

**INFLUENCES OF CATEGORICAL PROCESSING ON CROSS-CATEGORY
FACE RECOGNITION DEFICITS**

MICHELLE ANNE CORCORAN
Bachelor of Arts (Hon.), McMaster University, 2005

A Thesis
Submitted to the School of Graduate Studies
of the University of Lethbridge
in Partial Fulfillment of the
Requirements for the Degree

MASTER OF SCIENCE

Department of Psychology
University of Lethbridge
LETHBRIDGE, ALBERTA, CANADA

© Michelle Anne Corcoran, 2009

Abstract

The influence of categorisation on recognition memory was explored in the context of two prominent effects in the memory literature: the other-race effect and the other-sex effect. It is proposed that both effects may share similar underlying mechanisms. Consistent with social categorisation perspectives that emphasise the use of individuation and categorisation processes, both the other-race effect and the other-sex effect were modulated as a result of a categorisation manipulation that emphasised either the race category or the sex category. The results lend support to the use of individuation and categorisation processes in both effects confirming the notion that the other-race effect and the other-sex effect seem to share some similar underlying mechanisms. Processes of individuation and categorisation may be representative of a more general memory phenomenon that may be able to account for recognition performance of other major visual categories of faces in addition to the other-race effect and the other-sex effect.

Acknowledgments

First and foremost I would like to express the greatest thanks to my supervisor, Dr. John R. Vokey. John, you have inspired me in ways that words can never express. You introduced me into a skeptical world where nothing can be taken at face value. I have learned far more than simply what is held in the scope of my thesis and I am forever thankful for it. You are a person that I have never stopped looking up to and are a true mentor.

I have always looked forward to our intense conversations that ultimately end in yet another interesting book being thrown in my face. You taught me a new level of independence and showed me that figuring things out for yourself was worth more than anything anyone could ever tell you. I am particularly grateful that you nurtured my independence and gave me the academic freedom to make my own decisions. You were always there to help, but always gave just the right amount so as to let me figure things out for myself and learn from my own mistakes. If I could become equipped with even half of the knowledge, skills, discipline, kindness and professionalism that you exhibit on a daily basis, I would have met my goals as a scientist. Most of all, I am truly honoured to have been able to work with you on my Masters project and look forward to any future work we might do as our work is definitely not finished, but only beginning.

I would also like to thank the members of my committee: Dr. Scott Allen and Dr. Andrew Hurly. Scott, I'd like to thank you for the vast amount of help and advice you have given me along the way. You have an extremely warm approach when it comes to helping students and I always felt comfortable walking into your office. Most importantly, I always appreciated the kind ear and nice suggestions when I just wanted to organise my thoughts.

Andy, I have always been inspired by your ability to reason around things and bring new ideas to the table. You have always provided me with insightful comments on my research that were from a different angle than I normally look at things.

Special thanks to Dr. Drew Rendall who has been a significant role model as I went about my studies. Drew, I am astonished by your intelligence and the care you put forth in trying to create the best academic environment for students. I sincerely appreciate all of the support you have given me over the last few years. I would also like to extend my thanks to Dr. Louise Barrett and Dr. Peter Henzi for their support since their arrival as well as to Dr. Martin Lalumiere, Dr. Paul Vasey and Dr. Gail Hepburn. In addition, I'd like to thank Leanne Wehlage-Ellis for being the one to turn to if I needed help with pretty much anything concerning matters of the department.

My thanks to Shannon Digweed who has given me a tremendous amount of support throughout the making of this thesis. Shannon, words cannot express how much your unconditional support over the years has meant to me. I wish to thank my other fellow graduate students John Granzow, Nicola Forshaw, Sandeep Mishra, Kelly Suschinsky and Doug Vanderlaan for their continuing support.

I'd like to thank Christine Johnson for all the support she has given me, both personal and professional, throughout the making of this thesis. You truly have been my "Lethbridge Mom" and have touched my heart. You are one of the most beautiful people that I know.

I'd also like to thank Christopher Vokey and Megan Torry for being two exceptional friends who have always been there for me whenever I needed them and always gave me an excuse to get away from work. My thanks also go out to Valarie Gibbons, Sema Sali and Tom Corrigan. Finally, I would like to thank my parents, Joe and Martha Corcoran, for doing more throughout the years than any parent really needs to do. I am forever grateful to you both for supporting me through everything and anything.

Contents

Approval/Signature Page	ii
Abstract	iii
Acknowledgments	iv
Table of Contents	vi
List of Tables	viii
List of Figures	ix
1 Introduction	1
1.1 Introduction to the Other-Race Effect	2
1.2 Testing the ORE	3
1.3 Statistical Measures of the ORE	4
1.3.1 Signal Detection Analyses	6
1.4 Overview of ORE Explanations	7
1.4.1 Experiential Hypotheses	8
1.4.2 Social Categorisation Hypotheses	9
2 ORE Replication	11
2.1 Experiment 1: ORE Replication	11
2.1.1 Methods	12
2.1.2 Results	14
2.1.3 Discussion	17
2.2 Experiment 2: Effects of Changing Photographs	19
2.2.1 Methods	20
2.2.2 Results	21
2.2.3 Discussion	24
3 ORE Explanations	26
3.1 Experiential Hypotheses	26
3.1.1 Contact Hypothesis	26
3.1.2 Developmental Contact Hypothesis	28
3.1.3 Configural Processing	29
3.1.4 Face Space	30
3.2 Social Categorisation Models	34
3.2.1 Feature-Selection Hypothesis	35

4	Context Effects	37
4.1	Experiment 3: Influence of Context	37
4.1.1	Methods	38
4.1.2	Results	39
4.1.3	Discussion	43
5	Race Categorisation	46
5.1	Experiment 4: Influences of Categorisation	46
5.1.1	Methods	47
5.1.2	Results	48
5.1.3	Discussion	50
6	Other-Sex Effect	54
6.1	Experiment 5: Other-Sex Effect Replication	54
6.1.1	Methods	55
6.1.2	Results	56
6.1.3	Discussion	59
6.2	Experiment 6: Sex Categorisation	60
6.2.1	Methods	61
6.2.2	Results	62
6.2.3	Discussion	64
7	General Discussion	71
	Bibliography	84
	References	84

List of Tables

2.1	Mean hit and false alarm rates for Caucasian and Asian photographs for both Caucasian and Asian participants in Experiment 1.	14
2.2	Mean hit and false alarm rates on Caucasian and Asian photographs by Caucasian participants when photographs are changed between study and test.	21
4.1	Mean hit and false alarm rates on Caucasian and Asian photographs by Caucasian participants under the context manipulation. Error bars indicate mean standard error.	40
5.1	Mean hit and false alarm rates on Caucasian and Asian photographs by Caucasian participants when categorising on the basis of race during study.	48
6.1	Mean hit and false alarm rates for Male and Female photographs for both Male and Female participants in Experiment 5.	56
6.2	Mean hit and false alarm rates for Male and Female photographs for both Male and Female participants in the sex categorisation experiment.	62

List of Figures

2.1	Mean receiver-operating characteristic (ROC) hit and false-positive values derived from confidence judgements and the corresponding fitted ROC curves (assuming equal-variance, Gaussian distributions) for each race (Caucasian vs. Asian) of participant as a function of the same (SR) or other (OR) race of the photograph in Experiment 1.	16
2.2	Recognition memory performance, measured in A' , for Caucasian and Asian photographs by Caucasian and Asian participants in Experiment 1. Asterisks indicate a significant result. Error-bars within-cell standard errors. . . .	18
2.3	Mean receiver-operating characteristic (ROC) hit and false-positive values derived from confidence judgements as well as the corresponding fitted ROC curves (assuming equal variance, Gaussian distributions) depicting recognition for both same- and other-race faces as a result of changing the photos between the study and test phases of Experiment 2.	22
2.4	Recognition, A' , for Caucasian participants on both Caucasian and Asian photos when the photograph of each individual presented in the study phase changes between the study and test phases of the experiment. Error-bars are within-cell standard errors.	23
3.1	The proposed distributions of same-race (SR) and other-race (OR) faces within a predominantly same-race face space. Other-race faces are projected within a predominantly same-race face space in a dense distribution.	33
4.1	Mean receiver-operating characteristic (ROC) hit and false-positive values derived from confidence judgements as well as the fitted ROC curves (assuming equal-variance, Gaussian distributions) as a function of race (Caucasian vs. Asian) of photo for the current context experiment as well as the ROC values and corresponding fitted ROC curves from the ORE replication experiment for comparison.	41
4.2	Recognition, measured in A' , from the ORE replication experiment (left) for comparison with the results from the current context experiment (right) plotted as a function of race of the photograph (Caucasian vs. Asian). Error-bars are within-cell standard errors.	42
5.1	Mean receiver-operating characteristic (ROC) hit and false-positive values derived from confidence judgements and the corresponding fitted ROC curves (assuming equal-variance, Gaussian distributions) plotted as a function of experiment type (categorisation vs. ORE replication) for each race (Caucasian vs. Asian) of photo.	49
5.2	Recognition, A' , for Caucasian participants from both the ORE replication experiment (left) and the current race categorisation experiment (right) on same- and other-race photos. Error-bars are within-cell standard errors. . . .	51

6.1	Mean receiver-operating characteristic (ROC) hit and false-positive values derived from confidence judgements and the corresponding fitted ROC curves (assuming equal-variance, Gaussian distributions) plotted as a function of sex of participant (male vs. female) for both same- and other-sex photos.	57
6.2	Recognition, A' , for male and female participants on both male and female photos using a recognition memory task. Data are collapsed for race. Error-bars are within-cell standard errors.	58
6.3	Mean receiver-operating characteristic (ROC) hit and false-positive values and the corresponding fitted ROC curves (assuming equal-variance, Gaussian distributions) as a function of sex of participant (male vs. female) for same- and other-sex photos with the categorisation manipulation introduced.	63
6.4	Recognition, A' , for male and female participants on both male and female photos using a categorisation task within the recognition memory paradigm. Data are collapsed for race. Error-bars are within-cell standard errors.	65
6.5	Recognition, A' , for Caucasian and Asian photographs under the sex categorisation manipulation. Error-bars are within-cell standard errors.	66

Chapter 1

Introduction

Face recognition plays a crucial role in the ability of individuals to navigate their social environment. Interactions with peers and the ability to associate a particular face with an individual are crucial to upholding a social structure largely dependent upon the ability to recognise individuals. Indeed, disorders marked by an inability to recognise faces, specifically prosopagnosia, are also marked by significant social impairments (Bodamer, 1947).

Learning new faces is a task that can occur as often as every day. Upon onset of a particular face, face recognition requires making a decision about whether that face was previously experienced or not. The ability of humans to recognise faces is rather remarkable given the sheer number of faces that an individual must recognise in a lifetime.

All faces share the same basic structure and configuration: two eyes, nose, mouth, etc. Recognition of individual faces cannot be based solely upon these macro-features because information common to many faces will not suitably allow for discrimination between individual faces. For example, encoding the eye as a visual feature for face recognition will not help differentiate Bob from Tom, as they both have eyes. Eye colour may be used to differentiate Bob from Tom, but again, this feature is useless if both Bob and Tom have brown eyes. Face recognition mechanisms must make use of more subtle differences between faces in order to differentiate one face from all other previously learned faces.

Face recognition is mediated by the social environment of which individuals are a part. Individuals often parse faces, by specific features, according to different social groups, and exhibit recognition differences between socially-defined groups. One such example involves the category of race. People have the general tendency to recognise faces of their own race better than faces of another race (Cross, Cross, & Daly, 1971; Malpass & Kravitz, 1969; Shepherd, Deregowski, & Ellis, 1974).

1.1 Introduction to the Other-Race Effect

The phenomenon known as the other-race effect (ORE; also known as own-race bias, cross-race effect) has been widely replicated; meta-analyses demonstrate the robustness of the effect (for reviews, see, Brigham & Malpass, 1985; Meissner & Brigham, 2001; Shapiro & Penrod, 1986). In the most recent meta-analysis, Meissner and Brigham (2001) found that individuals are 2.23 times more likely to identify a same-race face. The ORE is tested using two different races of participants who perform a recognition task that contains photos of faces from their own race as well as those from a different race that corresponds to the race of the other set of participants in the experiment. Both races are expected to demonstrate a same-race advantage. Using two different races is necessary in order to establish that recognition differences between the two races of photos are not brought about by any inherent differences in the stimulus set used.

Even though it is not always the case (e.g., Malpass & Kravitz, 1969), the ORE is generally known to be reciprocal across races. Some have speculated that certain races, specifically Caucasian, are more likely to exhibit an effect (Sporer, 2001), but differences in the level of inter-racial experience may vary across racial groups, which could explain why some races may be more likely to demonstrate the effect. In addition, race is sometimes ill-defined within studies. The definition of race is established by the experimenter and can be based on skin colour, country of origin, but the definition of race occurs mostly on generally accepted racial labels. The majority of races that have been investigated in the context of the effect have been Caucasian, African, African American, Asian and Hispanic (for a review, see Sporer, 2001; Meissner & Brigham, 2001)

1.2 Testing the ORE

The ORE has been demonstrated using a variety of paradigms. One such paradigm is the match-to-sample task. A sample face is displayed for a brief time followed by two faces. The participant must choose which of the two target faces they believe was the previously displayed sample face (Lindsay, Jack, & Christian, 1991). Field studies, where the ORE is tested in a naturalistic setting like a convenience store, have also been shown to produce a significant effect (Brigham, Maass, Snyder, & Spaulding, 1982; Wright, Boyd, & Tredoux, 2001) as well as experiments involving line-up identification (Brigham et al., 1982). The most common method of testing the ORE, however, has been to use a recognition memory paradigm that requires participants to discriminate faces previously seen from new faces.

The recognition memory paradigm consists of a study phase and a test phase. In the study phase, participants are presented with a series of photographs of faces, each displayed for a short time (e.g., 3 seconds). They are required to study the faces as closely as possible for a subsequent recognition test. In an experiment investigating the ORE, half of the photos are of one race and the other half are of the second race being tested. The test phase consists of the photos of faces that were presented in the study phase (termed “old” faces) randomly intermixed with an equal number of photos of faces that were never previously seen (termed “new” faces). Thus, the “old” and “new” faces as well as the race of a face in the photos are presented in a random order. The “new” faces, like “old” faces, also contain an equal number of same- and other-race faces.

Counterbalancing the stimuli is an important tenet of ensuring that any effects found within the experiment are due to the variables manipulated and not any effects of order of presentation within the experiment. A properly counterbalanced design would ensure that each photo served as both an “old” photo and a “new” photo. If the same photos were always “old” across participants, it would be unclear whether the effects found would be

due to features inherent in the set of “old” photos used. By counterbalancing the assignment of faces to the “old” group such that different participants see different “old” faces, any inherent stimulus differences would simply become a part of the measured variability and effects found in the experiment can be attributed to a source other than effects of stimulus set.

The recognition decision occurs in the test phase where participants are presented with one photo at a time and required to determine whether the face in the photo is “old” or “new”. Based on the recognition decision made for each photo in a particular experiment, statistics can be calculated to determine how well an individual was able to discriminate “old” photos from “new” photos and hence, provide a measure of recognition memory.

1.3 Statistical Measures of the ORE

As a measure of recognition, some studies simply take a cumulative measure of “old” responses and then analyse the percent or proportion correct to yield a measure of recognition (Brigham et al., 1982; Buckhout & Regan, 1988; Chance, Goldstein, & McBride, 1975; Lindsay et al., 1991; Platz & Hosch, 1988; Rhodes, Brake, Taylor, & Tan, 1989; Sangrigoli, Pallier, Ventureyra, & Schonen, 2005; Tanaka, Kiefer, & Bukach, 2004). Most recent studies have employed signal detection theory (e.g., McNicol, 1972) as a method of analysis of recognition that provides a more complete analysis of the responses that are given in a recognition memory paradigm.

Although analysing percent correct is a measure of how well you can accurately recognise photos that were previously seen, analysing this measurement as well as the other alternative outcomes within the recognition memory paradigm can provide more information about how participants’ recognition is reflected in their responding to “old” and “new” photos. There are four possible outcomes to the recognition memory experiment that are

labelled as “Hits”, “False Alarms”, “Correct Rejections” and “Misses”.

Hits and misses both stem from examining responses to faces that were in fact “old”. A hit occurs when the participant recognises an “old” face as “old”. A miss is a complement to a hit and reflects when a participant incorrectly responds “new” to an “old” face. Thus, a miss reflects the proportion of errors made on “old” photos, while hits represent the proportion of correct responses made in identifying an “old” faces as “old”. False alarms and correct rejections are also complements to one another and refer to participants’ responses towards “new” faces. False alarms occur when a participant incorrectly labels a “new” face as “old”. A correct rejection occurs when a participant responds “new” to a “new” face.

Previous experiments analysing hits are making use of information extracted in “old” items only. Simply analysing hits, however, does not provide any information about how participants are responding to “new” faces and cannot provide a measure of how well an individual is able to discriminate “old” faces from “new” faces. Analysing both measures seems advantageous to using proportion correct alone. Analysing hits without an idea for the errors that are made on “new” faces may hide particular response patterns with participants that can provide further cues as to what is contributing to their recognition of “old” faces.

Assume that a particular participant has a high hit rate. Analysing hits would produce a conclusion that recognition was high for that particular participant. Taking false alarms into account in addition to the hit rate creates a different picture altogether. If the hit rate is high and the false alarm rate is also high, the high hit rate is not indicative of superior recognition. Although the participant scored accurately in recognising “old” faces, he/she made a large number of errors on “new” faces. This result is indicative that participants were extremely biased in responding “old” to many of the photos regardless of whether the photos were “old” or “new”. A good measure of recognition should also take bias into account.

1.3.1 Signal Detection Analyses

As an alternative to analysing hit and false alarm rates independently, most recent investigations have employed the signal detection statistics of d' (Green & Swets, 1966) or A' (Rae, 1976) as a measure of recognition. Both the parametric measure, d' , and its nonparametric version, A' , combine hits and false alarms in order to produce a measure of how well “old” faces are discriminated from “new” faces.

These measures represent a more pure measure of recognition, as they both take bias into account. Signal detection statistics employ a separate measure of the level of response bias within a particular experiment for both d' and A' , they are C (Macmillan & Creelman, 1991) and $B''d$ (Donaldson, 1992) respectively. A signal detection approach to measure the ORE would involve a significant interaction, using either d' or A' , between recognition scores for same- and other-race photos involving two different races such that both races of participants should demonstrate a same-race advantage.

Although some associate a liberal response bias towards other-race faces with the presence of the ORE (Slone, Brigham, & Meissner, 2000; Sporer, 2001), a significant effect of response bias is not necessary to define the effect as many experiments fail to report significant effects of response bias but do report significant differences between same- and other-race photos in recognition (e.g. Ng & Lindsay, 1994). Some studies only yield a significant bias for one race (Shepherd et al., 1974; Slone et al., 2000) but many experiments fail to report bias measures entirely and rely on discrimination to define the effect (e.g. Buckhout & Regan, 1988; Chance et al., 1975; Chiroro & Valentine, 1995; Cross et al., 1971; Goldstein & Chance, 1980; Lindsay et al., 1991; Rhodes et al., 1989; Wright, Boyd, & Tredoux, 2003). The role of response bias in the ORE remains unclear to date.

1.4 Overview of ORE Explanations

Several hypotheses have been proposed to account for the ORE. One early explanation involves the role of racial attitudes. Individuals exhibiting less prejudiced attitudes were thought to be motivated to differentiate other-race members more than individuals who are racially prejudiced (Meissner & Brigham, 2001). Some early experiments provided support for the hypothesis, but subsequent examination revealed that the relationship between racial attitudes and the ORE could be explained solely in terms of a response bias from prejudiced individuals exhibiting a more liberal response criterion for other-race faces (Elliot & Wittenberg, 1955; Meissner & Brigham, 2001; Sporer, 2001). In addition, prejudiced individuals are less likely to have contact with other-race members which may explain any correlation between racial attitudes and recognition for other-race faces (Brigham & Barkowitz, 1978; Slone et al., 2000). Other experiments have failed to find any relationship between racial attitudes and memory for other-race faces (Brigham & Barkowitz, 1978; Lavrakas, Buri, & Mayzner, 1976; Platz & Hosch, 1988; Slone et al., 2000)

Another possible explanation of the observed differences in recognition between same- and other-race faces involves the level of physiognomic variability between different races of faces. That is, some races of faces may be inherently less variable and more difficult to recognise. Evidence for this hypothesis, however, has been virtually non-existent. Goldstein (1979) investigated the level of physiognomic variability across faces and found that there were no differences in the level of variability among Japanese, Black, and White faces.¹

¹Racial labels are defined by the experimenter. When discussing a particular experiment, the racial labels used will be consistent with the racial labels defined by the experimenter of that experiment.

1.4.1 Experiential Hypotheses

The most commonly-accepted explanation for the ORE involves differential levels of experience across races. More specifically, it is postulated that individuals generally have more experience with their own race than with other races. Expertise with same-race faces may produce a form of expert processing that is highly efficient and optimised to extract relevant features for recognition from same-race faces.

