would be shown one scene at a time, but would have a recognition task immediately after viewing the scene. The recognition task would include trials in which a face comprised the same upper half as one of the faces in the scene but a different lower half and trials in which the top half of the face was not from the scene. In some recognition trials the top and bottom half of the face would be aligned (involves holistic processing) whereas other trials would have the top and bottom half of the face misaligned (disrupts holistic processing). Participants would have to indicate whether or not the top half of that face was one of the faces from the scene. I would expect participants to do more poorly on the aligned trials than the misaligned trials for own-race faces (a pattern known as the composite face effect) with a smaller effect observed for other-race faces (Michel et al., 2006; reviewed in Mondloch et al., 2010). If the difference between participants' recognition accuracy on the aligned trials and the misaligned trials is larger for own-race faces than other-race faces, then these results would show that holistic processing was used during the learning phase for own-race faces but not (or at a reduced rate) for other-race faces (Michel et al., 2006).

Additionally, featural processing could be evaluated by showing participants scenes comprised of own- and other-race faces in the learning phase, and in the recognition phase, the face features would be presented in a scrambled fashion. Participants would have to respond whether or not that face had been seen before (e.g. Hayward et al., 2008; Schwaninger, Lobmaier & Collishaw, 2002). I would expect participants to do better on the scrambled task for own-race faces than other-race faces and this would demonstrate better own-race featural processing (e.g. Hayward et al., 2008).

Furthermore, sensitivity to feature spacing, another marker of expertise, could be evaluated by showing participants scenes comprised of own- and other-race faces and in the recognition task, faces would be blurred, effectively removing featural information and leaving only feature spacing information (e.g. Hayward et al., 2008; Schwaninger et al., 2002). Participants would have to indicate whether or not the blurred face had previously been seen. It would be expected that participants would have better own-race recognition accuracy than other-race recognition accuracy (e.g. Hayward et al., 2008; Mondloch et al., 2010) thereby demonstrating better sensitivity to featural spacing for own-race faces than other-race faces.

One caution that must be mentioned, however, is that performance on these tasks may reach floor effects when faces are presented in scenes; in all previous studies testing these markers of expertise, faces were presented sequentially. In the sequential-sequential task from Experiment 1, own-race face recognition accuracy was very high. Similarly, when tasks evaluating configural and featural processing are used, participants learn one face at a time. Recognition accuracy in both the array task from Experiment 1 and the memory task from Experiment 2 were much lower than expected for both own- and other-race faces and this is a task where only normal, upright faces were used in both the familiarization and testing phases. Therefore, if faces in the familiarization and testing phases were manipulated (e.g. blurred or inverted) recognition accuracy would decrease even further and could result in floor effects for both own- and other-race recognition accuracy. Although providing a test immediately after presenting each scene should improve recognition accuracy, if accuracy is very poor it may indicate that participants only display perceptual expertise when learning faces one at a time; however, until a study is performed combining scenes and holistic processing, it is unknown whether these same processes are utilized when encoding multiple people in complex scenes.

Social Cognition

In terms of the social cognitive models, it was expected that own-race faces would be attended to more than other-race faces and that the cross-race effect would be largest in the array task from Experiment 1 and the impressions task from Experiment 2. Both of these tasks had complex stimuli for the learning phases meaning there was competition for participants' attention. It was expected that participants would individuate own-race faces first and then very quickly categorize other-race faces (Ge et al., 2009; Levin, 1996). Additionally, based on Rodin's (1987) study, it was hypothesized that participants would spend less time on other-race faces than own-race faces.

Based on the results of Experiments 1 and 2 of the current study, there is partial support for the social cognitive model. More attention was given to own-race faces than other-race faces in Experiment 2 and own-race faces were recognized more accurately than other-race faces in the complex array task in Experiment 1 and the impressions group in Experiment 2.

However, many aspects of the social cognitive model were not supported by the data in Experiments 1 and 2. The social cognitive model predicts that own-race faces would be preferentially attended to and other-race faces would be disregarded (Rodin, 1987). Although own-race faces were preferentially attended to, other-race faces were by no means disregarded. In the sequential-sequential recognition task, participants were given 2 seconds to learn each face regardless of race. In the impressions group from Experiment 2 (where other-race disregard was expected to be greatest) each other-race face received approximately 3.11 seconds of looking time, which is even longer than the sequential familiarization phase from Experiment 1. Nonetheless, the mean other-race d' value for the impressions group was 0.58, identical to the d' value in the sequential-sequential task. Therefore, it seems that spending more time on other-race faces when not instructed to remember the face does not influence other-race recognition accuracy.

The social cognitive model also predicts that the cross-race effect would be larger in the array-array task than in the sequential-sequential task in Experiment 1 and larger in the impressions group than the memory group in Experiment 2 of the current study. However, when comparing the magnitude of the cross-race effect in the array familiarization method and the sequential familiarization method, the largest difference was in the sequential familiarization method, and when comparing the magnitude of the cross-race effect in the memory and impressions tasks, there was *no* difference. Overall, the largest cross-race effect was actually found when participants learned faces sequentially in Experiment 1—the task that was expected to result in the smallest cross-race effect! Due to the difficulty of the array task I expected lower performance, but not to such the extent observed. The results of the array-array group in Experiment 1 and both groups of Experiment 2 suggest that recognition of faces—even when own-race faces are expected to be individuated—is actually not that accurate when faces are presented in the context of complex scenes or stimulus arrays. However, there was still a reliable cross-race effect for every group that was tested in both Experiments 1 and 2.

Furthermore, the social cognitive model predicts that increased attention correlates with better recognition accuracy (e.g. Lovén et al., 2012). When the amount of time spent looking at faces and recognition accuracy are examined, it is only evident at an *overall* level that both increased looking time and higher recognition accuracy are evident for own-race faces. Individual differences in the magnitude of the cross-race effect were not correlated with individual differences in own-race looking time advantages. This pattern of results is similar to that observed in a similar scene task being conducted in the Face Perception lab; that task is comprised of young adult faces and older adult faces—

another out-group. The young-adult bias is evident in that the young adult sample tends to allocate more attention to young adult faces *and* remember those faces better (Short, Proietti, Semplonius & Mondloch, 2013). Just like the results in Experiment 2, there was no correlation between young adult looking time advantages and the young adult recognition advantage at the individual level (Short et al., 2013). This should lead one to consider that the amount of time spent observing faces is not what is crucial, rather, the initial encoding process is what is important for determining the accuracy with which a face is likely to be recognized.

Overall, even though other-race faces were not disregarded, the lack of correlation between own-race looking time bias and own-race recognition advantage suggests that the cross-race effect cannot be predicted only by looking time, especially at an individual level. Rather, the cross-race effect is also due to the level of processing (see Hayward et al., 2008; Mondloch et al., 2010; see *Perceptual Expertise above*).

Limitation and future directions. A limitation and potential area for future research is the manner in which the scenes in Experiment 2 were made. Although combining own- and other-race faces in Hirose and Hancock's (2007) study was effective for the Caucasian participant sample, it may be that in Experiment 2, combining races in the scenes mitigated the difference between scanning behaviour and recognition accuracy for own- and other-race faces. When faces of different races are presented in a block design, the cross-race effect tends to be larger than the effect in a mixed design (reviewed in Meissner & Brigham, 2001). Therefore, using a blocked design for the scene task may result in a larger cross-race effect than the mixed design used in Experiment 2 of the current study. Follow-up studies could be done in which each scene is comprised of only one face race. Doing so would help to evaluate whether or not the faces in scenes containing own-race faces are allocated more time and attention while the faces in scenes containing other-race faces are allocated less time and attention. If the faces from scenes comprised of only other-race faces were recognized to an even lesser extent than the faces in the mixed design scene task in Experiment 2, then other-race faces may be categorized to a greater extent in the blocked design.

Alternatively, if both own- and other-race faces present in the stimuli are in contact with each other (i.e., portrayed as friends or acquaintances) this may reduce the magnitude of the cross-race effect even more. The current study did not use a blocked design as both own- and other-race faces were present in each scene. However, the people in the scenes were not necessarily interacting with each other. There were some instances where couples were holding hands, but as the stimulus faces were all looking straight at the camera any possible interactions seem disrupted. New versions of these scenes could be created in which interactions between own- and other-race faces are fairly obvious. Having scenes in which both own- and other-race people are obviously interacting may mitigate the difference between own- and other-race recognition.