There are a couple of ways of assessing the level of experience. The first involves self-report questionnaires where measures of inter-racial experience are correlated with recognition to establish whether there is any relationship between the two (Carroo, 1986, 1987; Malpass & Kravitz, 1969; Platz & Hosch, 1988; Slone et al., 2000; Wright et al., 2003). The second involves controlling the area from which participants are drawn. Level of experience can be assessed by selecting individuals from racially segregated areas (some neighbourhoods, others entire towns), where it is known they have had minimal contact with other-race individuals (Chance et al., 1975; Chiroro & Valentine, 1995; Cross et al., 1971; Malpass & Kravitz, 1969; Ng & Lindsay, 1994; Wright et al., 2003). If differences in the level of experience are the source of the effect, the ORE should be larger in racially segregated areas where minimal experience with other-race faces should be associated with poorer recognition.

Experiments investigating the expertise hypothesis have found inconclusive results (Carroo, 1986, 1987; Malpass & Kravitz, 1969; Ng & Lindsay, 1994; Platz & Hosch, 1988; Slone et al., 2000; Wright et al., 2003). Perhaps some of the inconsistency can be explained by the inability to assess level of experience among individuals. Self-report questionnaires, for example, may not contain questions that adequately probe previous experience with races. Participants may also not be able to provide an accurate account of their own racial experience, or they may be biased by racial motives, or they may have an unwillingness to

admit information that may be construed as racially biased. A pure measure of the level of experience for both races in question may not exist and, as such, some of the inconsistency in results may be due to these factors. However, this inconsistency may also be indicative that previous experience with same- and other-race faces is not the only factor that is contributing to the size of the ORE across experiments.

Given the failure to provide conclusive support in favour of experiential hypotheses, the role of experience in the ORE still remains unclear. There are several theories, all of which fall under the broader category of experiential hypotheses, that attempt to elucidate exactly how experience may be involved. A more detailed review of these hypotheses will be presented later, but, as of yet, no clear mechanisms relating the role of experience to the ORE have been revealed.

1.4.2 Social Categorisation Hypotheses

An alternative to experientially-based hypotheses involves social categorisation mechanisms. Social categorisation accounts make use of the effect of out-group homogeneity to account for differential recognition between same- and other-race faces (Linville, Fischer, & Salovey, 1989). Members of a socially-defined out-group are thought to be perceived as less variable than members within one's own in-group. Information coded in out-groups is thought to be categorical in nature. The other-race recognition deficit is thought to occur because other-race faces constitute an out-group and are categorised. Categorisation processes interfere with coding individuating information in other-race faces that results in inferior recognition for these faces (Levin, 2000).

An important feature to note is that social categorisation hypotheses can account for a substantial amount of the results in the literature that expertise-based hypotheses cannot. A downfall of this perspective, however, is that social categorisation models fail to incorporate

the role of experience in their explanation of the ORE. Thus, both experiential and social categorisation models have received support within the ORE literature, but both are able to account for different sets of results and are seen by some as two competing accounts of the ORE (Caldara & Abdi, 2006; Levin, 2000). A more detailed discussion of the role of both experiential and social categorisation models in modulating the ORE will be provided in subsequent chapters.

Chapter 2

ORE Replication

2.1 Experiment 1: ORE Replication

The ORE has been a widely replicated phenomenon (for a review, see Meissner & Brigham, 2001) across a number of experimental paradigms. Nevertheless, it is crucial to replicate the effect with the current stimuli before further investigating the mechanisms underlying it. It is necessary to demonstrate that the current set of stimuli also produces recognition differences between same- and other-race faces. As such, Experiment 1 was designed in order to replicate the ORE. Successful replication of the ORE entails testing two different races of participants on their recognition for two races of photos, where one race in these sets of faces would be the same as the participant's race. In Experiment 1, both Caucasian and Asian participants were tested on Caucasian and Asian photographs using a recognition memory paradigm.

The participant studies a particular set of faces during the study phase and is tested for recognition of these items in the test phase. The faces from the previous study phase are randomly intermixed with novel faces in the test phase. Faces are presented one at a time and during the test phase, and the participant is asked to judge whether the face presented was previously seen in the study phase, or whether it is new. If an ORE is present, recognition should be higher for same-race faces when compared to other-race faces for both races of participants being tested. A significant race of photo by race of participant interaction is expected. In consensus with most of the ORE literature, identical photos of faces were used across both study and test phases. The procedure in this experiment serves as a reference point for subsequent experiments in this paper, as the paradigm and methods are similar across all experiments.

2.1.1 Methods

Participants

Participants were sixteen self-identified Caucasian and sixteen self-identified Asian undergraduate students at the University of Lethbridge who participated in the experiment in exchange for a partial course credit.

Stimuli and Apparatus

The stimuli consisted of 64, scanned, black and white high school yearbook photos of grade 10 and 11 faces. One-half of the photos were Asian faces and the other half were Caucasian faces. Race of the photo was determined by the experimenter. In addition, half of the faces in each set were male, and one-half were female.

These 64 photographs were taken from a larger stimulus set of Caucasian and Asian photographs. Photos were selected based on the similarity between a grade 10 and 11 photo of the same individual (see Experiment 2 where the influence of changing photos across study and test phases is investigated), chosen do as to minimize differences in pose, hairstyle, facial expression and jewellery across the two photos of the same individual. This experiment used the same photos across the study and test phases of the experiment. The photographs were a frontal view of the head and neck only. The stimuli were displayed on a Macintosh eMac computer.

There were a total of 4 counterbalancing conditions crossing grade of photo (grade 10 vs. grade 11) and status at test (target vs. distractor). The 128 photos (two photos of each of the 64 individuals) were split into two sets of 64. One of these sets contained a photo of each individual taken either in grade 10 or grade 11 (one-half were from each grade). The

other set contained the “opposite” photos from the first set, that is, an individual portrayed in grade 10 in the first set was portrayed in grade 11 in the second set and vice versa. An individual participant would see one of the sets of photos that were counterbalanced across participants. In addition the half of the stimulus set that was seen in training (targets) and that were foils at test (distractors) was counterbalanced across subjects so that any individual photograph would be seen equally often, across subjects, as a target and as a distractor and equally often, across subjects, as a grade 10 photograph and a grade 11 photograph. The order of presentation was randomised so that each participant had a uniquely ordered presentation of the faces in both phases of the experiment.

Procedure

Prior to the experiment, participants were instructed that they would be presented with a series of photographs of faces that would be displayed on the screen, one at a time. They were asked to study these faces closely in preparation for a memory test that would follow immediately after the study phase. During the study phase, participants were presented with 16 Caucasian (8 male) and 16 Asian (8 male) “target” faces at a rate of 3 seconds each. Each trial was separated by a fixation cross that appeared for 1 second to cue participants to the commencement of the next trial. Upon completion of the study phase, “End of Phase” was displayed on the screen and instructions for completing the old/new judgement task in the test phase were provided. Participants were informed that a single face would be displayed on the screen and they would be required to decide whether the face presented was “old” or “new”. Participants were also informed that the photographs may have changed between the study and test phases of the experiment such that, in the test phase, they may see a different photograph of the same face that was presented in the study phase (The photos did not change in this experiment but participants were instructed in this way so as to keep

Race of Photo	Caucasian Ss		Asian Ss	
	Hits	False Alarms	Hits	False Alarms
Caucasian Photo	0.78	0.28	0.64	0.35
Asian Photo	0.71	0.33	0.70	0.27

Table 2.1: Mean hit and false alarm rates for Caucasian and Asian photographs for both Caucasian and Asian participants in Experiment 1.

instructions consistent with Experiment 2; see Experiment 2).

The test phase consisted of the 32 “target” faces shown in the study phase (“old” faces) as well as 32 “distractor” (“new”) faces that were not presented previously. These 32 target faces consisted of 16 Caucasian photos and 16 Asian photos. One-half of these photos were male and the remainder were female. The same photos were used across both study and test phases of the experiment such that the photo of an individual that was presented in the study phase was identical (same grade of photo) to the photo of that same individual in the test phase. Participants were required to judge whether the face presented on the screen was “old” or “new”. They responded on a 12-point scale anchored with four points: “sure old”, “guess old”, “guess new”, “sure new”.

2.1.2 Results

Table 2.1 displays the mean hit and false alarm rates for Caucasian and Asian participants on Caucasian and Asian photographs. Statistical tests were assessed at $\alpha = 0.05$ level of significance. The hit (scale responses > 6 to targets) and false alarm (scale responses > 6 to distractors) rates were adjusted to avoid rates of 0 or 1 so as to facilitate comparison of signal detection measures (Snodgrass & Corwin, 1988). This adjustment was performed for the analyses of all experiments reported in this thesis.

The differences in recognition found between same- and other-race faces for both Cau-

casian and Asian participants can easily be seen in the receiver-operating characteristic (ROC) curves shown in Figure 2.1 that are fitted to the mean confidence scale responses for each group of faces and participants. ROC curves plot the unit square of paired hit and false alarm rates for different criterion settings based on the willingness to respond “old”. These data were compiled for each participant, then averaged, and are based on the confidence levels assigned to each response of “old” or “new” (see Wickens, 2001). The fitted curves were computed using a web-based software (Eng, n.d.).

Recognition can be seen based on the curvature of the fitted line that represents the plotted points. An inability to discriminate the stimulus photos is evidenced by a fitted line that runs diagonally through the centre of the graph. As levels of recognition increase, the curve will bend more towards the top-left corner such that the false alarm rate is minimised and the hit-rate is at a maximum. As can be seen in Figure 2.1, both Caucasian and Asian participants perform at similar levels of recognition on same-race photos. Performance on other-race photos for these participants is also similar, however the ROC curve falls closer to the centre of the graph demonstrating lower levels of discrimination on other-race photos for both sets of participants. Thus, same-race photos led to higher levels of recognition than other-race photos by both Caucasian and Asian participants.

An analysis conducted on A' scores confirms the existence of the recognition differences seen in the ROC curves between same- and other-race faces for both Caucasian and Asian participants. A 2 (race of photo: Caucasian/Asian) X 2 (race of participant: Caucasian/Asian) ANOVA was conducted that yielded a significant 2-way interaction between race of photo and race of participant, $F(1, 30) = 12.981; MS_e = 0.077; p = 0.001$. There was no main effect of race of face, $F(1, 30) = 0.416; p = 0.524$, indicating that one set of photos was not more difficult to recognise than the other. There was also no main effect of race of participant, $F(1, 30) = 0.036; p = 0.851$.

In order to explore the significant interaction between race of participant and race of

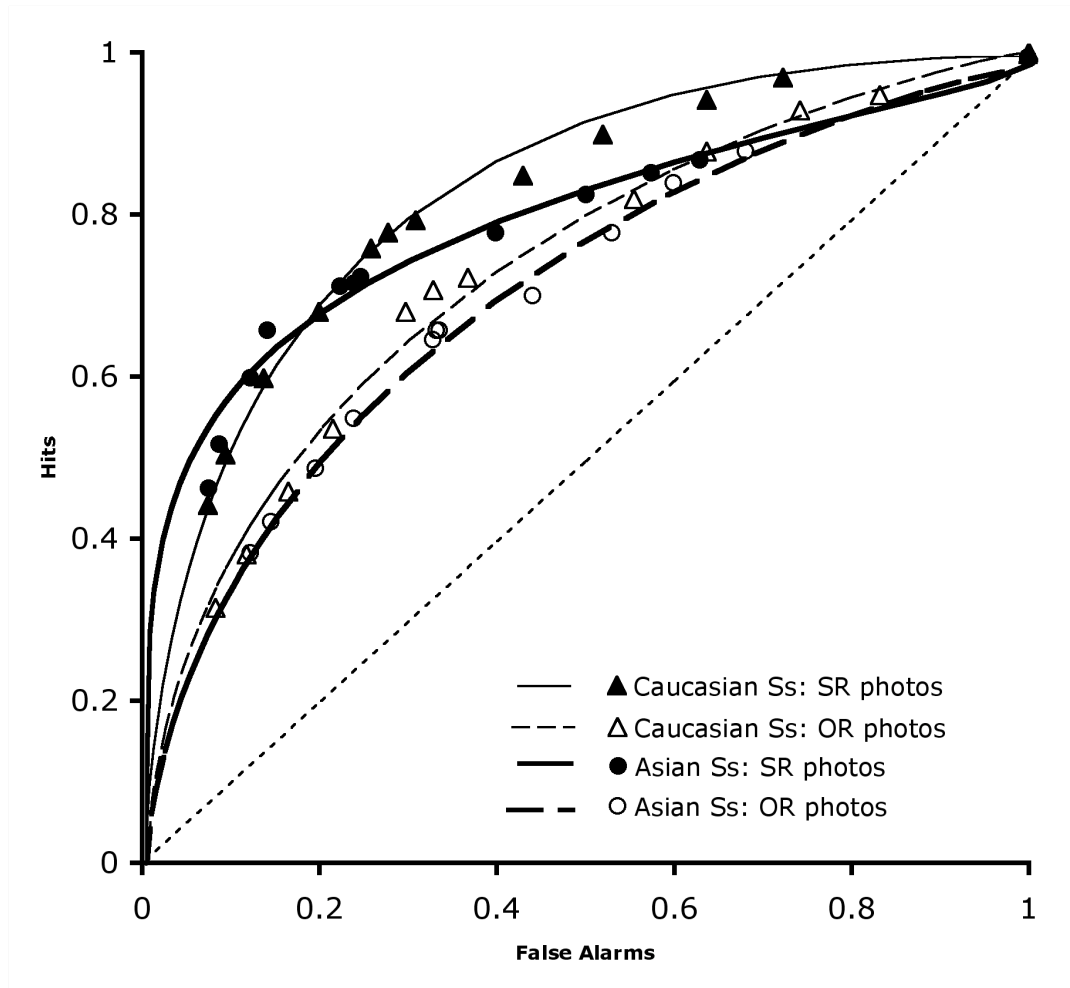


Figure 2.1: Mean receiver-operating characteristic (ROC) hit and false-positive values derived from confidence judgements and the corresponding fitted ROC curves (assuming equal-variance, Gaussian distributions) for each race (Caucasian vs. Asian) of participant as a function of the same (SR) or other (OR) race of the photograph in Experiment 1.

photo, simple effects tests were conducted examining the differences between Caucasian and Asian photo performance for both sets of participants. An analysis of A' scores on Caucasian and Asian photos for Caucasian participants yielded a significant effect of race of photo, $F(1, 15) = 7.922; MS_e = 0.026; p = 0.013$. Caucasian photos ($M = 0.796$) were discriminated better than Asian photos ($M = 0.739$). Tests performed on Asian participants also yielded a significant effect of race of photo, $F(1, 15) = 6.231; MS_e = 0.059; p = 0.025$, where Asian photos ($M = 0.802$) were discriminated better than Caucasian photos ($M = 0.721$). These results are depicted in Figure 2.2.

For the measure of bias, $B''d$, there was no main effect of race of participant, $F(1, 30) = 0.239; p = 0.629$, no main effect of race of photo, $F(1, 30) = 0.608; p = 0.442$, nor was there a significant interaction between race of participant and race of photo, $F(1, 30) = 0.212; p = 0.648$. Similarly, Caucasian participants had similar levels of bias for Caucasian ($M = -0.066$) and Asian ($M = -0.040$) photos, $F(1, 15) = 0.044; p = 0.836$. Asian participants also demonstrated no differences in bias to Caucasian ($M = -0.033$) and Asian ($M = 0.068$) photos, $F(1, 15) = 0.903; p = 0.357$.

2.1.3 Discussion

The results from Experiment 1 replicated the ORE (Malpass & Kravitz, 1969). Caucasian participants discriminated Caucasian photos better than Asian photos. Asian participants, in contrast, showed the reverse pattern where recognition on Asian photos was better than on Caucasian photos. Thus, the ORE has been replicated for both Asian and Caucasian participants using these stimuli.

The same photos were used across study and test phases of this experiment in accordance with most of the ORE literature. However, by using the same photos across both study and test phases of the experiment, participants may be engaging in photo recognition

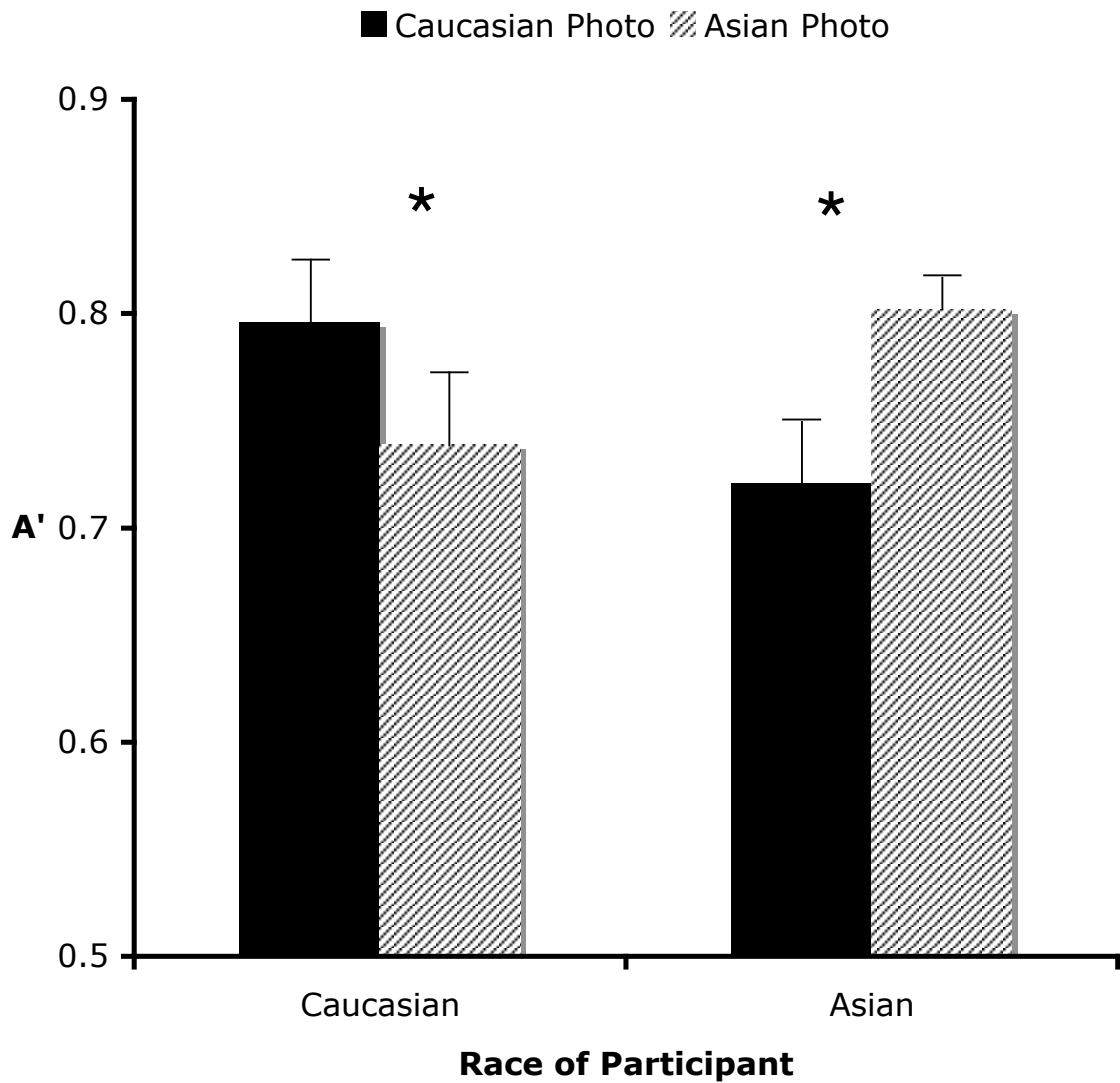


Figure 2.2: Recognition memory performance, measured in A' , for Caucasian and Asian photographs by Caucasian and Asian participants in Experiment 1. Asterisks indicate a significant result. Error-bars within-cell standard errors.

as opposed to face recognition. Participants could be making their recognition judgements based on superficial characteristics of the image instead of actually recognising the face in the image (e.g. recognition through a scratch in the photo). Changing the photo between study and test phases of the experiment may force participants to rely on characteristics of the face instead of on superficial image characteristics when making their recognition judgement. The following experiment examines the influence of changing the photo across the study and test phases with the current stimuli.

2.2 Experiment 2: Effects of Changing Photographs

Although the same photo is typically used in recognition experiments, the question of interest here concerns whether changing the photos across the two phases produces a different set of results when compared with an experiment where the photos remain the same. Investigations of the ORE are concerned with person recognition, but using the same photos across study and test may have participants encoding superficial image characteristics as opposed to recognising the actual face in the photo. Changing the photo across study and test phases may more strongly emphasise face recognition as opposed to picture recognition. As of yet, no investigations have been found that assess whether changing photos across study and test phases may influence the ORE.

Grade 10 and 11 yearbook photos of the same face were used so that participants saw a different photograph of the same person at test from what they saw at study. Caucasian and Asian participants in Experiment 1 both exhibited a same-race advantage. In Experiment 2, only Caucasian participants were tested as it was difficult to obtain Asian participants. Regardless, there is no reason to suspect that Asian participants would perform any differently from Caucasian participants under the change photo manipulation. Because the ORE was replicated with both Caucasian and Asian races in Experiment 1, and is reciprocal by

nature, it is unlikely that a manipulation where the photographs are changed between the study and test phases would differentially affect one race over the other, as a race-related manipulation is not involved.

In Experiment 2, the experimental design is equivalent to that of Experiment 1 except that a photograph of an individual presented at test phase was a slightly different photo of the same individual presented at study.

2.2.1 Methods

Participants

Participants were sixteen Caucasian undergraduate students who participated in the experiment in exchange for a partial course credit.

Stimuli and Apparatus

The stimuli and apparatus were identical to that of Experiment 1.

Procedure

The procedure was identical to that of Experiment 1, except the photographs of a single individual changed between the study and test phases. Participants presented with a grade 10 photograph of an individual during the study phase were presented with a grade 11 photograph of the same individual during the test phase, and vice versa. As in Experiment 1, the experiment was counterbalanced for grade of photo (grade 10 vs. grade 11) and status at test (target vs. distractor). Thus, grade of photo and whether the photo was a target or a

Race of Photo	Caucasian Ss	
	Hits	False Alarms
Caucasian Photo	0.55	0.32
Asian Photo	0.60	0.49

Table 2.2: Mean hit and false alarm rates on Caucasian and Asian photographs by Caucasian participants when photographs are changed between study and test.

distractor was presented an equal number of times in the study and test phases across the participants. Finally, as in Experiment 1, where the photos remained the same, participants were also instructed that the photos may change between the study and test phases of the experiment where they may see a different photo of the same person in the test phase. They were instructed to respond “old” to the face if they believed it was a different photograph of the same person.

2.2.2 Results

Table 2.2 displays mean hit and false alarm rates for Caucasian and Asian photos. The ROC curves for same- and other-race photo performance are depicted in Figure 2.3. Recognition for both same- and other-race photos is at similar levels, although neither same- nor other-race photos were discriminated very well overall.

Confirming information displayed in the ROC curve, an ANOVA performed on A' scores for Caucasian ($M = 0.658$) and Asian photos ($M = 0.582$) found no significant main effect of race of photo, $F(1, 15) = 2.046; p = 0.173$. Thus, as can be seen in Figure 2.4 depicting A' values for same- and other-race faces as a result of the change photo manipulation, no ORE was obtained.

Analyses on $B''d$ yielded a significant main effect of race of photo, $F(1, 15) = 8.732; MS_e =$

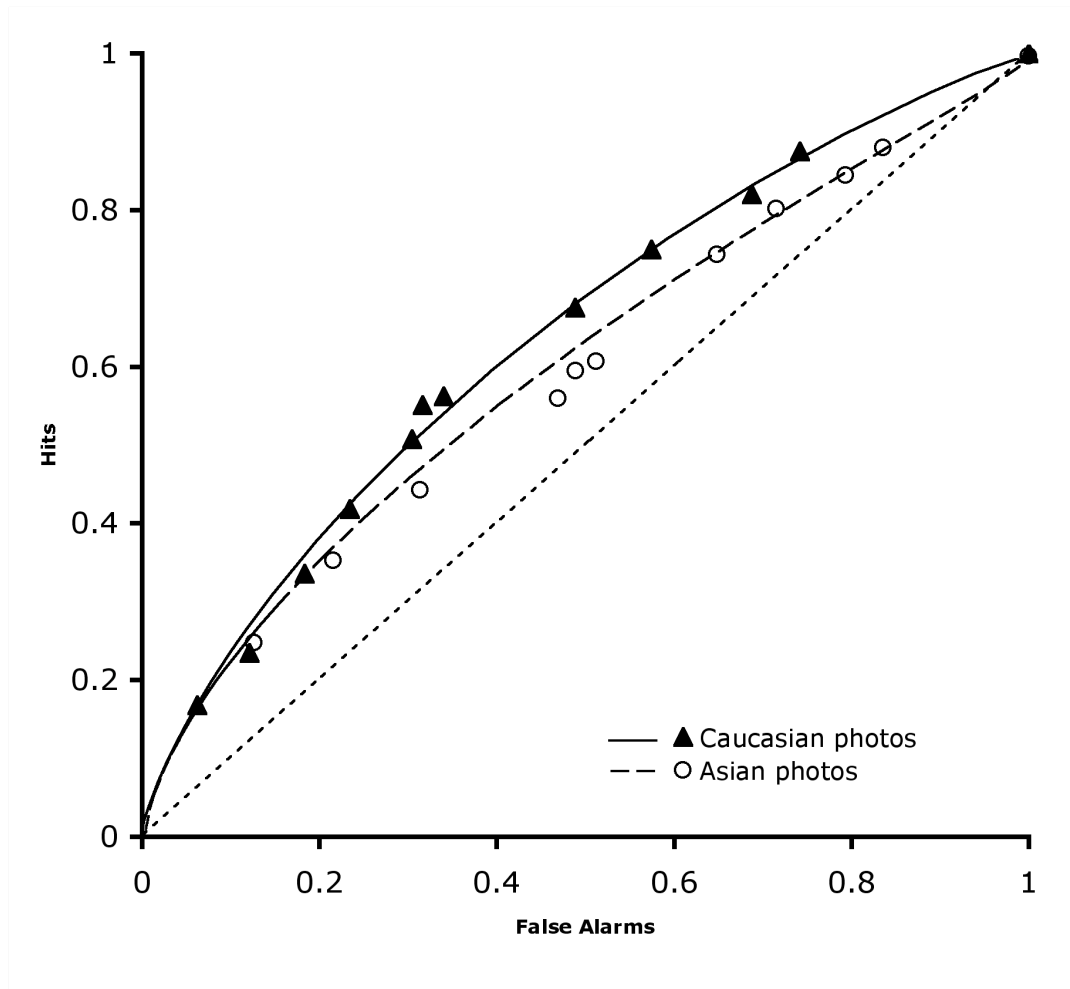


Figure 2.3: Mean receiver-operating characteristic (ROC) hit and false-positive values derived from confidence judgements as well as the corresponding fitted ROC curves (assuming equal variance, Gaussian distributions) depicting recognition for both same- and other-race faces as a result of changing the photos between the study and test phases of Experiment 2.

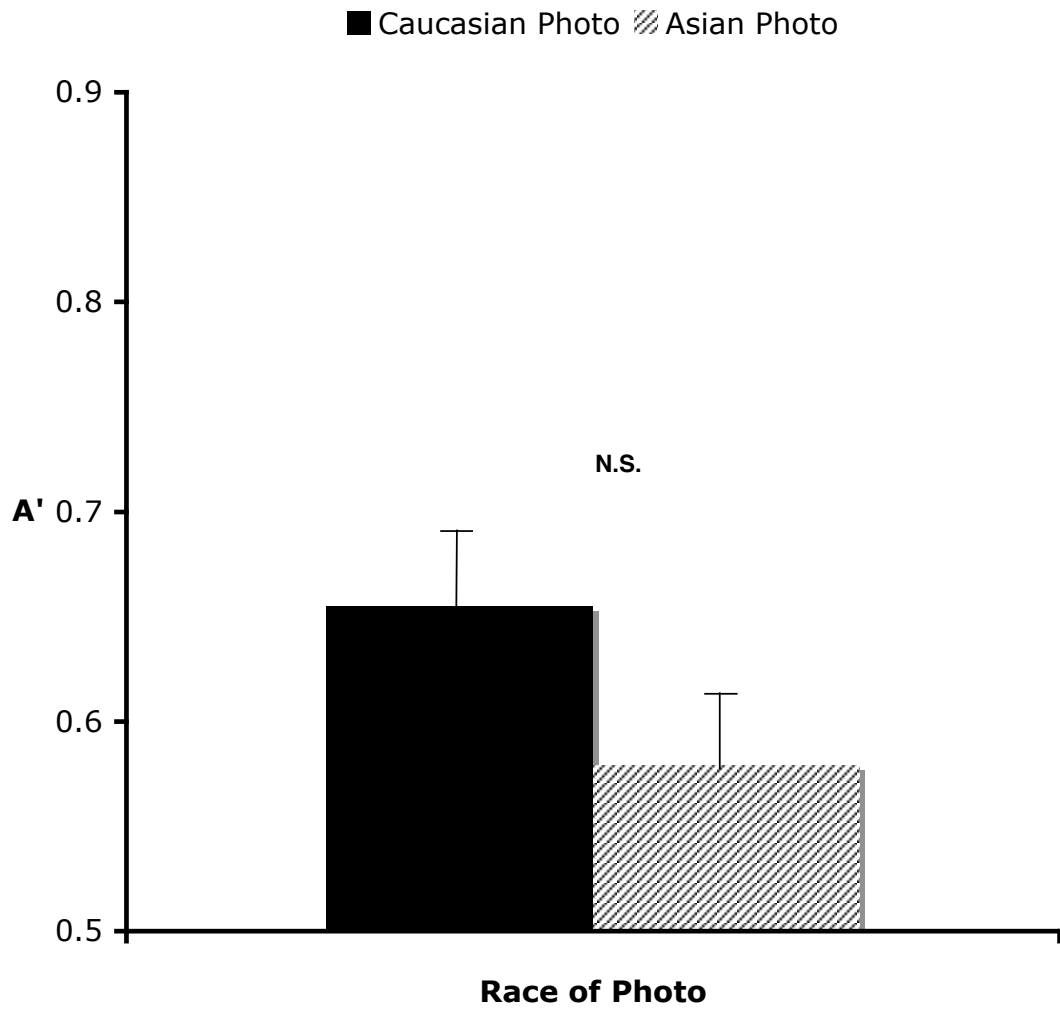


Figure 2.4: Recognition, A' , for Caucasian participants on both Caucasian and Asian photos when the photograph of each individual presented in the study phase changes between the study and test phases of the experiment. Error-bars are within-cell standard errors.

1.036; $p = 0.009$. Responses to Caucasian photos ($M = 0.223$) were more conservative than responses to Asian photos ($M = -0.136$). Participants were less likely to respond “old” to Caucasian photos than to Asian photos.

2.2.3 Discussion

Experiment 2 examined the influence of changing the photos across the study and test phases of the experiment. An ORE was not obtained. The only significant effect was found on bias measures where the manipulation made participants more conservative when responding to Caucasian faces. Participants were less likely to label a Caucasian face as “old” under the change photo manipulation. These results contrast with Experiment 1 where there was an ORE, but there were no significant shifts in bias.

It could be argued that changing the photos in the current experiment produced a much more difficult task as photos of an individual were separated by a year. In fact this idea is likely the case given the research presented by Bruce (1982) that demonstrates the difficulty participants in general have when attempting to recognise photos that have changed when the photos are only different in terms of expression and pose.

Unfamiliar face processing is fundamentally different from familiar face processing and produces different levels of performance in comparison to familiar faces (Megreya & Burton, 2006, 2007). Unfamiliar face processing is thought to rely on image-matching rather than more sophisticated face matching processes and is much more sensitive to changes in orientation and expression (Bruce et al., 1999; Bruce, 1982). In addition, processing of unfamiliar faces is disrupted by minor image variations and seems to be treated in a more superficial image dependent fashion (Megreya & Burton, 2007).

Megreya and Burton (2007) compared unfamiliar faces to inverted faces and claimed they were processed in a manner similar to objects where processing is less sophisticated.

Even though there was a large difference between the changed photos in the current experiment, changing photos still produce large differences in performance when there is very little memory load and the difference between the photos is quite small. When memory load is reduced by using a matching task where participants are required to match a target photo from within an array of faces, participants demonstrate remarkably poor performance even when high quality images are used that are taken on the same day under the same conditions (Bruce et al., 1999; Megreya & Burton, 2007). In these experiments, the only thing that differs between the two photos is image characteristics brought about by taking the photos using two different cameras.

Changing the photos across study and test phases of the recognition memory task eliminated the ORE. This is in contrast to the ORE replication experiment where significant differences between same- and other-race photo performance were found. Other investigations have also noted performance differences as a function of changing photos. Bruce (1982) examined the influence of changing photos on recognition accuracy and latency. In comparison to unchanged photos, changed photos were recognised less accurately and more slowly. Read, Vokey, and Hammersly (1990) examined the influence of changing photos as a function of exposure duration. They varied the similarity of photos as a measure of change and found that the similarity of the photos interacted with exposure duration such that when photo similarity was high, increased exposure duration always improved subsequent recognition. When similarity between photos was low, however, increases in exposure duration reduced recognition. Changing the photos does seem to produce processing differences between changed and unchanged photos, although it is unclear at this point exactly how changing the photos may have affected processing for same- and other-race faces.

Chapter 3

ORE Explanations

In Experiment 1 (ORE replication), the ORE was successfully replicated as evidenced by the significant race of participant by race of photo interaction. There are two main theories to account for the ORE: experiential and social categorisation accounts. Both are viable accounts of the effect that have received empirical support albeit both theories can account for different aspects of the data presented in the literature thus far. A more detailed analysis of experiential and social categorisation accounts is provided below.

3.1 Experiential Hypotheses

3.1.1 *Contact Hypothesis*

The most common explanation for the ORE involves the amount of experience that individuals have with same- versus other-race faces. According to the contact hypothesis, a same-race advantage occurs due to the large amount of experience individuals are presumed to have with faces of their own race. The contact hypothesis predicts that the size of the effect is related to the amount of experience an individual has had with same- and other-race faces, with individuals less experienced with other-race faces exhibiting a larger ORE than individuals with more experience with both races of faces.

Common tests of the contact hypothesis have found mixed results. In examining whether self-reported interracial experience was related to the size of the ORE, Slone et al. (2000) used a social experience questionnaire to assess the level of interracial contact and found that amount of contact was positively correlated with recognition for same- and other-race faces. Ng and Lindsay (1994), on the other hand, failed to find a significant correlation be-

tween reported contact and recognition. Other studies examining the relationship between self-reported interracial contact and size of the ORE have also found mixed results (Carroo, 1986, 1987; Malpass & Kravitz, 1969; Platz & Hosch, 1988; Wright et al., 2003). Across studies, Meissner and Brigham (2001) report that self-rated interracial contact accounted for a small, but reliable 2% of the variability across samples.

Other tests of the contact hypothesis involve comparing the size of the ORE in groups with different levels of interracial experience. Chance et al. (1975) tested Black and White subjects on Black, White, and Japanese faces. The participants were presumed to have more familiarity with White and Black faces than with Japanese faces. Their results showed the predicted pattern: both races of participants were best on same-race faces and performance was worst for Japanese faces. Chiroro and Valentine (1995) also showed some evidence for the influence of contact on the ORE. They tested African and Caucasian individuals who were either in the low contact group (minimal contact with other-race faces) or in the high contact group (high amount of contact with other-race faces). In accordance with the predictions, high contact African participants showed no ORE. This group had similar recognition for same- and other-race faces. Low contact Africans, on the other hand, demonstrated a same-race advantage. The Caucasian participants showed no effect of contact. The size of the effect for both low and high contact groups for these participants was the same. The contact hypothesis was supported by African participants who showed differing sizes of the effect as a function of contact, but Caucasian participants showed no difference in the size of the effect as a function of interracial contact.

These patterns of results are fairly common within the ORE literature. It is very typical for the size of the effect to vary between and within a particular race across studies investigating experiential hypotheses. Other studies examining the effect of differing levels of interracial experience on the ORE also only tend to show an effect of experience with one race (Cross et al., 1971; Malpass & Kravitz, 1969; Ng & Lindsay, 1994; Wright et al.,

2003).

3.1.2 Developmental Contact Hypothesis

So far, evidence in favour of a direct relationship between experience and size of the ORE is weak. Perhaps early experience with same and other race faces is a better predictor of the size of the ORE. As an alternative to a generic contact hypothesis, Furl, Phillips, and O'Toole (2002) proposed a developmental contact hypothesis that emphasizes the importance of experience during development as a mediator of the ORE. According to the developmental contact hypothesis, early experience with faces may act as a better predictor of the magnitude of the effect than experience later in life. In order to test this hypothesis, Furl et al. (2002) compared recognition from four face recognition algorithms that employed a generic contact hypothesis, a developmental contact hypothesis and two non-contact control algorithms.

The generic contact algorithm, when trained with predominantly same-race faces, produced a recognition advantage for other-race faces. This is opposite to the result found by human participants. The two non-contact control algorithms did not demonstrate an advantage for either race. The developmental contact hypothesis algorithm provided the closest match to human performance by producing an advantage for same-race faces suggesting that developmental experience with same- and other-race faces may be a stronger mediator of the effect.

Further evidence in support of the developmental contact hypothesis comes from studies examining the developmental course of the ORE. Sangrigoli et al. (2005) tested Caucasian participants residing in France, native Korean participants, and Korean participants who were adopted by Caucasian families when they were children (between 3 and 9 years of age). The Caucasian participants and Korean natives show the typical same-race advan-

tage. The Korean adoptees, however, showed an advantage for Caucasian faces suggesting that early experience with other-race faces is an important mediator of the ORE.

3.1.3 Configural Processing

Another expertise-based hypothesis of the ORE is concerned with identifying two types of processing that are thought to occur in face recognition. One process involves coding faces with featural information, while the other involves coding the configural relations between features in the face or general information about face shape (Rhodes et al., 1989; Fallshore & Schooler, 1995). Given this processing dissociation, same-race faces are thought to be coded configurally as a result of expertise. Other-race faces, on the other hand, are thought to be processed featurally which involves attention to individual features in the face. Featural processing is associated with poor recognition and would account for the other-race deficit.

Evidence in favour of the configural hypothesis comes from studies investigating the verbal overshadowing effect. The verbal overshadowing effect refers to the observation that verbally describing a face impairs later recognition of that face (Schooler & Engstler-Schooler, 1990). Verbally describing a face is thought to impair processing of the configural information that is difficult to verbalize and place a reliance on featural information (Fallshore & Schooler, 1995; Schooler & Engstler-Schooler, 1990). Because the use of configural information is associated with expertise, Fallshore and Schooler (1995) hypothesised that other-race faces would be less subject to verbal overshadowing than same-race faces as same-race faces are hypothesised to be processed with expertise-based configural coding. In their first experiment, as predicted, verbalisation impaired recognition of same-race faces, but did not effect recognition of other-race faces that was worse to begin with.

As a further test of the hypothesis that other-race face recognition relies on featural information whereas same-race face recognition relies on nonverbalisable configural information, Fallshore and Schooler (1995) examined whether the verbal descriptions of faces from their experiment were predictive of other-race face recognition. To do so, they had judges try to recognise the same- and other-race faces using the verbal descriptions provided by participants in the previous experiment. If other-race face recognition is reliant on the featural information provided in the verbal descriptions, verbal descriptions of other-race faces should be more predictive of recognition than the verbal descriptions of same-race faces. As predicted, for same-race faces, there was no relationship between judges' identification performance and that from previous participants. For other-race faces, however, judges were more likely to identify a target face. These results provide some evidence that expertise may bring about different types of processing for same- and other-race faces and that these processes may manifest themselves in terms of configural coding of the expert class as a function of experience.

3.1.4 Face Space

Unlike other experiential models of the ORE, the face space model proposed by Valentine (1991) was originally aimed at providing a computational model of face recognition that could account for various effects in the literature including the ORE. Face space emphasises the role of experience in explaining recognition differences between same- and other-race faces. Face space consists of a multidimensional space that is constructed based upon the lifetime of experience we have with faces. Previously experienced faces are encoded as points within the multidimensional space. Exemplars of experienced faces are distributed within the space in terms of their similarity to one another. The dimensions of the space are unknown, but are thought to represent facial features that are optimal for distinguish-

ing between previously experienced faces. These facial features are not necessarily easily verbalisable features of faces such as nose or mouth. Dimensions of the space are thought to be constructed by the types of exemplars previously experienced, that in turn, affect the location and distribution of face exemplars in the space. Face recognition within face space is assumed to involve a process of encoding a stimulus face as a location in the multidimensional space and determining whether the stimulus face projected into the space matches that of an already known face (Valentine, Chiroro, & Dixon, 1995). Errors in recognition will occur depending on the magnitude of encoding error and the proximity of neighbouring faces within the space.

The conception of face space according to Valentine (1991), relies mainly on explaining the ORE in terms of previous experience with both same- and other-race faces. A same race advantage occurs due to the distributions of same- and other-race faces within face space. Assuming that people tend to have more experience with same-race faces, the dimensions of the space would be constructed to optimise discrimination of same-race faces by making use of the features best used to discriminate that group of faces. Thus, the overall structure of face space should be biased towards optimising recognition of same-race faces.

Because other-race faces will be encoded in the space using dimensions that are optimized for distinguishing same-race faces, the dimensions of the space may not capture the variation within other-race faces that is useful for discriminating between them and a recognition deficit is expected as a result. Other-race faces would manifest themselves within this biased space in a dense distribution where distinguishing between particular exemplars would be difficult. These faces would be subject to error as confusion between exemplars within the space at the time of recognition would arise. Thus, other-race faces would be perceived as perceptually similar to one another by the space.