A second change that would be possible for the scenes in Experiment 2 would be to manipulate the context in which faces are learned. Following studies by Shriver et al. (2008) and Bernstein et al. (2007) manipulating in- versus out-group status by presenting faces in contexts depicting wealth or poverty or by presenting individuals as teammates versus opponents may influence recognition accuracy—especially for own-race faces. If these effects are evident in tasks in which only single faces are presented to the participants the effects may be magnified by a task in which participants learn multiple faces at a time. The first step of manipulating scene context would be to use only own-race faces in order to match expertise and evaluate whether changing the context of a scene containing multiple own-race faces alters own-race face recognition accuracy and looking patterns.

Because recognition accuracy could be influenced by either increased attention to in-group faces (social cognition) or perceptual expertise, the results of this study would help tease apart the underlying process. If the underlying mechanism is social cognition, then in-group, own-race faces would be looked at longer *and* recognized more accurately than the out-group, own-race faces. However, if the underlying mechanism is perceptual expertise, then in-group, own-race faces may be looked at for longer periods of time, but recognition accuracy for both in-group and out-group own-race faces would be equally accurate.

These results would address the surprising lack of correlation between individual differences in the magnitude of the cross-race effect and individual differences in own-race looking time biases which suggests that recognition of own- and other-race faces is dependent on individual differences in expertise and is independent of the differences in attentional allocation. If this is the case, then social cognition has no relationship to the cross-race effect. However, as own-race faces are still attended to more than other-race faces, there must be an explanation for the behaviour reported in multiple tasks. Perhaps when expertise is matched (e.g. the future directions experiment mentioned above) looking time would then correlate with recognition accuracy.

A second way this issue could be evaluated would be to examine each individual face in Experiment 2 and correlate the amount of time spent on that face to the recognition accuracy of that face for each participant. Although this analysis was not performed in the current study, it would lead to some insight into whether actual looking time at a specific face does, in fact, increase recognition accuracy of that face later on.

Attention

DeAngelus and Pelz (2009) and Kaakinen et al. (2011) found that when participants were asked to take a certain perspective (i.e., by being told they would need to answer specific questions about the stimuli or to view stimuli from a homebuyer/burglar's perspective) participants attended to whatever was most relevant to the situation. Similarly in Experiment 2 of the current study, the impressions group spent more time on bodies and objects than the memory group, but also spent less time on faces than the memory group. This is evidence that the task instructions used in Experiment 2 of the current study did work.

Using the complex scene stimuli in Experiment 2 allowed me to further the results that were presented in Birmingham et al.'s (2008a, 2008b) studies. Rather than simple scenes comprising one or three people sitting in a room, the scenes in the current study contained four or six people who were walking on city streets or were engaged in an activity. Like the participants in Birmingham et al.'s studies, faces received attentional priority. In Experiment 2 of the current study, even when faces only comprised 16% of the scenes overall (8% for both own- and other-race faces), the memory group spent 51.2% of the total available time looking at faces and the impressions group spent 32.7% of the total available time looking at faces.

Although faces received more attention than other components of the scenes, that allocation of attention was not equal across face categories. Overall, own-race faces received more visits than other-race faces and participants spent more time fixating own-race faces compared to other-race faces; these findings are consistent with Lovén et al. (2012). It was surprising that the memory group did not allocate attention equally across own- and other-race faces. Even though the instructions given meant that participants had to remember every face *regardless* of race, more attention was still given to own-race faces despite the case that one likely needs to devote more time towards other-race faces in order to later recognize them later on.

A strength of Experiment 2 is that there is no doubt that the task instructions worked because there was a difference in scanning patterns between the memory and impressions groups. These results demonstrate that the failure to allocate attention to other-race faces was not because the instructions did not work; rather, participants simply did not look at other-race faces as much as own-race faces.