Same-race faces, on the other hand, have the recognition advantage as the dimensions are optimised to discriminate subtle features of these faces. Same-race faces would be

widely distributed within the space and, as a result would be subject to fewer recognition errors. Recognition is optimal for these faces, in comparison to other-race faces, and encoded within the space by individuating features optimal for recognition that would produce the same-race advantage. Figure 3.1 depicts the account of the ORE proposed by Valentine (1991) that has other-race faces projected into a predominantly same-race face space resulting in a dense cluster of other-race faces within the space.

Using an autoassociative neural network that is comparable to the face space model proposed by Valentine (1991), O'Toole, Deffenbacher, Abdi, and Bartlett (1991) simulated the other-race effect as a problem in perceptual learning that relies upon previous experience to explain the ORE. They trained the neural network on a majority of one race and found that the model was better at reconstructing majority race faces. They also found that minority race faces had a higher inter-item similarity, as measured by taking the cosine between the two faces of interest, than majority race faces providing support for the idea that other-race faces are perceived as perceptually similar in the model. After simulating a recognition task with both sets of faces, they did find that majority race faces (as trained by the model) were better recognised than the minority. Thus, the simulation produced an other-race effect when the structure of the space was biased towards same-race faces by training the model with a majority race.

Caldara and Abdi (2006) tested a key assumption of the face space model using neural network simulations that examined the distributions of same- and other-race faces within the space. Using Caucasian and Asian faces, they trained two neural networks one with each race and projected same- and other-race faces into both Caucasian and Asian face spaces. Using Euclidean distances and cosine values for faces projected into the space, they found that same-race faces were more widely distributed and dissimilar to one another than other-race faces. Other-race faces projected into face space were densely distributed in accordance with the predictions from the face space model.

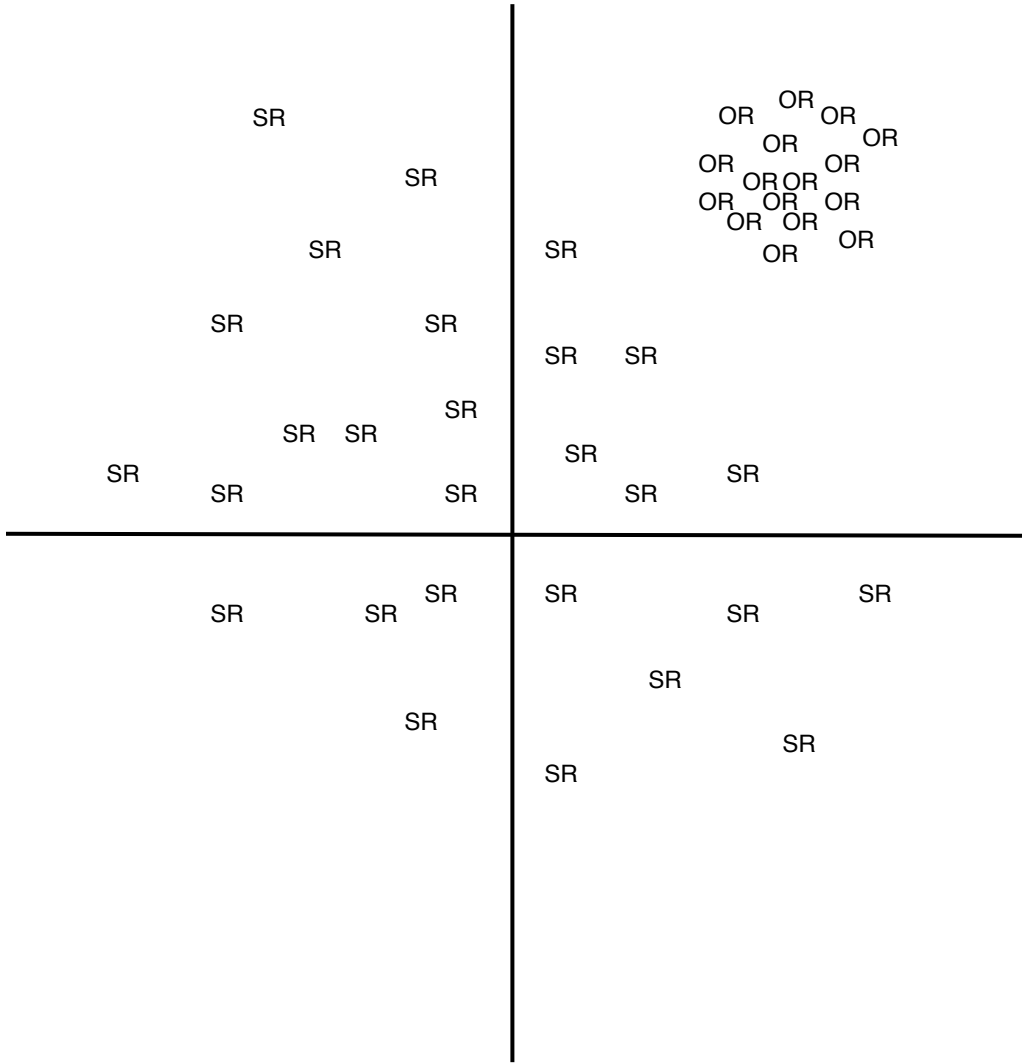


Figure 3.1: The proposed distributions of same-race (SR) and other-race (OR) faces within a predominantly same-race face space. Other-race faces are projected within a predominantly same-race face space in a dense distribution.

Given the evidence, the face space model seems to be a viable model of face recognition in accounting for the ORE as tests of a few of the main tenets of the model have received confirming evidence. The assumptions underlying the face space model, however, rely solely on experience to explain the same-race advantage. As reviewed previously, experiential models in general have received inconsistent evidence in attempting to support the link between experience and size of the ORE. Using any expertise-based model of the ORE alone seems inadequate to understand the nature of the mechanisms underlying the ORE as the variability found across tests of the experiential hypothesis suggests that there is more to explaining the ORE than simply conceptualising it in terms of expertise with a stimulus class.

3.2 Social Categorisation Models

Social categorisation models offer a newer approach to conceptualising the ORE that does not heavily rely on assumptions of expertise with same-race faces. In general, social categorisation models account for the ORE through categorisation processes that occur for socially-defined outgroups. The use of categorisation processes within social categorisation models stem from the out-group homogeneity effect where categorisation processes are thought to occur for members of socially defined out-groups (Linville et al., 1989). Members of a group outside one's own are thought to be perceptually more homogeneous than in-group members. Out-groups are defined as a function of social cognitions that give rise to group categories and create processing differences between the socially-defined in-groups and out-groups that manifest themselves in terms of categorisation of out-group members.

3.2.1 Feature-Selection Hypothesis

Levin (2000) proposed a social categorisation account specifically designed to account for the ORE that highlights individuation and categorisation processes as main contributors to the effect. Levin (2000) proposes that the ORE is due to a feature-coding asymmetry between same- and other-race faces. He hypothesises that same- and other-race faces are processed differentially such that other-race faces are coded with race-specifying information but same-race faces are not. Race-specifying information is categorical in nature and contains information about the race of the face. The other-race deficit occurs because the categorical information that is said to be coded in other-race faces is coded at the expense of individuating information. Individuating information is crucial for successful recognition as it contains unique information about faces. Thus, same-race faces are proposed to be processed with individuating information and other-race faces are thought to be coded with categorical information at the expense of individuating information. Categorical information associated with the race of a face is coded in other-race faces that results in a recognition deficit for these faces. According to Levin (2000), the information coded in other-race faces is optimal for classification, not recognition, as a result of categorical processing of other-race faces.

Evidence in support of the use of individuation and categorisation processes in the ORE comes from Hugenberg, Miller, and Claypool (2007). Using a simple instructional manipulation that informed participants of the bias to code other-race faces inaccurately, Hugenberg et al. (2007) eliminated the ORE through an increase in other-race photo performance. The increase in other-race performance can be explained fully by the instructional manipulation inducing individuation processes for other-race faces that was suitable to equate other-race face performance with same-race face performance. This experiment demonstrates that it is possible to recognise other-race faces so the performance is at the

same level as same-race faces. Thus, individuation and categorisation processes may be significant modulators of the ORE and interestingly, all that was required to eliminate the ORE was a simple instructional manipulation.

Chapter 4

Context Effects

4.1 Experiment 3: Influence of Context

The other-race effect has typically been studied under conditions where there are equal numbers of same- and other-race faces across the experiment. Using equal numbers of both same- and other-race faces may not be adequately portraying the nature of this effect as these proportions do not reflect our real-world experience with these faces. According to the experiential hypotheses, people typically have more experience with same-race faces. Tests of the ORE, however, use equal numbers of same- and other-race faces that do not provide for a simulation of the real-world scenario that encompasses how these faces are supposedly normally encountered in the world. It would be interesting to examine the effect of simulating real-world experience on the ORE by approximating the proportions of same- and other-race faces that may be encountered in the world.

A context of predominantly same-race faces was introduced into the recognition memory paradigm in order to investigate this question. There appears to be agreement that the locus of the other-race effect is at encoding (e.g. Lindsay et al., 1991). As such, manipulations invoked at the time of learning may have a larger impact on any effects seen. A context of predominantly same-race faces was introduced into the encoding phase of the recognition paradigm. The context consisted of a learning environment where the ratio of same- and other-race faces was 5 to 1 (about 83.33% to 16.67%) respectively. To assess differences in the size of the ORE as a result of the context manipulation, comparisons will be made between this context experiment and the ORE replication (Experiment 1).

The stimuli analysed in this experiment were identical to the stimuli contained in the ORE replication experiment and are considered to be the critical stimuli for this experi-

ment. The context faces, which were selected independently from the critical faces, were randomly intermixed with the critical faces in the encoding phase of the experiment in order to simulate real-world proportions during learning. The context items are not considered a part of the critical stimuli and, as a result, were not subject to analysis. Their main role was simply to provide a context around the critical stimuli in order to provide a way to determine how the context items may affect performance on the critical faces. Thus, the context experiment is identical in every way to the ORE replication except for the addition of context faces during study.

4.1.1 Methods

Participants

Sixteen Caucasian undergraduate students participated in this experiment in exchange for a partial course credit.

Stimuli and Apparatus

The stimuli consisted of the 64 critical stimuli (32 “old”, 32 “new”) from Experiment 1 (ORE replication). One-half of the photos were Asian and one-half were Caucasian. The remaining photos consisted of 64 context faces to be used as context in the study phase, all of which were Caucasian. Thus, there are 16 Caucasian photos from the critical stimuli and 64 Caucasian photos serving as the context stimuli for a total of 80 Caucasian faces and 16 Asian faces in the study phase. The test phase of the experiment was identical to the ORE Replication experiment with 16 Caucasian and 16 Asian photos that are a part of the critical stimuli.

The context faces came from the same stimulus set as the critical stimuli and were selected on the basis of minimising distinguishing characteristics within each photo. As such, all the photos were black and white yearbook photos. They were photos of the head and neck only with minimal distinguishing characteristics (e.g., jewellery).

Counterbalancing in this experiment was identical to that of the ORE Replication experiment. The context items were counterbalanced for grade of photo (grade 10 vs. grade 11) such that half of the context set contained grade 10 photos and the other half contained grade 11 photos. Each context face was presented as either a grade 10 or a grade 11 photo across participants. Each group of photos contained an equal number of male and female photos.

Procedure

Prior to the experiment, participants were instructed that they would be required to study a set of faces that they would have to remember for a subsequent memory test. The experiment consisted of a study phase and a test phase. During the study phase, participants were presented with 32 critical faces (1/2 Caucasian; 1/2 Asian) and the 64 context faces in random order. Each face was presented on screen for 3 seconds. Once the study phase was complete, participants were given instructions on how to complete the test phase. The test phase was identical to ORE replication experiment. None of the context items were presented during the test phase.

4.1.2 Results

Only data from the 64 critical faces were submitted to the following analysis. Table 4.1 displays mean hit and false alarm rates for Caucasian and Asian photos. The ROC curves

Race of Photo	Caucasian Ss	
	Hits	False Alarms
Caucasian Photo	0.63	0.38
Asian Photo	0.69	0.37

Table 4.1: Mean hit and false alarm rates on Caucasian and Asian photographs by Caucasian participants under the context manipulation. Error bars indicate mean standard error.

plotted in Figure 4.1 demonstrate the effects of the context manipulation on same- and other-race faces. In comparison to the ORE replication experiment, performance on same-race photos dropped down to the level of other-race face performance while performance on Asian photos remained the same.

An ANOVA performed on A' scores for both Caucasian photos ($M = 0.679$) and Asian photos ($M = 0.707$) yielded no significant main effect of race of photo, $F(1, 15) = 0.897; p = 0.358$. Caucasian participants performed equally well on Caucasian and Asian photos. No ORE was obtained. Recognition, in A' , for Caucasian participants from both the ORE replication and the current context experiment is displayed in Figure 4.2. There was no main effect of bias between Caucasian ($M = -0.016$) and Asian ($M = -0.063$) photos, $F(1, 15) = 0.135; p = 0.718$.

In order to determine the source of the elimination of the ORE in this experiment, recognition for both the ORE replication experiment (no context) and the current context experiment was analysed. A 2 (Race of Photo: Caucasian/Asian) X 2 (Experiment Type: Context/No context) mixed ANOVA with race of photo as a within subject factor was conducted on A' scores yielding a marginally significant main effect of Experiment Type, $F(1, 30) = 3.851; MS_e = 0.090; p = 0.059$, where recognition in the context experiment was lower than in the ORE replication experiment.

There was a significant interaction between Experiment Type and Race of Photo, $F(1, 30) =$

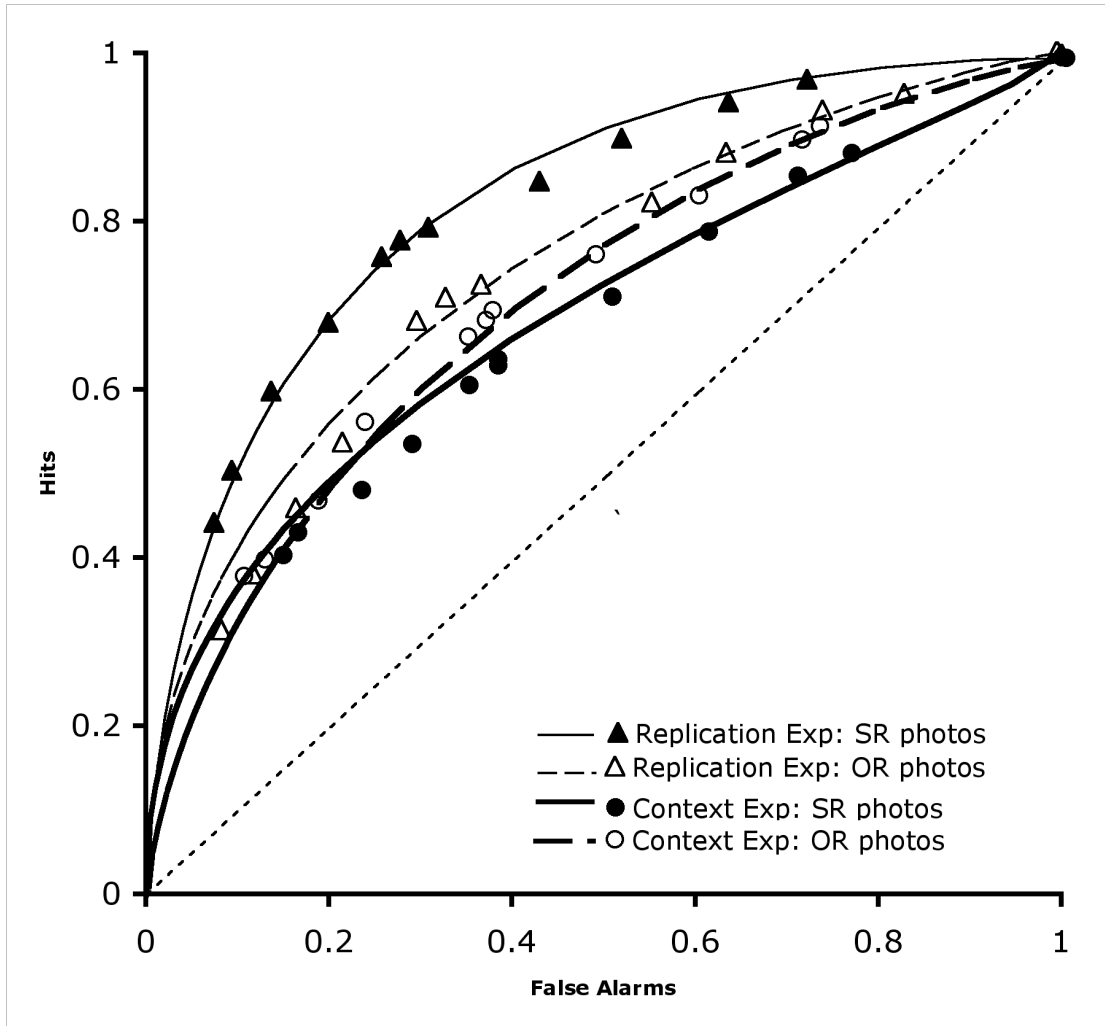


Figure 4.1: Mean receiver-operating characteristic (ROC) hit and false-positive values derived from confidence judgements as well as the fitted ROC curves (assuming equal-variance, Gaussian distributions) as a function of race (Caucasian vs. Asian) of photo for the current context experiment as well as the ROC values and corresponding fitted ROC curves from the ORE replication experiment for comparison.

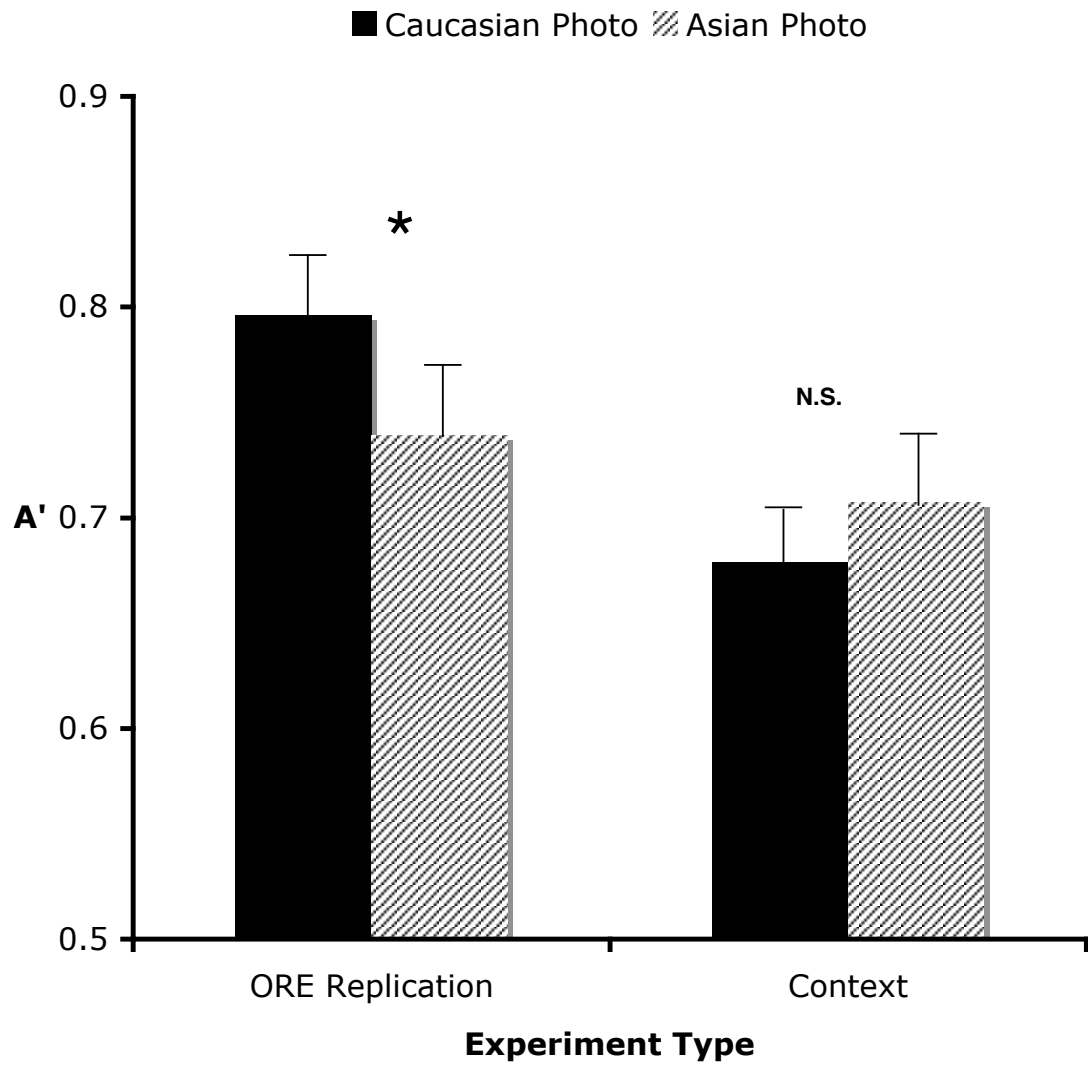


Figure 4.2: Recognition, measured in A' , from the ORE replication experiment (left) for comparison with the results from the current context experiment (right) plotted as a function of race of the photograph (Caucasian vs. Asian). Error-bars are within-cell standard errors.

5.673; $MS_e = 0.029$; $p = 0.024$. To explore this interaction further, simple effects tests were conducted on Caucasian and Asian photo performance. This analysis yielded a significant effect of Experiment Type, $F(1, 30) = 9.705$, $MS_e = 0.110$, $p = 0.004$. Recognition of Caucasian photos was significantly lower in the context experiment in comparison to the no context experiment. Asian photo performance was not significantly different between the context and no context experiments, $F(1, 30) = 0.501$; $p = 0.484$. Performance on Asian photos did not change as a function of context.

4.1.3 Discussion

Introducing a context of predominantly same-race faces during encoding eliminated the ORE. After comparing recognition across the ORE replication (no context) and the current context experiment, the results revealed that the elimination of the ORE in the context experiment was brought about by a significant drop in Caucasian photo performance. Asian photo performance did not change across both experiments.

Although it is difficult to truly match real-world scenarios in the laboratory, simulating real-world proportions eliminated the ORE. As a result of these findings, the contextual environment within which the ORE is studied seems to have a large impact on the nature of the effect. The results from this experiment call into question the types of memory processes that are being measured in both the standard 1:1 ratio and the current experiment where a 5:1 ratio was used. A context of predominately same-race faces during encoding is likely to produce different processing strategies than when the proportions of same and other-race faces are equal. The current context experiment highlights the importance of the contextual experience in modulating the ORE, but it is still unclear what processes may be mediating the influence of context. Further investigations that manipulate the contextual environment in experiments investigating the effect may be helpful in understanding the

influence of context on processes for same- and other race faces.

One of the main arguments that could be made for the elimination of the ORE in the current experiment is task difficulty. In comparison to the ORE replication experiment, there were significantly more photos during the study phase. The larger number of photos could have created more interference and difficulty in remembering faces that might explain the significant drop in same-race photo performance. This idea is likely given the marginally significant effect of experiment type where recognition is lower in the context experiment. Interestingly, however, increasing the number of same-race faces in the experiment did not affect performance on Asian photos at all, but had a large effect on Caucasian faces. If task difficulty is the only explanation to the effect, it is unclear why Asian performance remained untouched with the context manipulation. Whether or not the source of the context effect found in this experiment is related to task difficulty, this experiment does provide evidence for a dissociation between processing for same- and other-race faces as only Caucasian performance was affected by the context manipulation.

Assuming task difficulty is not the only thing mediating the elimination of this effect, experiential hypotheses would have difficulty accounting for the selective influence of context on same-race faces alone. Experiential hypotheses emphasise the role of past experience with faces in moderating the recognition advantage for same-race faces. Same-race face performance, however, was equated with other-race face performance as a result of context. If expertise with same-race faces is the sole mediator to the effect, one would expect the ORE to be much more robust to simple effects of context and rely more heavily on past experience as a guide to remembering same-race faces. Instead, the context manipulation eliminated the ORE altogether. Using an experiential argument alone fails to account for the current results. It is unclear how a lifetime of bias towards optimally processing same-race faces can be eliminated by a simple manipulation introduced during the time of encoding. Something about the context manipulation disrupted participants'

expert processing of same-race faces. Given that the level of expertise was held constant in this experiment and in the ORE replication experiment, the differences in same-race face processing that were observed in the current experiment suggest that there must be more to explaining the ORE than expertise alone.

Also consistent with social categorisation models, the results from this experiment support a processing dissociation between same- and other-race faces. It is possible to explain the reduction in same-race photo performance in terms of categorisation processes that were induced as a result of the large number of Caucasian photos presented. The larger proportion of same-race photos may have had participants categorising each photo simply because individuating the substantial number of same-race faces may have been too difficult when attempting to remember each particular same-race photo.

Both Caucasian and Asian faces are assumed to be categorised in this experiment as a result of context that can explain why performance was equated between the two races of photos. This conclusion is in contrast to the ORE replication experiment where it is presumed that same-race faces are being individuated, not categorised. Thus, the elimination of the ORE could have been brought about by the induction of categorisation processes for same-race faces. Because other-race faces are already categorised, their performance did not change. The influence of context may have brought about categorisation processes for same-race faces. A processing dissociation between same- and other-race faces is also supported by the current experiment as the context manipulation selectively affected performance on Caucasian photos.

Chapter 5

Race Categorisation

5.1 Experiment 4: Influences of Categorisation

Given that same- and other-race faces are likely subject to processing differences, many accounts of the ORE attempt to determine the nature of these differences. Both expertise-based accounts (e.g., configural hypothesis) and social categorisation accounts (e.g., feature-selection hypothesis) propose explanations for the processing differences between same- and other-race faces. As of yet, the nature of the processing differences that might occur for same- and other-race faces is highly debated between the two accounts.

The ORE was modulated by introducing a context manipulation at the time of learning suggesting that situational factors, as opposed to past experience, may play a role in the effect. The ORE may be a flexible phenomenon that can be modulated by various factors given the right task parameters. Expertise-based accounts assume the bias to code same-race faces more accurately than other-race faces is produced by lifelong experience. As a result of this assumed bias, expertise-based accounts have difficulty accounting for the results found in the context experiment as it is unclear why effects of lifelong experience would be over-ruled by a simple context manipulation assuming it is the sole contributor to the effect.

Processes of individuation and categorisation seem to bring with them an inherent flexibility such that manipulations targeting these two processes should produce significant modulations of the effect under the right task parameters. If performance differences for same- and other-race faces are a result of individuation processes for same-race faces and categorical processes for other-race faces, emphasising specific information at the time of learning might modulate the extent to which individuation and categorisation processes are

employed for both races of faces and modulations of the ORE should be seen as a result.

Levin (2000) claims that other-race faces are coded with race-specifying information and same-race faces are coded with individuating information. Experiment 4 tested this hypothesis by associating the categorical label of race with each of the photos in the stimulus set by having participants categorise each face on the basis of race during learning. This manipulation results in pairing the race category with each photo. According to the hypothesis forwarded by Levin (2000), emphasising the race category should be sufficient to induce categorical processing in both same- and other-race faces if it didn't already exist. Categorisation is likely to produce deficits in recognition for these faces if categorical processing is invoked because information contained in categorical processing is not optimal for distinguishing individual faces from one another.

5.1.1 Methods

Participants

Sixteen Caucasian participants took part in the experiment in exchange for a partial course credit.

Stimuli and Apparatus

The stimuli and apparatus were identical to that of Experiment 1 (ORE replication).

Race of Photo	Caucasian Ss	
	Hits	False Alarms
Caucasian Photo	0.55	0.18
Asian Photo	0.68	0.24

Table 5.1: Mean hit and false alarm rates on Caucasian and Asian photographs by Caucasian participants when categorising on the basis of race during study.

Procedure

The procedure of the experiment is identical to that used in the ORE replication experiment except that during the study phase, participants were required to categorise each face as either “Caucasian” or “Asian” using the buttons presented on the screen directly underneath the photo of the face. As in the ORE replication experiment, the images were displayed on screen for 3 seconds even if the categorisation response was made prior to 3 seconds. If no categorisation response was made within 3 seconds, an error message was displayed on screen notifying participants that they must respond within 3 seconds. The button presses were not analysed in this experiment as the intent was to change overall processing of the faces with this manipulation. Failures to categorise the faces were a rare occurrence.

5.1.2 Results

Table 5.1 displays mean hit and false alarm rates for Caucasian and Asian photos. ROC curves for same- and other-race photos as a function of experiment type are plotted in Figure 5.1.

The general pattern shown by the ROC curves was confirmed by a within-subjects ANOVA conducted on A' scores for Caucasian ($M = 0.760$) and Asian ($M = 0.778$) photos. This analysis did not yield a significant main effect of race of photo, $F(1, 15) = 0.472; p =$

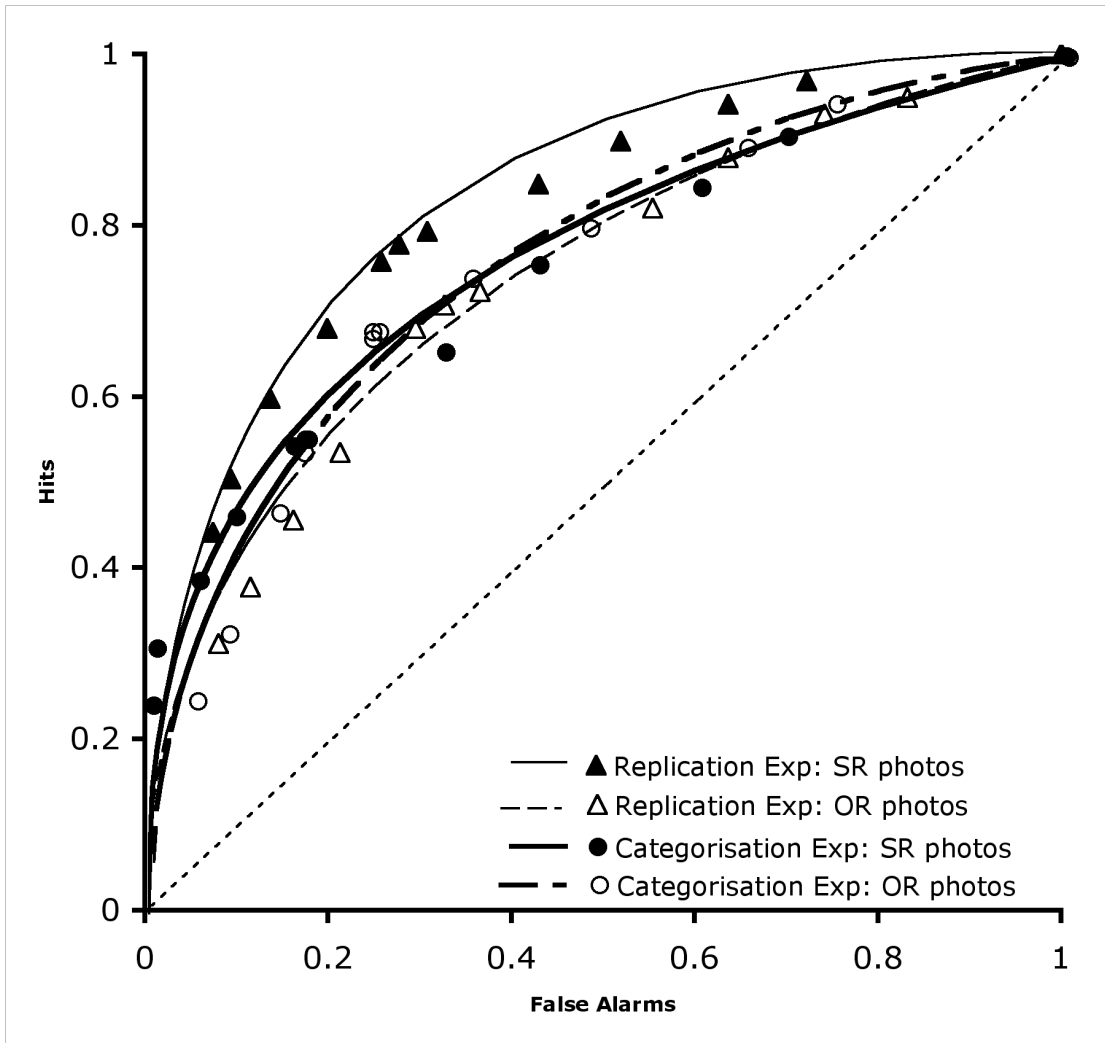


Figure 5.1: Mean receiver-operating characteristic (ROC) hit and false-positive values derived from confidence judgements and the corresponding fitted ROC curves (assuming equal-variance, Gaussian distributions) plotted as a function of experiment type (categorisation vs. ORE replication) for each race (Caucasian vs. Asian) of photo.

0.502. Thus, categorising on the basis of race during study eliminated the ORE. There was a marginally significant effect of bias, $B''d$, $F(1, 15) = 3.720$; $MS_e = 0.761$; $p = 0.072$. Responses to Asian faces ($M = 0.161$) were slightly more liberal than responses to Caucasian faces ($M = 0.470$). Thus, participants were marginally more likely to judge a face as “old” if it were Asian.

In order to determine the source of the elimination of the ORE, analyses were performed comparing recognition from the current race categorisation experiment to the ORE replication experiment. Graphs from both experiments are displayed in Figure 5.2 for comparison purposes.

A 2 (Race of Photo: Caucasian/Asian) X 2 (Experiment Type: replication/categorisation) mixed ANOVA with Race of Photo as a within-subjects variable was conducted on A' scores that yielded a significant Race of Photo by Experiment Type interaction, $F(1, 30) = 4.721$; $MS_e = 0.022$; $p = 0.033$.

5.1.3 Discussion

Emphasising the race category by having participants categorise on the basis of race at encoding eliminated the ORE. Comparisons between the ORE replication and the race categorisation experiments revealed significant differences in recognition suggesting a shift in the way that same- and other-race faces were processed between the two experiments.

Same and other-race face performance was equated in the current experiment suggesting that categorisation no longer subjects same- and other-race faces to the processing differences that occurred in the ORE replication experiment. Levin (2000) explains the other-race deficit as being due to the coding of categorical information in other-race faces that takes away from coding these faces with individuating information. The elimination of the ORE in the current experiment emphasises the role of categorisation processes in

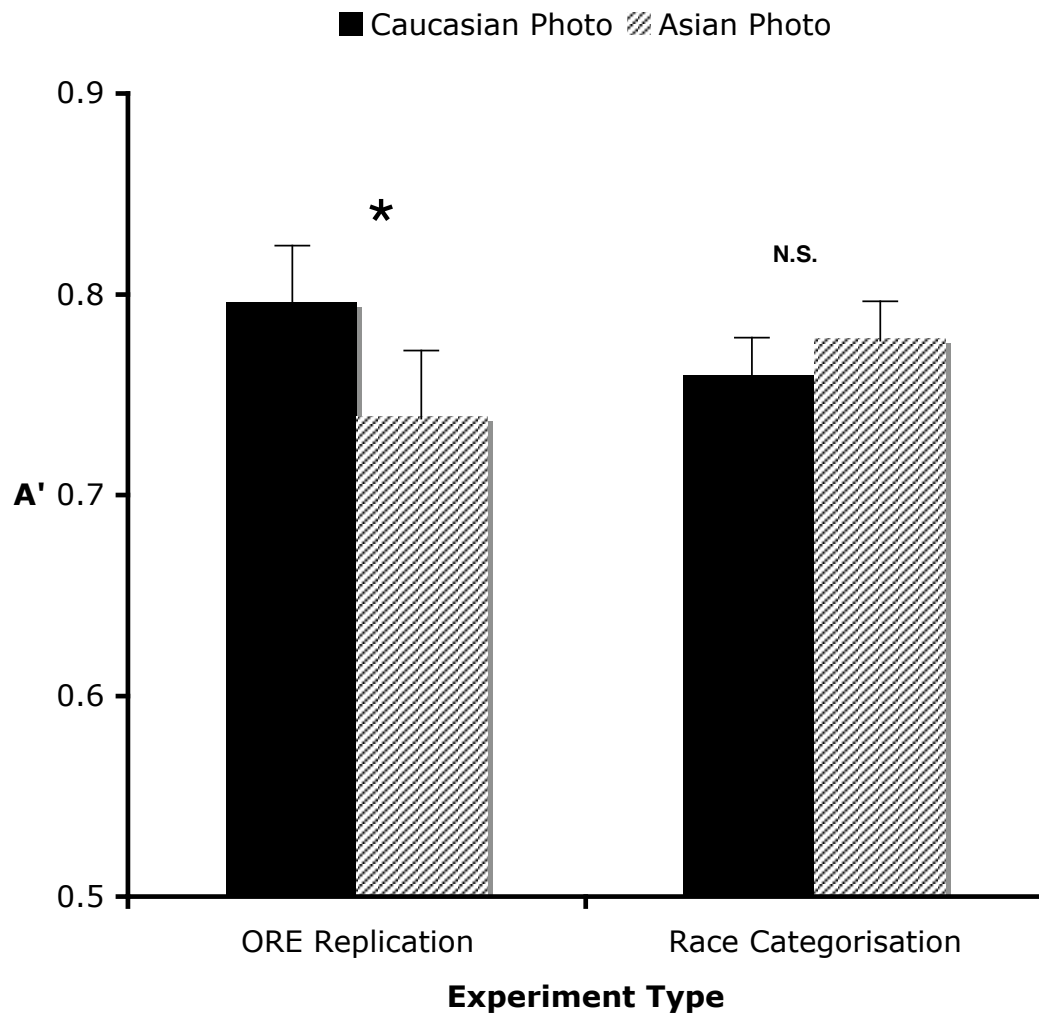


Figure 5.2: Recognition, A' , for Caucasian participants from both the ORE replication experiment (left) and the current race categorisation experiment (right) on same- and other-race photos. Error-bars are within-cell standard errors.

modulating the effect and supports the hypothesis proposed by Levin (2000). Although same- and other-race faces were processed for individuation and categorisation in the ORE replication experiment respectively, the elimination of the ORE as a result of categorisation suggests that both same- and other-race faces were categorically processed to the same degree in the race categorisation experiment.

The results from this experiment provide evidence for the flexible nature that may be inherent in the ORE. Where an effect was present in the ORE replication experiment, a simple categorisation manipulation presumably equated processing between same- and other-race faces to eliminate the effect. Thus, same- and other-race face processing can be modulated rather easily by manipulating information at the time of encoding. Hugenberg et al. (2007) also provide evidence for the flexible nature of the effect by demonstrating an elimination of the ORE by providing participants with individuating instructions. These experiments complement each other nicely because both eliminate the effect in opposite ways using assumptions from social categorisation hypotheses.

It is obvious, when considering the current set of results in combination with those from Hugenberg et al. (2007), that both same- and other-race face performance can be modulated given the right task parameters. These experiments provide further evidence that situational factors may mediate the ORE. The demonstrated flexibility of the effect creates problems for expertise-based models that assume past experience is a strong mediator of the ORE. If expertise was the sole source of the effect, the ORE should have remained intact as there is no reason for expertise-based models to predict the modulations of the effect that were observed in the current experiment as well as in Hugenberg et al. (2007). These modulations likely have nothing to do with the notion of expertise as it was held constant.

It is unclear how a categorisation manipulation or an instructional manipulation might manifest within face space, particularly in terms of their influences on the distributions of same- and other-race exemplars within the space. Generally, the current conception

of face space does not have tenets to allow for the dynamic nature of the ORE nor does it contain any assumptions about how current experience (as opposed to past experience) may influence or be influenced by the dynamics of the space. Despite the cited robustness of the effect, the current results, as well as those of Hugenberg et al. (2007), lead to the conclusion that the ORE is not a static effect and can easily be modulated at the very least by manipulating the use of processes of individuation and categorisation in experimental tasks.

Chapter 6

Other-Sex Effect

6.1 Experiment 5: Other-Sex Effect Replication

The previous experiments have shed some light on the nature of the processing differences that may occur for same- and other-race faces. Age and sex are two other major visual categories of faces that have shown similar recognition differences to the ORE (e.g., Anastasi & Rhodes, 2006; Cross et al., 1971). It is possible that a general memory mechanism may be responsible for recognition across different visual categories of faces. Individuation and categorisation processes may reflect at least a part of the general mechanisms responsible for recognition of different categories of faces.

The other-sex effect (also known as the own-sex effect, own-sex bias, own-gender bias) has been characterised by females having better recognition for female photos than for male photos and males having better recognition for male photos than for female photos. This general trend of performance as a function of sex may be accounted for in terms of individuation and categorisation processes arising for same-sex and other-sex faces respectively. Applying Levin's (2000) feature-selection hypothesis to the other-sex effect, same-sex faces are recognised better because they are coded with individuating information. Other-sex faces are coded using sex-specifying information that is categorical in nature limiting the ability to process these faces for individuation.

In order to examine whether individuation and categorisation processes can also provide an account for the other-sex effect, it is necessary to establish whether the other-sex effect can be replicated using the current set of stimuli. Experiment 5, using the same stimuli as previous experiments, attempted to replicate the other-sex effect. If an effect is found, recognition for female photos should be higher in females relative to males and male photo

performance should be higher in males relative to females. An other-sex effect is defined by a significant sex of participant by sex of photo interaction on A' scores.

6.1.1 Methods

Participants

Twenty-four Caucasian participants (12 male, 12 female) completed the experiment in exchange for a partial course credit in Psychology courses.

Stimuli and Apparatus

The stimuli and apparatus were identical to that of Experiment 1 (ORE replication). Equal numbers of male and female photos were presented to participants. In addition, as in Experiment 1, one-half of the photos in the experiment were Caucasian and one-half were Asian.

Procedure

The procedure of this experiment was identical to that of Experiment 1 (ORE replication) except that during this experiment, sex of photo and sex of participant was coded along with the data in order to determine whether sex effects were obtained.