Limitation and future directions. One limitation and a potential direction for future research would be to assess the level of participants' motivation to appear non-prejudiced. Bean et al. (2012) gave participants a questionnaire in which they assessed whether each participant was high or low in external motivation to appear unprejudiced. After the questionnaire participants took part in a learning task in which they were shown faces or objects displayed individually. In the recognition task, participants were shown pairs of images on an eyetracker and were instructed to indicate which images were familiar. Bean et al. (2012) found that participants who were high in external motivation to not appear prejudiced tended to look at other-race faces first in comparison to own-race faces when completing the surprise recognition task. However, Bean et al. (2012) did not report any results about the recognition accuracy—only the scanning pattern data was published. The participants in Bean et al.'s (2012) study were shown only one image in the learning phase, but if the participants had been shown multiple faces at a time (e.g. the complex arrays from Experiment 1 or the scenes from Experiment 2) I would expect that they would show the same looking trend. However, I do not think that this attention would benefit in later recognition. Even though the participants would be motivated to look at the faces this does not necessarily mean they would have equal accuracy for own- and other-race faces. This is the case in Experiment 2 of the current study as the memory group was motivated to remember other-race faces but still performed at lower levels than own-race face recognition.

Implications

The results from both Experiments 1 and 2 of the current study have implications for general face recognition in a laboratory setting and in everyday life in addition to important links with eyewitness testimony and false incarcerations.

Face recognition in the lab. The results of this series of experiments demonstrate that when using a traditional recognition task (sequential familiarization and testing) in the lab, the magnitude of the cross-race effect may be overestimated because own-race faces are recognized with much greater accuracy when presented sequentially than when they compete for attention with other stimuli. The results from these experiments demonstrate that recognition accuracy tends to be highest when participants are given two full seconds to learn a face (sequential learning in Experiment 1) or when specifically told to remember a face (memory group in Experiment 2). The results from Experiment 2 are consistent with Hugenberg et al. (2010) and Young and Hugenberg's (2012) finding that motivation to remember a face aids in recognition. However, in the absence of explicit instructions to remember a face, recognition accuracy was poor for both own- and other-race faces. Although each task group in Experiments 1 and 2 did display an own-race advantage, the advantage was smaller when faces were presented in the complex arrays or scenes. Perhaps when there is competition for attention the advantage of processing own-race faces quickly and efficiently is, to some extent, lost. Therefore, in a typical lab recognition task, the ability to recognize an own-race face is maximized when only one face must be learned at a time and the ability to recognize faces in general increases when instructions explicitly state that the task is a memory task.

Following Hugenberg et al.'s (2010) logic, recognition of faces presented in a complex arrays may be even better than what I observed in the memory group if the faces being learned were socially meaningful. In fact, Hugenberg et al. (2010) state that when motivation to individuate other-race faces is high, the cross-race effect is reduced and sometimes even eliminated. Therefore, if you are motivated to create a personal relationship with someone, this may increase the ability to recognize the person in a different context later on. Tasks could tap into this by increasing the motivation to remember a face. A way this could be done is to create a game in which participants are shown faces (both own- and other-race faces) and half of the faces are teammates while the other half is the opposing team. Participants would have to play a game that would involve some "interaction" with the teammates and after the game would be given a surprise memory task. Because motivation to recognize teammate faces would be high *and* the faces would be socially meaningful, both own- and other-race face in-group recognition accuracy may be more accurate than own- and other-race out-group recognition accuracy, although own-race in-group recognition accuracy may be higher than other-race in-group recognition accuracy. This type of game setup would simulate an event that could occur in everyday life but the surprise memory task would help evaluate the extent of face processing that occurs naturally.

Face recognition in everyday life. Following the results from the complex array tasks in Experiment 1 and the impressions group from Experiment 2, recognition accuracy for faces, regardless of race, may be poor in general. In everyday life, not only do we come into contact with multiple faces at a time, but the people whose faces we see are moving either towards or away from us, possibly speaking, turning side to side and other peripheral features with identifying information (e.g. clothes and hairstyle) change. All of these factors bring forth further difficulties in later recognition. Consequently, not only may we be poor at recognizing faces in general, recognition in everyday life could be even worse than what is found with the complex stimuli from Experiments 1 and 2.