Sex of Photo	Male Ss		Female Ss	
	Hits	False Alarms	Hits	False Alarms
Male Photo	0.69	0.22	0.66	0.21
Female Photo	0.68	0.26	0.66	0.19

Table 6.1: Mean hit and false alarm rates for Male and Female photographs for both Male and Female participants in Experiment 5.

6.1.2 Results

Table 6.1 displays mean hit and false alarm rates for male and female photos by male and female participants. Figure 6.1 displays the ROC curves for each sex of participant on both male and female photos. As can be seen, recognition was similar on same- and other-sex faces for both male and female participants.

To confirm the lack of recognition differences between same- and other-sex faces for male and female participants that is shown in the ROC curves, an analysis of A' scores using a 2 (Sex of Participant: Male/Female) X 2 (Sex of Photo: Male/Female) mixed ANOVA with Sex of Photo as within subject factors was conducted. Race was collapsed in this analysis. The analysis yielded no significant interaction between sex of participant and sex of photo, $F(1, 22) = 1.179; p = 0.289$.

Although the data superficially appear to fit the pattern of an other-sex effect with both male and female participants, a significant other-sex effect was not obtained. As can be seen in Figure 6.2 depicting A' scores, male participants performed equally well on male ($M = 0.712$) and female ($M = 0.688$) photos, $F(1, 11) = 0.525; p = 0.484$. Female participants also performed equally well on male ($M = 0.780$) and female ($M = 0.798$) photos, $F(1, 11) = 0.788; p = 0.394$. There was a significant main effect of participant sex, $F(1, 22) = 9.281; MS_e = 0.096; p = 0.006$. Male ($M = 0.700$) participants performed at lower levels overall in comparison to female ($M = 0.790$) participants.

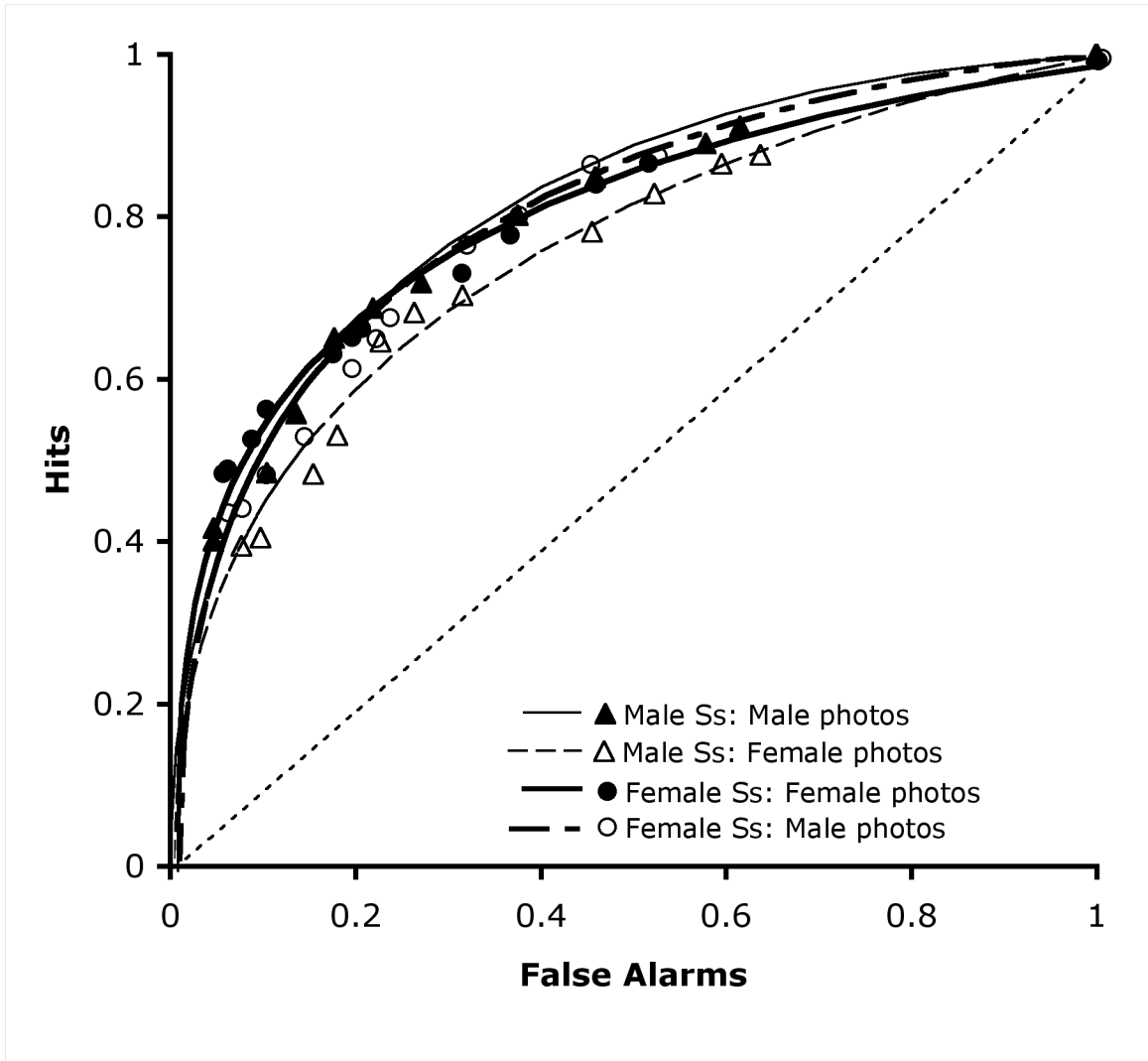


Figure 6.1: Mean receiver-operating characteristic (ROC) hit and false-positive values derived from confidence judgements and the corresponding fitted ROC curves (assuming equal-variance, Gaussian distributions) plotted as a function of sex of participant (male vs. female) for both same- and other-sex photos.

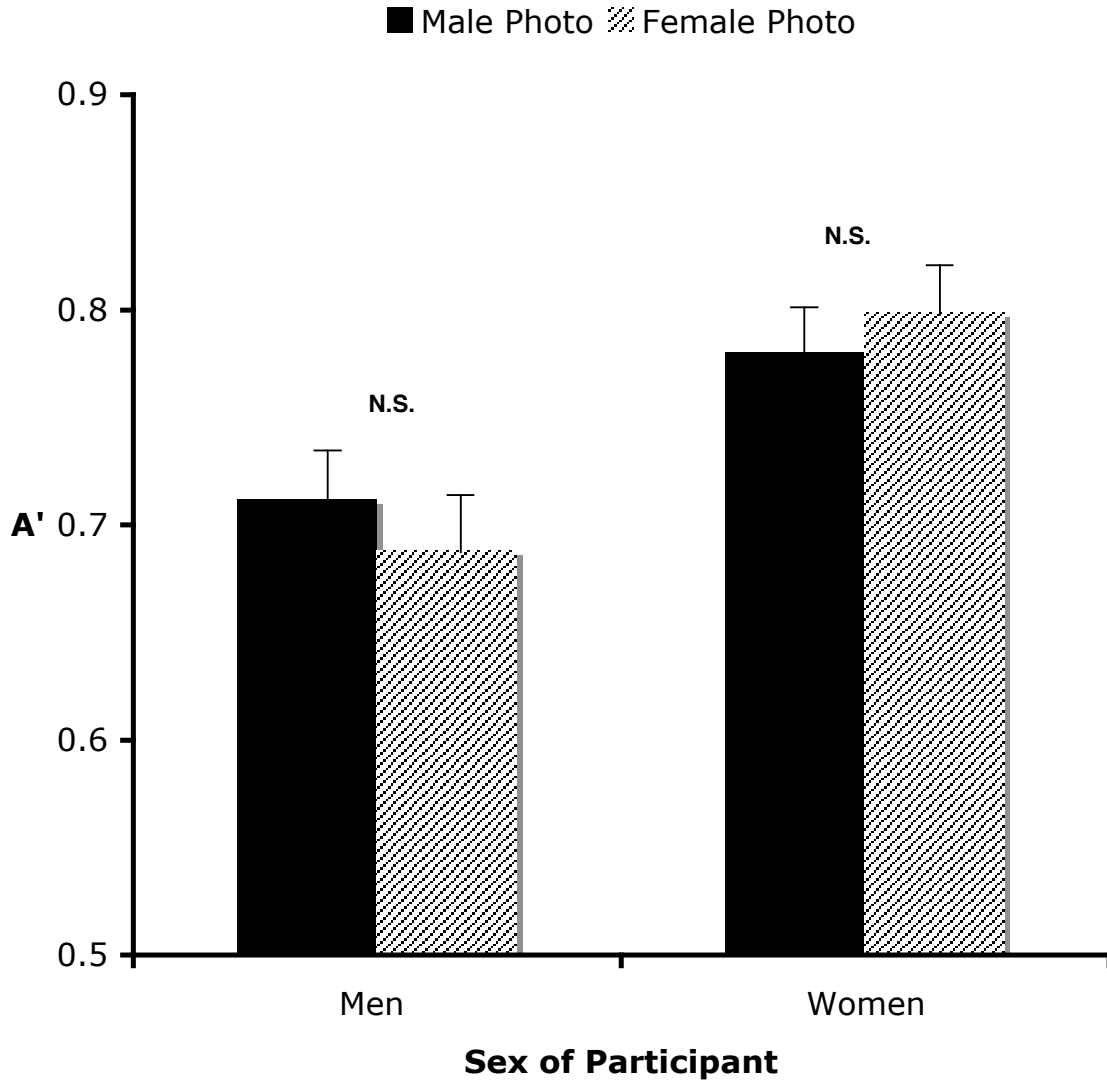


Figure 6.2: Recognition, A' , for male and female participants on both male and female photos using a recognition memory task. Data are collapsed for race. Error-bars are within-cell standard errors.

There was a significant main effect of sex of participant, $F(1,22) = 32.822; MS_e = 3.710; p < 0.0001$ on bias measures. Male participants responded more conservatively ($M = 0.833$) overall than female ($M = 0.277$) participants. There was no main effect on bias of the sex of the photos, $F(1,22) = 0.096; p = 0.759$, nor was there a significant interaction between sex of photo and sex of participant, $F(1,22) = 0.039; p = 0.846$. Males performed at similar levels of bias for male ($M = 0.847$) and female ($M = 0.820$) photos, $F(1,11) = 0.631; p = 0.443$, as did females for male ($M = 0.280$) and female ($M = 0.274$) photos, $F(1,11) = 0.004, p = 0.953$.

A separate analysis was performed to examine whether participants still demonstrated the ORE in this experiment. This analysis was collapsed for sex. An ANOVA conducted on A' scores for Caucasian and Asian photographs yielded a significant main effect of race, $F(1,23) = 5.337; p = 0.03$. Caucasian photos ($M = 0.819$) were recognised better than Asian ($M = 0.771$) photos. Thus, the ORE was replicated suggesting that the lack of an other-sex effect in this experiment is not due to insufficient power.

6.1.3 Discussion

The results of this experiment did not demonstrate a significant other-sex effect. Male and female participants performed equally well on male and female photos. The lack of finding an other-sex effect in this experiment is not a surprising finding given the lability of the effect that has been reported in the literature. McKelvie (1981) performed a small review of the literature examining sex differences in face recognition tasks. Of the 10 studies he examined that make reference to a sex of photo by sex of participant interaction, only 6 of them produced a significant effect.

In comparison to the robust ORE, the other-sex effect for both males and females is not widely established across studies. A significant sex of photo by sex of participant

interaction is sometimes found, but the source of the significant interaction that defines the other-sex effect usually comes from females. (Cross et al., 1971; Lewin & Herlitz, 2002; Rehnman & Herlitz, 2007; Vokey & Read, 1988). Obtaining an other-sex effect in males is extremely rare; however, there are a couple of reported experiments that show an other-sex effect in males, but not in females (Heisz & Shedden, 2007; McKelvie, 1981), as well as a couple of experiments that have been able to produce the other-sex effect in both males and females (Heisz & Shedden, 2007; Wright & Sladden, 2003).

Given the lability of the other-sex effect, it has been difficult to conceptualise possible mechanisms as modulations across experiments have failed to lead to a conclusive source that might explain the lability. It is possible that both the ORE and the other-sex effect share at least some similar mechanisms seeing as they both involve two major visual categories of faces. Experiment 6 attempted to determine whether the mechanisms proposed by Levin (2000) to account for the ORE also provide a theoretical account of the other-sex effect.

6.2 Experiment 6: Sex Categorisation

Although Experiment 5 failed to produce a significant other-sex effect, the primary interest of this line of research was to determine whether processes of individuation and categorisation could provide an account of the effect. Keeping in line with hypotheses forwarded by Levin (2000) to account for the ORE, an other-sex effect may not have been found in the previous experiment because neither sex exhibited a processing dissociation for male and female photos. Thus, an other-sex effect may not have been present because other-sex faces were not categorically processed to a greater extent than same-sex faces.

Experiment 6 was meant to establish whether individuation and categorisation processes could provide an account of and modulate the other-sex effect. It is hypothesised that in the previous experiment, other-sex faces were not being categorically processed to

a greater extent than same-sex faces. If other-sex faces are responded to poorly because they are coded with sex-specifying categorical information, an other-sex effect should be obtained with the present stimuli if the sex category is emphasised at the time of learning. Emphasising the sex category should make participants more aware of the categorical distinctions between male and female and an other-sex effect might emerge.

6.2.1 *Methods*

Participants

Sixteen Caucasian undergraduate students (8 male) participated in the experiment in exchange for a partial course credit.

Stimuli and Apparatus

The stimuli and apparatus were identical to those of the previous experiment (other-sex effect replication).

Procedure

The procedure is identical to that of the previous experiment except that during the study phase of the experiment, participants were required to categorise each face as either “male” or “female” using two buttons underneath the photo. The buttons were presented below the photo of the face. The photo was on screen for 3 seconds regardless of when the participant made their button response. If a categorisation response was not made within 3 seconds, an error message replaced the image and notified participants that they must respond within

Sex of Photo	Male Ss		Female Ss	
	Hits	False Alarms	Hits	False Alarms
Male Photo	0.65	0.23	0.59	0.31
Female Photo	0.59	0.21	0.68	0.24

Table 6.2: Mean hit and false alarm rates for Male and Female photographs for both Male and Female participants in the sex categorisation experiment.

3 seconds. Button responses were not coded as the primary interest was the influence of the categorisation task on face processing. Participants were observed during this time, however, and very few trials occurred where participants did not categorise the face.

6.2.2 Results

Table 6.2 displays mean hit and false alarm rates for male and female photos by male and female participants. Figure 6.3 shows ROC curves for male and female participants on male and female photos. Recognition was similar across all groups except for lower levels of recognition from female participants on male photos.

To explore this pattern of data, an analysis of A' scores using a 2 (Sex of Participant: Male/Female) X 2 (Sex of Photo: Male/Female), ANOVA with sex of photo as a within subject factor yielded a significant interaction between sex of participant and sex of photo, $F(1, 14) = 5.073; MS_e = 0.028; p = 0.041$. Thus, a significant other-sex effect was obtained. There was no main effect of participant sex, $F(1, 14) = 0.237; p = 0.633$, nor was there an effect of sex of photo, $F(1, 14) = 1.358; p = 0.263$.

On bias, there was no significant main effect of sex of participant, $F(1, 14) = 0.812; p = 0.382$, nor was there a main effect of sex of photo, $F(1, 14) = 0.057; p = 0.815$. There was also no significant interaction between sex of photo and sex of participant, $F(1, 14) =$

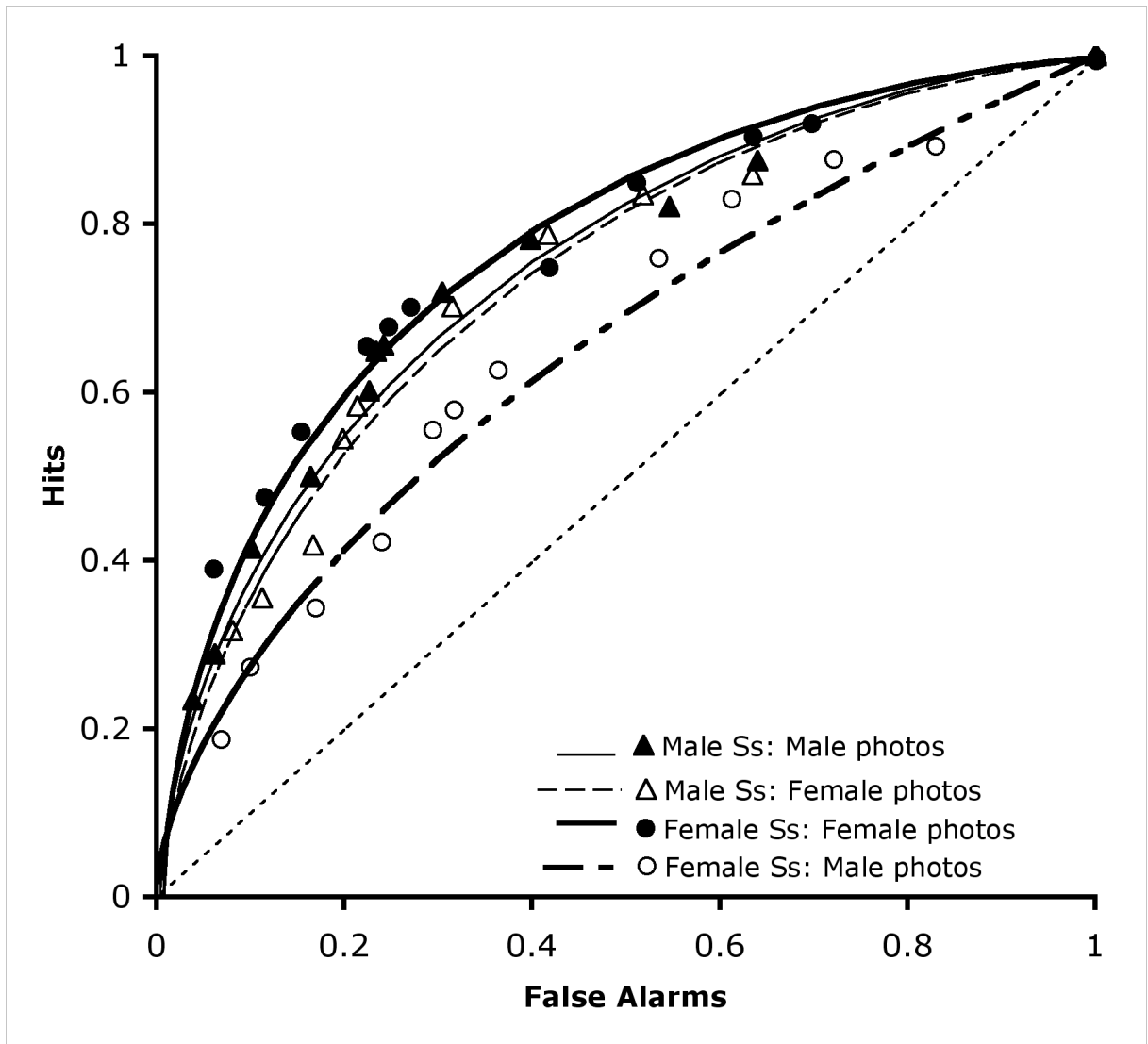


Figure 6.3: Mean receiver-operating characteristic (ROC) hit and false-positive values and the corresponding fitted ROC curves (assuming equal-variance, Gaussian distributions) as a function of sex of participant (male vs. female) for same- and other-sex photos with the categorisation manipulation introduced.

0.444; $p = 0.516$. Male participants performed at similar levels of bias for male ($M = 0.267$) and female ($M = 0.401$) photos, $F(1, 7) = 0.479$; $p = 0.511$, as did female participants on male ($M = 0.199$) and female ($M = 0.135$) photos, $F(1, 7) = 0.080$; $p = 0.785$.

In order to examine the nature of the other-sex effect for male and female participants, separate analyses were performed on male and female participants examining recognition on male and female photos. Female participants demonstrated a significant other-sex effect, $F(1, 7) = 11.076$; $MS_e = 0.032$; $p = 0.013$. Male participants, on the other hand, did not exhibit any recognition differences between male and female photos, $F(1, 7) = 0.401$; $p = 0.547$. As can be seen in Figure 6.4 depicting mean A' scores for each sex of participant on same- and other-sex photos, female participants performed better on female photos ($M = 0.781$) in comparison to male photos ($M = 0.691$). Male participants, however, performed equally well on male ($M = 0.763$) and female ($M = 0.741$) photos.

In order to determine effects of race on sex categorisation, an ANOVA was performed examining recognition of Caucasian and Asian photos. This analysis was collapsed for sex. It is interesting to note in this analysis that there was no significant main effect of race of photo, $F(1, 15) = 0.082$; $p = 0.779$, suggesting that the act of categorising by sex is sufficient to eliminate the ORE. This effect is depicted in Figure 6.5. Categorising on the basis of sex at encoding eliminated the other-race effect. There was not a significant effect of bias between Caucasian and Asian photos, $F(1, 15) = 2.128$; $p = 0.165$.