However, Hugenberg et al. (2010) suggest that motivation—especially when socially meaningful—may aid in later recognition. Therefore, if one works in a job setting with people of multiple races, motivation to recognize co-workers would be incredibly high, thereby aiding in subsequent recognition of the individual. However, while motivation may increase recognition for other-race faces, theoretically the same increases should be evident for own-race faces—the only constraint to the increase in recognition for other-race faces is perceptual expertise, so perhaps motivation is still limited in regards to increasing recognition accuracy.

Eyewitness testimony. Much of the eyewitness literature has suggested that there is an advantage to using sequential lineups in contrast to simultaneous lineups (i.e., Clark & Davey, 2005; Malpass, 2006). This has typically been based on the fact that simultaneous lineups tend to induce *relative judgments* (Wells, 1984) from participants. In other words, people compare between the available faces who looks the most like who committed the crime, while sequential lineups use *absolute criterion* (is this individual person the perpetrator of the crime or not?; Clark & Davey, 2005; Lindsay & Wells, 1985). However, the success of sequential versus simultaneous correct identification differs depending on whether or not the guilty suspect is actually *in* the lineup. Malpass (2006) suggests that only when one is at least 50% sure that the criminal is in the lineup are simultaneous lineups better than sequential lineups. Lindsay and Wells (1985) and Carlson, Gronlund and Clark (2008) found that there was no difference between the false alarm rates in sequential and simultaneous lineups when the lineups are fair (i.e, innocent suspects do not stand out, Carlson et al., 2008) or when the perpetrator of the crime is definitely in the lineup (Lindsay & Wells, 1985).

One further construct to be aware of is the instructions participants received. Malpass & Devine (1981) found if participants received biased instructions (i.e., they had to choose someone from the lineup) 100% chose a suspect when the vandal was present and 78% of participants chose a suspect when the vandal was not present. However, Malpass and Devine (1981) found that if participants received un-biased instructions (i.e., the vandal may or may not be present) participants were much more conservative in their responses. Therefore, it seems that all things being equal, the outcomes of the simultaneous and sequential lineups do not seem to differ. What matters is the composition of the lineup (e.g. whether or not the guilty suspect is actually present) and whether participants are aware of this or not (e.g. what instructions were they given).

Taking into consideration our poor recognition for both own- and other-race faces in the lab setting (as demonstrated in Experiment 1 of the current study) and, potentially, in everyday life, there are definite implications for eyewitness testimony. The impressions group in Experiment 2 gave the closest approximation of recognition accuracy performance for eyewitness testimony. Typically when someone witnesses a crime they do not encounter the perpetrator of the crime with the intent of having to later recognize that person (the crime would not be an expected event). Therefore, the impressions group with the surprise memory task best mimics eyewitness testimony.

The impressions group from Experiment 2 demonstrates that own-race face recognition accuracy is better than other-race recognition accuracy. Additionally, Experiment 2 results show that detailed memory for own-race faces is better than the detailed memory for other-race faces. Therefore, not only is general recognition better due to fewer false alarms for own-race faces than other-race faces, but participants were better able to place own-race faces in the context in which they learned the face. Based on these results, during eyewitness testimony, more other-race suspects may be falsely accused as perpetrators of a crime in addition to being falsely placed into a context in which they never were.

One way to reduce the amount of false alarms for other-race faces was provided in Experiment 1. Participants' responses biases tended to be less conservative when familiarized and tested with sequentially presented faces. However, for participants who learned faces in arrays, this less conservative response bias was seen only for other-race faces when participants recognized faces that were presented sequentially. Therefore, in terms of eyewitness testimony if reducing the amount of false incarcerations is key, it would be most beneficial to have eyewitnesses recognize an other-race perpetrator of a crime from a lineup comprising multiple people rather than from an individual presentation of people. In Wilson, Hugenberg and Bernstein's (2013) review paper, they state that eyewitness lineups do tend to be performed with suspects being presented individually rather than in a group.

Lindsay and Wells (1985) found that participants who identified suspects in sequential lineups had lower false alarm rates. The results of Experiment 1 of the current study demonstrated that when faces were learned and recognized with the sequential presentation method, there were more false alarms than when faces were recognized in arrays. However, when participants learned faces in arrays and were tested with sequentially presented faces, there were more false alarms for other-race faces than own-race faces. However, there were some task differences between the current study and Lindsay and Wells' (1985) study. The recognition arrays used in both Experiments 1 and 2 of the current study always contained faces that had been previously seen while Lindsay and Wells' (1985) lineups did not always contain the perpetrator of the crime. Additionally, Lindsay and Wells (1985) only had one suspect whereas participants in Experiment 1 of the current study were attempting to recognize 32 faces in total. It may be that the difference in strategy when responding to faces was due to the fact that the amount of faces trying to be remembered differed between the two studies and recognition strategies were different.

Evaluating the best method of eyewitness testimony is not the purpose of the current set of studies, but there are definitely still some connections to the eyewitness literature. The eyewitness testimony field seems to be quite mixed in terms of which methodology is most effective in terms of accurate recognition so more research should be conducted in this area. However, based on the results of Experiments 1 and 2 of the current study, the recognition methodology that should result in the more conservative approach to responses biases and fewer false alarms (or false incarcerations) would be to have participants recognize the face or person in simultaneous lineups. As real life would more closely emulate the array familiarization (rather than the sequential familiarization method), the most interesting question is how accurately participants recognized faces after being familiarized with faces in arrays. The results of Experiment 1 showed that testing with arrays after learning faces in arrays results in similar false alarm rates and response biases for own- and other-race faces. In contrast, testing with sequentially presented faces after learning faces in arrays results in more false alarms and more liberal responses biases for other-race faces in comparison to own-race faces. Based on these findings, it seems that the best testing strategy would be to use a simultaneous lineup so that responses biases will be similar for both own- and other-race faces.

Summary

It is a widely held belief that faces are “special” and are recognized with remarkable accuracy. These experiments call that view into question—at least when people learn faces from complex stimuli and are not instructed to remember the faces. Although participants can accurately identify faces, the *d′* values that resulted from learning faces in complex arrays and scenes were incredibly low—much lower than what is typically seen in the face perception literature. Overall, then, it seems that when attention is divided amongst multiple stimuli face recognition is quite poor and this is especially evident when participants were not told to remember the faces and when faces belong to individuals of a different ethnicity. Nonetheless, the well-established other-race effect was seen under these new task conditions. Own-race faces received more attention than other race faces and own-race recognition was still higher than other-race recognition regardless of the task participants were given. This finding demonstrates that the cross-race effect is still a robust finding in the lab even when complex stimuli are utilized to examine this prevalent phenomenon.

The novelty of both Experiments 1 and 2 of the current study emulate, to some extent, real world conditions. By extrapolating on these findings, it may be even more evident that in the *actual* real world, recognition would be very poor, especially for other-race faces during eyewitness testimony.