6.2.3 Discussion

Emphasising categorical information about sex during study produced a significant other-sex effect. The result is in comparison to Experiment 5 where an other-sex effect was not obtained. The ability to invoke an other-sex effect based on the categorisation manipulation provides evidence that individuation and categorisation processes may be significant medi-

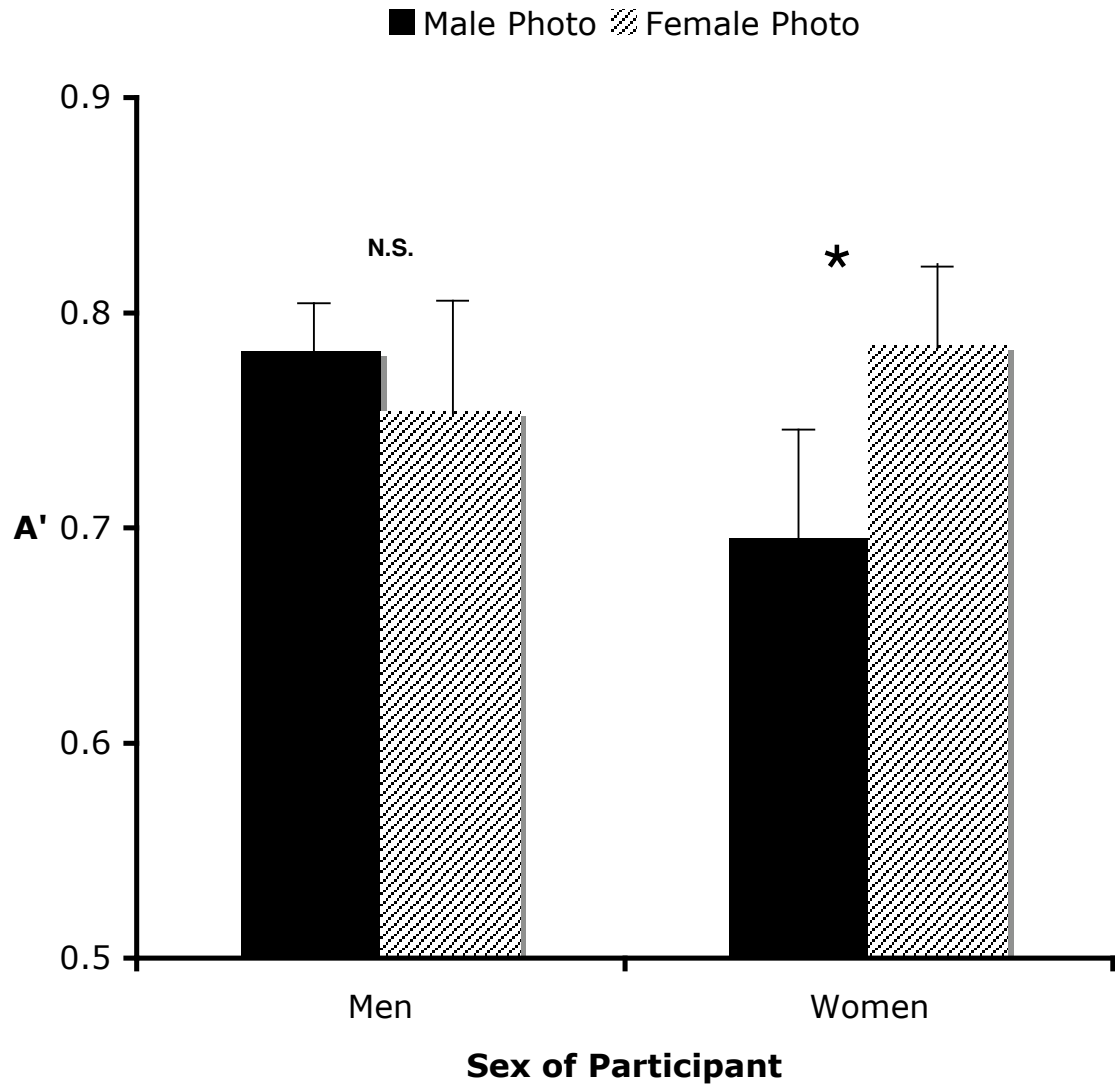


Figure 6.4: Recognition, A' , for male and female participants on both male and female photos using a categorisation task within the recognition memory paradigm. Data are collapsed for race. Error-bars are within-cell standard errors.

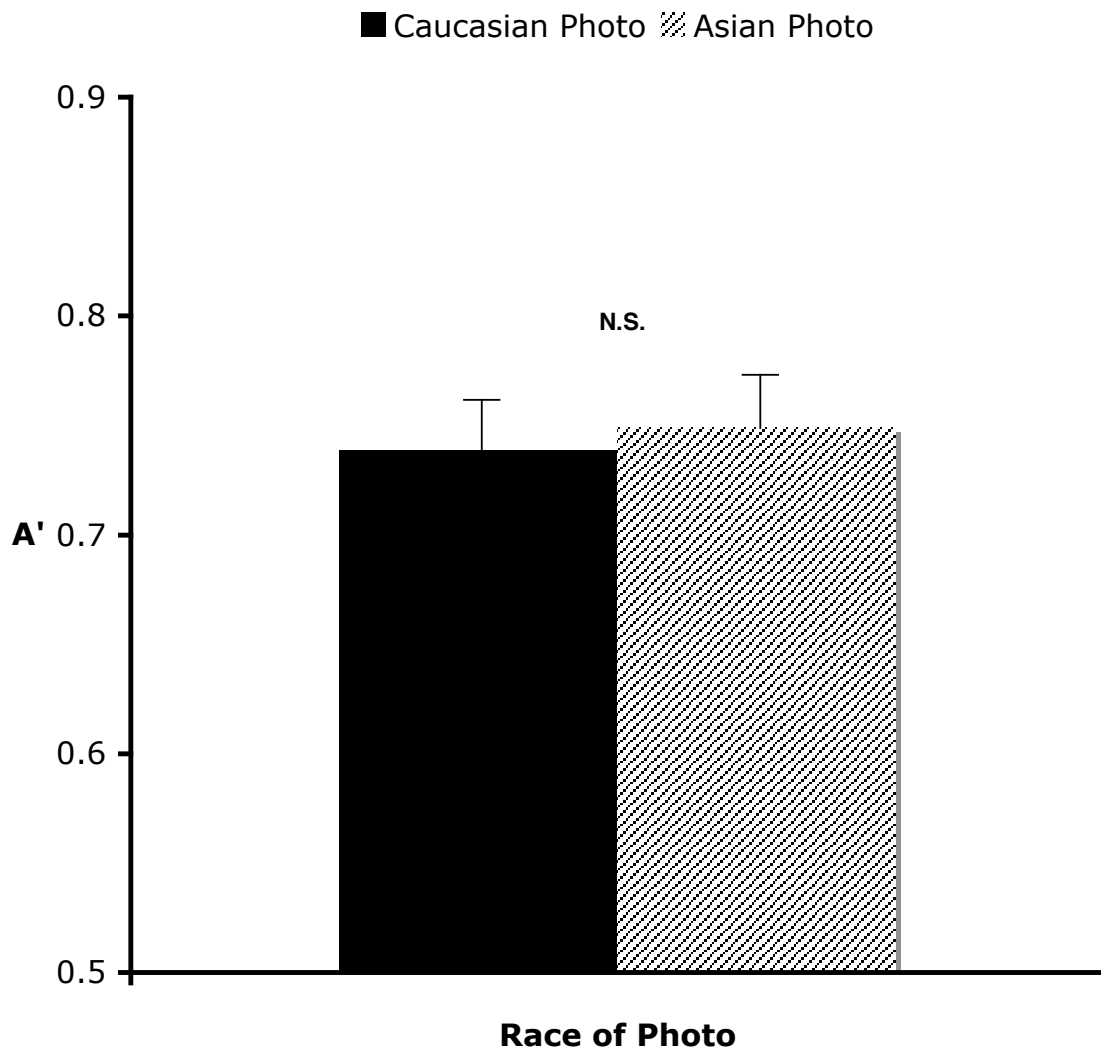


Figure 6.5: Recognition, A' , for Caucasian and Asian photographs under the sex categorisation manipulation. Error-bars are within-cell standard errors.

ators of the effect. The results of this experiment provide support for social categorisation models, particularly an extended version of the feature-selection hypothesis forwarded by Levin (2000). Although the hypothesis forwarded by Levin (2000) was proposed to explicitly account for the ORE, it seems as though similar mechanisms are involved in the other-sex effect. The results suggest that the categorisation manipulation led to categorical processing of other-sex faces for female participants. It is unclear why the categorisation manipulation selectively affected other-sex faces as opposed to inducing categorisation processes in both sexes of photos. Regardless, this experiment provides evidence that the ORE and the other-sex effect may be accounted for by similar mechanisms.

A significant sex of subject by sex of photo interaction was obtained that defines the other-sex effect. Further analyses, however, revealed that only female participants exhibited recognition differences between Experiment 5 and the sex categorisation experiments. There was a reduction in male photo performance for female participants in comparison to female photo performance. It is thought that females were originally individuating both same- and other-sex faces in Experiment 5, but the categorisation manipulation shifted processing of male photos to categorisation in the current experiment.

Males showed no performance differences between male and female photos across either Experiment 5 or 6. It is hypothesised that males processed all faces for individuation across both experiments. At this point, it is unclear as to what factors may induce an other-sex effect in males or why females tend to prominently exhibit the effect. It is obvious from the literature that there are differences between males and females that could affect their recognition for same- and other-sex faces.

Men and women have consistently been found to perform differently on different forms of episodic memory tasks including face recognition tests. Women have been found to excel over men on episodic memory tasks emphasising a verbal component and have been found to outperform men on overall face recognition (Herlitz, Airaksinen, & Nordstrom,

1999; Lewin, Wolgers, & Herlitz, 2001; Herlitz & Yonker, 2002; Rehnman & Herlitz, 2007). The advantage that women show in verbal episodic memory tasks is not due to an overall superiority in verbal ability as men and women do not show any differences on tests of verbal ability (Lewin & Herlitz, 2002). Men, on the other hand, tend to outperform women on most episodic memory tasks with a visuospatial component (Herlitz et al., 1999; Lewin et al., 2001; Herlitz & Yonker, 2002; Rehnman & Herlitz, 2007). Thus, there are obviously inherent differences in males and females that create performance differences on a variety of episodic memory tasks all of which can confound finding the right modulators of the other-sex effect.

Despite all these differences, however, the current experiment suggests that information coded at the time of learning might also be crucial to understanding this effect. Introducing the sex category disrupted females' ability to recognise male faces but had no effect on recognition for male participants. Heisz and Shedden (2007) confirmed these notions and was the only set of experiments found that manipulated the type of information associated with the face at the time of learning. They demonstrate modulations of the other-sex effect by manipulating verbal labels at the time of learning. When pairing sex category labels, unique names or nothing (no label), male and female participants had an other-sex effect for all associational groups. In Experiment 2, everything was identical except for the trials associated with the sex category. Those trials were switched with a sex neutral occupation and they found that only male participants demonstrated a significant sex interaction. Thus, the type of information associated with the photos at the time of learning does seem to be a modulator of the other-sex effect in males and females. It seems as though the act of categorising as well as the specific information on the label may modulate male and female performance differences for this effect. Due to various differences between males and females, they may differentially respond to numerous categorical variables (e.g. women to sex category, men to occupation) and whether they make use of individuation or cate-

gorisation processes as a result of a manipulation is likely highly variable and difficult to predict.

McKelvie (1981) suggests that the other-sex effect may be a result of the ability of participants to identify with the faces in the photos. If the other-sex effect is related to the extent to which individuals can identify with the stimuli, perhaps the key to finding some consistency within the highly variable other-sex effect literature maybe is taking advantage of information that males and females can identify with in memory tasks to produce differential responding between male and female photos. Occupation may be one such example that might produce a male other-sex effect as males may identify with the labels and begin categorising the females.

Although Heisz and Shedden (2007) manipulated occupation information as one of the labels and obtained a significant male other-sex effect, it is unclear to what extent the occupation label affected the male other-sex effect if at all. The male other-sex effect was present in both Experiment 1, with no occupation label, and Experiment 2 when the occupation label was present and had replaced the sex category label. Thus, the significant male other-sex effect seen could be a function of stimulus set or some other variable, not necessarily type of information manipulated. Given these concerns, it is still an open question whether directly manipulating occupation information might produce a male other-sex effect.

By manipulating the use of individuation and categorisation processes in addition to the specific type of information emphasised in those manipulations it may be possible to find some form of consistency within the highly variable other-sex effect literature. Females predominantly show this effect. However, experimental tasks may be designed to favour a female other-sex effect. Given the results of the current experiments, it may be possible to obtain a male other-sex effect by emphasising male-specific information and manipulating the use of individuation and categorisation processes.

The other-sex effect is a difficult effect to study because of the lability seen across experiments. Nevertheless, the current experiments have shown a modulation of the other-sex effect as a function of a categorisation manipulation that was designed to have induced categorical processing of other-sex faces. The lack of an other-sex effect for males in this experiment could be attributed to a lack of using a categorical variable that males could identify with that might actually emphasise the sex category for them. Males may not have been sensitive to the sex category presented in this experiment and thus they didn't produce stronger categorisation towards females relative to males. Regardless, further understanding in the other-sex effect may be obtained by further manipulating the extent to which both males and females differentially use individuation and categorisation processes in their recognition judgements and how these processes are mediated by the type of information paired with the face during learning for both sexes.

Chapter 7

General Discussion

The present experiments were conducted primarily to explore mechanisms underlying the ORE. The other-sex effect was also explored within this set of research in order to establish whether both effects may be accounted for using similar mechanisms.

When face recognition is emphasized instead of picture recognition by changing the photos across study and test phases of the memory paradigm, the ORE disappears. Using the same photos across study and test phases creates an artificial environment where face recognition processes may not even be employed in the to-be-remembered faces as people can depend on superficial image characteristics when making their recognition judgements. The elimination of the effect under the change photo manipulation where face recognition is emphasized suggests that the ORE may be an artifact of the laboratory paradigm and not necessarily a phenomenon involving face recognition processes that are used in the natural world.

Introducing a context of predominantly same-race faces into the memory paradigm eliminated the ORE. The contextual environment of the faces within the memory paradigm moderated the effect. It may be possible that the elimination of the effect may be brought about by a mismatch in the contextual environments of the stimulus faces between the study and test phases. Having two different contexts between study and test might require two different processing strategies, whereas in the standard paradigm with a ratio of 50:50 same- versus other-race faces, the contextual conditions are equal suggesting the use of similar processing strategies between the two phases. In the real-world, contextual conditions will often not be equal between the time an individual learns a face and the time that same individual must recognise the face suggesting that the standard 50:50 ratio used may not be measuring how individuals process same- and other-race faces in the real-world. Al-

though differences between same- and other-race faces are considered robust, the standard 50:50 paradigm masks the influence of the contextual environment on same- and other-race face processing by holding the context constant. The results from this experiment suggest that the ORE is contingent upon the contextual environment that same- and other-race face performance is examined and that tests of this effect using a standard 50:50 ratio of same- and other-race faces may not be measuring processes used in the real-world to recognise same- and other-race faces.

Categorising on the basis of race eliminated the ORE. Consistent with the hypothesis forwarded by Levin (2000), categorisation modulated recognition of same- and other-race faces supporting the role of categorisation processes in the effect. Although it was difficult to obtain Asian participants for testing, in all of the race-related experiments reported here it would have been useful to demonstrate the same effects with Asian participants to ensure the effects could be replicated across different races of participants.

The other-sex effect was also modulated by emphasising categorical information. Categorising on the basis of sex during encoding induced an other-sex effect. The modulation of both the ORE and the other-sex effect as a result of the categorisation manipulations suggests that processes of individuation and categorisation may be suitable mechanisms for helping to understand the nature of both the ORE and the other-sex effect.

Although the current data support social categorisation explanations for the ORE, the most widely accepted explanation involves the amount of experience that individuals obtain with same- and other-race faces. Tests of the experiential hypothesis have found inconsistent results, but an explanation for the effect must involve differing levels of experience between the races. Experience is clearly necessary to produce the ORE.

The ORE is not found in young children at about the age of six (Chance, Turner, & Goldstein, 1982). Instead, it emerges later in life suggesting a strong experiential component. In addition, Sangrigoli et al. (2005) found that Korean individuals who were adopted

by Caucasian families show a reversal of the ORE in adulthood. It seems as though the effect requires time and experience to develop. Differing levels of experience likely have some role in the effect, although it remains unclear what expertise may actually contribute to processes underlying the ORE. It is possible that expertise helps to determine which set of faces is subject to categorisation processes.

The face space model originally proposed by Valentine (1991) explains the effect primarily in terms of how experience biases the dimensions within the multi-dimensional space towards optimal recognition of same-race faces. Poor recognition of other-race faces is thought to be brought about by their dense distribution within the space. The nature of this distribution is thought to occur because the space is not optimised to discriminate the subtle features with which other-race faces vary.

Although face space provides a viable account for some of the results surrounding the ORE, it cannot account for the race categorisation experiment. The face space model does not seem to have the tenets to explain why a categorisation manipulation would result in an elimination of the ORE. It is also unclear how the elimination of the effect might be manifested within the dynamics of face space. For example, the model does not make predictions about how categorisation might affect the distributions of faces within the space. Generally, face space has difficulty accounting for these results because it relies heavily on expertise to account for recognition and does not incorporate the role of situational factors in the effect.

The face space model also has difficulty accounting for various other effects in the literature as well. MacLin and Malpass (2001) directly tested the assumptions of the face space model using ambiguous race faces that were composed by overlapping facial features across racial lines from three races of faces. These faces were constructed to be perceptually similar in all respects except for the presence of a racial marker that signalled which racial category the face belonged to. In these experiments, the racial marker was hair and

participants accurately classified each of these faces as belonging to the racial category signalled by the hairstyle. The use of perceptually similar faces was done in an attempt to hold perceptual expertise with these faces constant. Given that there are no large perceptual differences between these faces, the face space model would predict that these faces should be located near each other within face space and should not exhibit any recognition differences between races as a result. Contrary to predictions from face space, participants demonstrated the standard ORE to these perceptually similar faces.

Face space also has difficulty accounting for the elimination of the ORE as a result of the instructional manipulation introduced by Hugenberg et al. (2007) where participants were instructed to individuate same- and other-race faces as best as possible. The manipulation did not alter the level of expertise in any way and eliminated the effect by emphasising individuating information. There are no tenets within face space to account for why individuating instructions might eliminate the effect.

The ORE has shown a remarkable amount of flexibility when considering recent experiments that emphasise the influence of situational factors in moderating the effect. Experiments involving modulations of the ORE as a function of mood as well as demonstrating an effect using experimentally-defined groups that are equivalent in terms of the level of expertise between groups have also shown modulations of the effect based on manipulations that do not directly address the level of expertise between groups (Bernstein, Young, & Hugenberg, 2007; Ackerman et al., 2006; Johnson & Fredrickson, 2005). It seems as though situational factors occurring during the experimental session can overcome any biases brought about as a result of expertise that is developed over an individual's lifetime. The emphasis that expertise-based accounts place on past experience limits their ability to incorporate current factors into the recognition decision process.

Processes of individuation and categorisation can account for all of the results presented above by assuming that other-race faces are processed categorically. The racial marker

in MacLin and Malpass (2001) that classified each perceptually similar face into a racial category served to instigate categorical processing of that face (given it was an other-race face) leading to poorer recognition. The elimination of the effect found by Hugenberg et al. (2007) can be explained through the induction of individuation processes for other-race faces. Modulations of the ORE as a result of manipulations of mood (Ackerman et al., 2006; Johnson & Fredrickson, 2005) and demonstrating an ORE with experimentally-defined groups that are equivalent in terms of the level of perceptual expertise in each group (Bernstein et al., 2007) are also examples of experiments that are difficult to account for using an expertise argument alone but are fully explainable in terms of differential emphasis on individuation and categorisation processes.

In contrast to expertise-based models that bear an inflexibility as they are highly dependent upon past experience to explain the effect, individuation and categorisation processes are inherently flexible and can account for various modulations of the effect because it is already presumed that different situational factors can modulate these processes. The inability for expertise models such as face space to account for the flexibility seen across the current experiments as well as others in the literature simply reflects an inability for these models to account for the dynamic nature of the ORE whose modulations are not necessarily directly dependent upon expertise.

Social categorisation models have the advantage of accounting for the flexibility in the ORE, but they fail to make explicit assumptions about the role of experience in the effect. Even though it is possible to incorporate hypotheses about the role of experience within social categorisation models, theoretical arguments for these models often involve arguing against the viability of experiential hypotheses (e.g., Levin, 2000). Both expertise-based models and social categorisation models provide some account of the data presented for the ORE thus far; however, both models in isolation cannot account for the mechanisms underlying the effect.

Interestingly, O'Toole, Abdi, Deffenbacher, and Valentin (1993) performed a set of simulations investigating the role of different subsets of eigenvectors in the reconstruction of faces using an autoassociative neural network that is comparable to the face space model. O'Toole et al. (1993) trained the neural network on a set of faces and examined whether the recognition produced by the model would differ depending on which subsets of eigenvectors were used to reconstruct the face images. Eigenvectors form the dimensions of a multidimensional space. In some sense eigenvectors can be thought of as representing macro features of faces because a face is reconstructed by adding the weighted eigenvectors together (Abdi, Valentin, Edelman, & O'Toole, 1995; Valentin, Abdi, & O'Toole, 1994).