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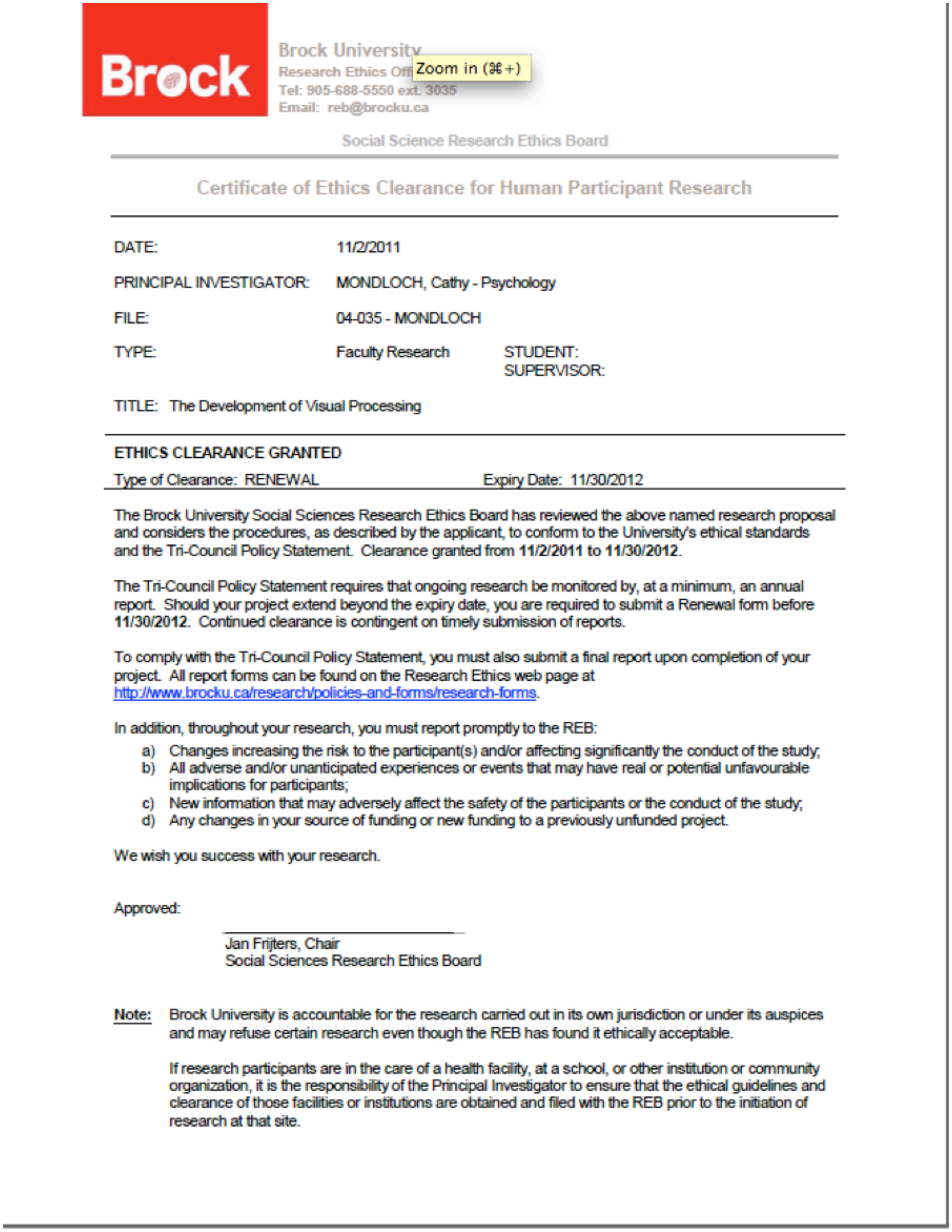
Appendix 1



Brock University
Research Ethics Off
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Social Science Research Ethics Board

Certificate of Ethics Clearance for Human Participant Research

DATE:	11/2/2011		
PRINCIPAL INVESTIGATOR:	MONDLOCH, Cathy - Psychology		
FILE:	04-035 - MONDLOCH		
TYPE:	Faculty Research	STUDENT: SUPERVISOR:	

TITLE: The Development of Visual Processing

ETHICS CLEARANCE GRANTED

Type of Clearance: RENEWAL Expiry Date: 11/30/2012

The Brock University Social Sciences Research Ethics Board has reviewed the above named research proposal and considers the procedures, as described by the applicant, to conform to the University's ethical standards and the Tri-Council Policy Statement. Clearance granted from **11/2/2011 to 11/30/2012**.

The Tri-Council Policy Statement requires that ongoing research be monitored by, at a minimum, an annual report. Should your project extend beyond the expiry date, you are required to submit a Renewal form before **11/30/2012**. Continued clearance is contingent on timely submission of reports.

To comply with the Tri-Council Policy Statement, you must also submit a final report upon completion of your project. All report forms can be found on the Research Ethics web page at http://www.brocku.ca/research/policies-and-forms/research-forms.

In addition, throughout your research, you must report promptly to the REB:

a) Changes increasing the risk to the participant(s) and/or affecting significantly the conduct of the study;
b) All adverse and/or unanticipated experiences or events that may have real or potential unfavourable implications for participants;
c) New information that may adversely affect the safety of the participants or the conduct of the study;
d) Any changes in your source of funding or new funding to a previously unfunded project.

We wish you success with your research.

Approved:

Jan Frijters, Chair
Social Sciences Research Ethics Board

Note: Brock University is accountable for the research carried out in its own jurisdiction or under its auspices and may refuse certain research even though the REB has found it ethically acceptable.

If research participants are in the care of a health facility, at a school, or other institution or community organization, it is the responsibility of the Principal Investigator to ensure that the ethical guidelines and clearance of those facilities or institutions are obtained and filed with the REB prior to the initiation of research at that site.

Appendix 2

BACKGROUND QUESTIONNAIRE

Name: ……………………………..….

What is your ethnicity?

Caucasian ☐
Chinese ☐
Eurasian ☐
Aboriginal ☐
Other ________☐
__*(please describe)*

In which country were you born? ………………
How long have you been in the country you are living in now? ………………..
Please list all the countries you have lived in, the length of time in each and your approximate age while you were living there.

Location	**Duration (approx)**	**Your Age when there (approx)**
……………………	……………………	……………………
……………………	……………………	……………………
……………………	……………………	……………………
……………………	……………………	……………………

In which country was your biological mother born? …………………………..
What is her ethnicity? …………………………..
In which country was your father born? …………………………..
What is his ethnicity? …………………………..

Do you have any other relatives who are members of other ethnic or racial groups?
(by birth or by marriage?) **Y \ N**
If so, please list:

Their Ethnicity	**Relationship to you (aunt, cousin etc)**	**By Birth/ Marriage**	**How often do you see them**			
			Weekly	***Monthly***	***Yearly***	***Less than Yearly***

Have you ever lived with people from other ethnic groups? **Y \ N**
If so, please list:

Their Ethnicity	**Length of cohabitation**	**Your age when you moved in with them (approximately)**
……………	………………………………	……………………………………………
……………	………………………………	……………………………………………
……………	………………………………	……………………………………………
……………	………………………………	……………………………………………
……………	………………………………	……………………………………………

In the following section, we would like you to indicate how well the following statements represent the type of interactions you have with Asian and White/Caucasian people. Please indicate the extent to which each statement represents **your** interactions by circling the number which best represents your opinion.

Scoring key:

Very strongly Disagree	Strongly Disagree	Disagree	Agree	Strongly Agree	Very strongly Agree
1	**2**	**3**	**4**	**5**	**6**

1. I know lots of Asian people……………………………***1 2 3 4 5 6***
2. I interact with White/Caucasian people during recreational periods………………………………………………………***1 2 3 4 5 6***
3. I live, or have lived in an area where I interact with White/Caucasian people……………………………………………………***1 2 3 4 5 6***
4. I live, or have lived in an area where I interact with Asian people……………………………………………………***1 2 3 4 5 6***
5. I interact with Asian people during recreational periods…………… ………………………………………………………***1 2 3 4 5 6***
6. I interact with White/Caucasian people on a daily basis ………………………………………………………***1 2 3 4 5 6***
7. I socialise a lot with White/Caucasian people ………………………………………………………***1 2 3 4 5 6***
8. I went to a high school where I interacted with Asian students……………………………………………………***1 2 3 4 5 6***
9. I socialise a lot with Asian people ………………………………………… ……………………………………………………***1 2 3 4 5 6***

10. I know lots of White/Caucasian people……………………..
……………………………………………………….***1 2 3 4 5 6***

11. I interact with Asian people on a daily basis………………………
………………………………………………………***1 2 3 4 5 6***

12. I went to a high school where I interacted with White/Caucasian students……………………………………………***1 2 3 4 5 6***

Think of up to 10 friends with whom you spend the most time. Of these 10 friends, how many are Caucasian? _______
How many are Chinese? _______
How many are any other race outside of Caucasian and Chinese? _______

Indicate your response by marking the point on the scale.

Please rate your amount of interaction with White/Caucasian individuals in this country.

1 ***Little or none***	**2**	**3**	**4**	**5**	**6**	**7** ***A lot***

Please rate your amount of interaction with Asian individuals in this country.

1 ***Little or none***	**2**	**3**	**4**	**5**	**6**	**7** ***A lot***