O'Toole et al. (1993) found that faces reconstructed using eigenvectors in the higher dimensions of the space produced better discriminability between old and new photos than eigenvectors in the lower dimensions of the space. High-dimensional eigenvectors appear to be optimal for recognition of faces and low-dimensional eigenvectors seem to code categorical information about faces. Valentin and Abdi (1996) were also able to demonstrate this point by manipulating face orientation and pose. Low-dimensional eigenvectors seem to convey low frequency information that contains information about the basic shape of the face highlighting information common to many faces while high-dimensional eigenvectors seem to contain unique information that is specific to only a few faces (Valentin et al., 1994).

The types of information coded in high- and low-dimensional eigenvectors becomes apparent in viewing Figure 1 of O'Toole et al. (1993) where faces reconstructed using low-dimensional eigenvectors lack individuating characteristics and only macro-features (e.g. shape of head, eyes) of the faces are visible. On the other hand, reconstructions using high-dimensional eigenvectors produce faces containing unique facial characteristics that allow for the identification of a particular individual.

It might be plausible to suggest that processes of individuation and categorisation may

already manifest themselves within face space in terms of being represented on different subsets of eigenvectors. These processes may arise depending on which subsets of eigenvectors are used for recognition among faces within the space. Individuation processes would be associated with codings on high-dimensional eigenvectors and categorisation processes would be associated with codings on low-dimensional eigenvectors. Given that low-dimensional eigenvectors are thought to code for categorical information and high-dimensional eigenvectors seem to code for individuating information, the main processes underlying the social categorisation perspective on the ORE already seem inherent within the structure of face space.

Given this, it seems intuitive to begin considering an integrative approach to studying the ORE by using tenets from both social categorisation models and the expertise-based face space model. Both models are able to account for various findings in the literature albeit each account for different sets of data. Approaching the ORE from an integrative perspective that incorporates both experience and processes of individuation and categorisation can account for the general trend of the ORE by claiming that same-race faces are coded among high-dimensional eigenvectors that are optimal for recognition whereas other-race faces are coded among low-dimensional eigenvectors that are coded categorically.

Given the robust nature of the effect, it can be argued that the general trend to code same- and other-race faces in this way may, at least in part, be due to the effect of past experience on the structure of the space. Past experience could create a bias to code same-race faces on high-dimensional eigenvectors and other-race faces on low-dimensional eigenvectors. Coding the faces in this way results in a general bias for processing same-race faces with individuation and other-race faces with categorisation. Thus, the general tendency to code other-race faces inaccurately may be due to the strong influence of past experience that sets up a structure to the space that biases other-race faces to be coded on eigenvectors that code for categorical information.

The ORE, however, represents much more than simply a general trend to code other-race faces inaccurately and the dynamic nature of the effect can be seen in the various experiments, including the current set, that show remarkable flexibility that cannot be attributed to past experience alone. Although flexibility is not obvious in face space as proposed by Valentine (1991), the simulations from O'Toole et al. (1993) demonstrate that multidimensional spaces such as face space that are primarily built upon experience might already contain an inherent flexibility where the dynamics of the space are modulated by various external factors that affect the perception and recognition of faces.

The current set of race categorisation results can be explained through this account. Same-race faces are thought to be coded by high-dimensional eigenvectors in the ORE replication experiment. The bias to code same-race faces with individuation was disrupted by the categorisation manipulation resulting in a shift in the eigenvectors that normally code same-race faces. Instead of being processed on high-dimensional eigenvectors, same-race faces were processed on low-dimensional eigenvectors. No such shift occurred for other-race faces as they continued to be coded on low-dimensional eigenvectors where categorisation was prominent. Thus, same- and other-race face performance was equated because both were being coded with low-dimensional eigenvectors.

The instructional manipulation introduced by Hugenberg et al. (2007) can also be accounted for by assuming that the instructions shifted the bias for other-race faces to be coded on low-dimensional eigenvectors. Instead, other-race faces were coded on high-dimensional eigenvectors and as such, same- and other-race performance was equated. At this point, it is not clear whether high-dimensional and low-dimensional codings can be as flexible as individuation and categorisation processes have been shown to be. This approach assumes that eigenvector codings are flexible with respect to experimental manipulations and the categorisation manipulation was sufficient to change the eigenvector ranges coding same-race faces from a high-dimensional eigenvector range to low-dimensional eigenvec-

tor range.

The primary assumptions regarding the influence of individuation and categorisation processes within a computational model such as face space still need to be tested in order to determine whether neural network simulations that test these assumptions provide a match to the human data already collected. In addition, although this approach can provide an account of the data presented here, very little is known about what the dynamics are between experience and individuation and categorisation processes and how these dynamics may manifest within the space.

Effects of experience may act to modulate the presence of individuation or categorisation processes in a given task or these processes may modulate effects of experience such that they may modulate the strength of past experience in mediating effects. In certain circumstances situational factors may dominate over past experience and eliminate the general bias to code same-race faces more accurately than other-race faces. Additionally, effects of expertise may modulate which subsets of eigenvectors code particular faces. At this point, any explanation involving how effects of experience may interact with the information coded by particular subsets of eigenvectors and how these influences may interact with the structure of the space is pure speculation.

The main attribute from face space that is missing from the above approach involves the role of the distributions of same- and other-race faces within the space and how these distributions reflect on the nature of the ORE. It may be possible that same- and other-race faces are represented in the proposed distributions in face space generally, but a static view of the distributions of same- and other-race faces in the space cannot account for many of the experiments reviewed above that demonstrate modulations of the ORE that cannot be explained by experiential hypotheses alone. It might seem logical to suggest that the distributions within the space are more dynamic with respect to the various factors that may modulate how same- and other-race faces are represented in the space. In terms of the

proposed approach to the ORE, it is unclear how the distributions of same- and other-race faces may interact with the structure of the space to modulate the effect. More specifically, how effects of experience and individuation and categorisation processes might modulate, and be modulated by, the distributions of exemplars within the space.

Although the proposed integrative approach remains to be tested, it is primarily meant to provide a more dynamic conceptualisation of the mechanisms underlying the ORE. Conceptualising the ORE using this approach allows for an account of the various modulations of the effect reported above while incorporating the role of experience. Integrating both expertise-based models and processes of individuation and categorisation seems to be intuitive given the results of O'Toole et al. (1993). Further investigations into how effects of experience and processes of individuation and categorisation interact together and manifest themselves within a multidimensional space may provide further insight into mechanisms underlying the effect. In addition, conceptualising the ORE in the proposed approach incorporates the dynamic nature of the effect that has been found in recent experiments as well as providing a way to explain it in terms of an approach that has the potential to be equally dynamic in nature.

The ORE may represent a phenomenon whose mechanisms reflect those of a more general memory phenomenon as opposed to being an isolated effect in and of itself. Processes of individuation and categorisation seem to have generality that would allow them to account for various memory phenomena. The other-sex effect was originally investigated to determine whether these processes might provide an account of this effect as well. Female participants exhibited a significant other-sex effect as a result of categorising on the basis of sex during learning while male participants did not.

Although a female other-sex effect is much more prominent in the literature than a male other-sex effect, it is unclear what mechanisms may be underlying the female other-sex effect. The induction of an effect for female participants cannot be explained by claiming

that females exhibit superior recognition in comparison to males as overall recognition between the sexes was equivalent in the sex categorisation experiment.

Perhaps females spend more time individuating members of their own sex than males. Thus, there may be a strong bias to code females for individuation leading to a more robust advantage in female participants for recognising female photos over male photos. The detriment in male photo performance as a result of categorisation may be accounted for by claiming that females, who may have more experience with same-sex faces, were less experienced at individuating male photos and as a result were more sensitive to the categorisation manipulation. Face processing of female photos by female participants, however, may be more robust to the categorisation manipulation as a result of experience that can provide an explanation for why categorisation did not affect performance on these photos. It is possible that males may not have been sensitive to the categorisation manipulation having spent equal amounts of time individuating both male and female photos.

Although the categorisation manipulation failed to invoke categorisation processes in male participants, it is probably possible to invoke categorisation processes in males. The other-sex effect may be as flexible and subject to situational factors as the ORE. Indeed, the lability of the effect suggests that it is dependent on situational factors. Thus, given the right task parameters, it should be possible to induce a male other-sex effect.

By emphasising categorical information during learning that is relevant to males, such as occupation, it may be possible to obtain a male other-sex effect with these stimuli. Future tests involving manipulations that modulate the use of individuation and categorisation processes in same- and other-sex faces are likely to further elucidate the specific mechanisms that underlie the other-sex effect and possibly lead to the induction of a male other-sex effect. A face space model of the other-sex effect was not found in the reviewed literature.

Social categorisation models, particularly the feature-selection hypothesis, receive full support from the experiments reported here. Social categorisation models, however, limit

the use of individuation and categorisation processes to the idea that social cognitions give rise to various categorical distinctions. Thus, explanations from social categorisation mechanisms are limited to socially-defined in-groups and out-groups. The ORE and the other-sex effect represent the social categories of race and sex. Categorical processing is thought to occur for the out-group—that would be other-race and other-sex faces. Recognition differences that were found based on age are another major socially-defined category that may be accounted for in terms of these processes.

The use of individuation and categorisation processes, however, may even extend beyond socially defined categories to reflect more general memory processes that can account for various categorical effects including those that extend beyond the social realm. This claim has yet to be investigated, but would require using a non-socially defined category of a face (e.g., nose size) and manipulating the use of individuation and categorisation processes within stimulus groups of that category to produce a recognition deficit for one group in that category. Thus, this experiment would represent a simulated other-race effect. If successful, individuation and categorisation processes would represent more of a general category mechanism of memory as opposed to a socially-defined mechanism.

Both the ORE and the other-sex effect have proven difficult effects to understand. Although they have their differences, the present experiments provide support that they may share some underlying mechanisms. Although the highly robust other-race effect and the highly labile other-sex effect do have differences, individuation and categorisation processes seem to be modulating both effects. Given that individuation and categorisation processes seem to be a commonality between both effects, the other-sex effect may fit into the integrative model of the ORE proposed above by claiming that different subsets of eigenvectors, those representing individuating and categorical information, code either same-sex or other-sex faces. The specific eigenvectors that these faces get coded on would be subject to various factors some of which might be related to the type of information

coded with the face. Thus, sex categorisation may have resulted in male faces, for female participants, being coded on low-dimensional eigenvectors because categorical information was emphasised. Sex categorisation must not have been the type of manipulation that would entail female faces to be coded on low-dimensional eigenvectors for males.

This account of the other-sex effect, however, is very premature and requires further testing in order to assess whether same- and other-sex faces may be mediated by differential codings on different subsets of eigenvectors. It is also unclear how same- and other-sex faces may be modulated by the dynamics of the space. Nevertheless, processes of individuation and categorisation seem to be significant modulators of both effects and may be representative of a more general memory phenomenon that can account for various category effects. Investigating how these processes modulate various category effects and their influences within face space will further provide a better understanding of the mechanisms underlying face recognition.

References

- Abdi, H., Valentin, D., Edelman, B., & O'Toole, A. (1995). More about the difference between men and women: Evidence from linear neural networks and the principal-component approach. *Perception, 24*, 539-562.
- Ackerman, J. M., Shapiro, J. R., Neuberg, S. L., Kenrick, D. T., Becker, D. V., Griskevicius, V., et al. (2006). They all look the same to me (unless they're angry): From out-group homogeneity to out-group heterogeneity. *Psychological Science, 17*, 836-840.
- Anastasi, J. S., & Rhodes, M. G. (2006). Evidence for an own-age bias in face recognition. *North American Journal of Psychology, 8*, 237-252.
- Bernstein, M. J., Young, S. G., & Hugenberg, K. (2007). The cross-category effect: Mere social categorisation is sufficient to elicit an own-group bias in face recognition. *Psychological Science, 18*, 706-712.
- Bodamer, J. (1947). Die prosop-agnosic. *Archiv fur Psychiatrie und Nervenkrankheiten, 179*, 6-53.
- Brigham, J., & Barkowitz, P. (1978). Do "they all look alike"?: The effect of race, sex, experience, and attitudes on the ability to recognise faces. *Journal of Applied Social Psychology, 8*, 306-318.
- Brigham, J., Maass, A., Snyder, L. D., & Spaulding, K. (1982). Accuracy of eyewitness identifications in a field setting. *Journal of Personality & Social Psychology, 42*, 673-681.
- Brigham, J., & Malpass, R. (1985). The role of experience and contact in the recognition of faces of own- and other-race persons. *Journal of Social Issues, 41*, 139-155.
- Bruce, V. (1982). Changing faces: Visual and non-visual coding processes in face recognition. *British Journal of Psychology, 73*, 105-116.
- Bruce, V., Henderson, Z., Greenwood, K., Hancock, P. J. B., Burton, A. M., & Miller, P. (1999). Verification of face identities from images captured on video. *Journal of Experimental Psychology: Applied, 5*, 339-360.
- Buckhout, R., & Regan, S. (1988). Explorations in research on the other-race effect in face recognition. In M. M. Gruneberg, P. Morris, & R. N. Sykes (Eds.), *Practical aspects of memory: Current research and issues: Volume 1. Memory in everyday life* (p. 40-46). New York: Wiley.
- Caldara, R., & Abdi, H. (2006). Simulating the "other-race" effect with autoassociative neural networks: Further evidence in favor of the face-space model. *Perception, 35*, 659-670.
- Carroo, A. W. (1986). Other-race recognition: A comparison of black american and african subjects. *Perceptual and Motor Skills, 62*, 135-138.
- Carroo, A. W. (1987). Recognition of faces as a function of race, attitudes and reported cross-racial friendships. *Perceptual and Motor Skills, 64*, 319-325.
- Chance, J. E., Goldstein, A. G., & McBride, L. (1975). Differential experience and recognition memory for faces. *Journal of Social Psychology, 97*, 243-253.
- Chance, J. E., Turner, A. L., & Goldstein, A. G. (1982). Development of differential

- recognition for own- and other-race faces. *Journal of Psychology*, *112*, 29-37.
- Chiroro, P., & Valentine, T. (1995). An investigation of the contact hypothesis of the own-race bias in face recognition. *Quarterly Journal of Experimental Psychology*, *48A*, 879-894.
- Cross, J. F., Cross, J., & Daly, J. (1971). Sex, race, age, and beauty as factors in recognition of faces. *Perception and Psychophysics*, *10*, 393-396.
- Donaldson, W. (1992). Measuring recognition memory. *Journal of Experimental Psychology: General*, *121*, 275-277.
- Elliot, D. N., & Wittenberg, B. (1955). Accuracy of identification of jewish and non-jewish photographs. *Journal of Abnormal & Social Psychology*, *59*, 339-341.
- Eng, J. (n.d.). *Roc analysis: Web-based calculator for ROC curves*. Available from <http://jrocfite.org> (Retrieved April 3, 2009 from <http://jrocfite.org>)
- Fallshore, M., & Schooler, J. W. (1995). Verbal vulnerability of perceptual expertise. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *21*, 1608-1623.
- Furl, N., Phillips, P., & O'Toole, A. (2002). Face recognition algorithms and the other-race effect: Computational mechanisms for a developmental contact hypothesis. *Cognitive Science*, *26*, 797-815.
- Goldstein, A. G. (1979). Race-related variation of facial features: Anthropometric data 1. *Bulletin of the Psychonomic Society*, *13*, 187-190.
- Goldstein, A. G., & Chance, J. E. (1980). Memory for faces and schema theory. *The Journal of Psychology*, *105*, 47-59.
- Green, D., & Swets, J. (1966). *Signal detection theory and psychophysics*. New York: Wiley.
- Heisz, J. J., & Shedden, J. M. (2007). *Introductions improve face recognition and determine own-sex effects*. (Unpublished Manuscript)
- Herlitz, A., Airaksinen, E., & Nordstrom, E. (1999). Sex differences in episodic memory: The impact of verbal and visuospatial ability. *Neuropsychology*, *13*, 590-597.
- Herlitz, A., & Yonker, J. E. (2002). Sex differences in episodic memory: The influence of intelligence. *Journal of Clinical and Experimental Neuropsychology*, *24*, 107-114.
- Hugenberg, K., Miller, J., & Claypool, H. M. (2007). Categorisation and individuation in the cross-race recognition deficit: Toward a solution to an insidious problem. *Journal of Experimental Social Psychology*, *43*, 334-340.
- Johnson, K. J., & Fredrickson, B. L. (2005). "We all look the same to me." Positive emotions eliminate the own-race bias in face recognition. *Psychological Science*, *16*, 875-881.
- Lavrakas, P., Buri, J., & Mayzner, M. (1976). A perspective on the recognition of other-race faces. *Perception & Psychophysics*, *20*, 475-481.
- Levin, D. (2000). Race as a visual feature: Using visual search and perceptual discrimination tasks to understand face categories and the cross-race recognition deficit. *Journal of Experimental Psychology: General*, *129*, 559-574.
- Lewin, C., & Herlitz, A. (2002). Sex differences in face recognition-Women's faces make

- the difference. *Brain and Cognition*, 50, 121-128.
- Lewin, C., Wolgers, G., & Herlitz, A. (2001). Sex differences favouring women in verbal but not in visuospatial episodic memory. *Neuropsychology*, 15, 165-173.
- Lindsay, D. S., Jack, P., & Christian, M. A. (1991). Other-race face perception. *Journal of Applied Psychology*, 76, 587-589.
- Linville, P. W., Fischer, G. W., & Salovey, P. (1989). Perceived distributions of the characteristics of in-group and out-group members: Empirical evidence and a computer simulation. *Journal of Personality & Social Psychology*, 57, 165-188.
- MacLin, O., & Malpass, R. (2001). Racial categorization of faces. The ambiguous race face effect. *Psychology, Public Policy and Law*, 1, 98-118.
- Macmillan, N., & Creelman, C. (1991). *Detection theory: A user's guide*. New York: Cambridge University Press.
- Malpass, R. S., & Kravitz, J. (1969). Recognition for faces of own and other race. *Journal of Personality & Social Psychology*, 13, 330-334.
- McKelvie, S. J. (1981). Sex differences in memory for faces. *The Journal of Psychology*, 107, 109-125.
- McNicol, D. (1972). *A primer of signal detection theory*. London: Allen & Unwin.
- Megreya, A. M., & Burton, A. M. (2006). Unfamiliar faces aren't faces: Evidence from a matching task. *Memory & Cognition*, 34, 865-876.
- Megreya, A. M., & Burton, A. M. (2007). Hits and false positives in face matching: A familiarity-based dissociation. *Perception & Psychophysics*, 69, 1174-1184.
- Meissner, C. A., & Brigham, J. C. (2001). Thirty years of investigating the own-race bias in memory for faces: A meta-analytic review. *Psychology, Public Policy and Law*, 7, 3-35.
- Ng, W., & Lindsay, R. C. L. (1994). Cross-race facial recognition: Failure of the contact hypothesis. *Journal of Cross-Cultural Psychology*, 25, 217-232.
- O'Toole, A., Abdi, H., Deffenbacher, K. A., & Valentin, D. (1993). Low-dimensional representation of faces in higher dimensions of the face space. *Journal of the Optical Society of America A*, 10, 405-411.
- O'Toole, A., Deffenbacher, K., Abdi, H., & Bartlett, J. (1991). Simulating the "other-race effect" as a problem in perceptual learning. *Connection Science*, 3, 163-178.
- Platz, S. J., & Hosch, H. M. (1988). Cross-racial/ethnic eyewitness identification: A field study. *Journal of Applied Social Psychology*, 18, 972-984.
- Rae, G. (1976). A non-parametric measure of recognition performance. *Perceptual and Motor Skills*, 42, 98.
- Read, D. J., Vokey, J. R., & Hammersly, R. (1990). Changing photos of faces: Effects of exposure duration and photo similarity on recognition and the accuracy confidence relationship. *Journal of Experimental Psychology: Learning, Memory and Cognition*, 16, 870-882.
- Rehman, J., & Herlitz, A. (2007). Women remember more faces than men do. *Acta Psychologica*, 124, 344-355.
- Rhodes, G., Brake, S., Taylor, K., & Tan, S. (1989). Expertise and configural coding in

- face recognition. *British Journal of Psychology*, 80, 313-331.
- Sangrigoli, S., Pallier, A., Ventureyra, V., & Schonon, S. de. (2005). Reversibility of the other-race effect in face recognition during childhood. *Psychological Science*, 16, 440-444.
- Schooler, J. W., & Engstler-Schooler, T. Y. (1990). Verbal overshadowing of visual memories: Some things are better left unsaid. *Cognitive Psychology*, 22, 36-71.
- Shapiro, P. N., & Penrod, S. (1986). Meta-analysis of facial identification studies. *Psychological Bulletin*, 100, 139-156.
- Shepherd, J. W., Deregowski, J. B., & Ellis, H. D. (1974). A cross-cultural study of recognition memory for faces. *International Journal of Psychology*, 9, 205-211.
- Slone, A., Brigham, J. C., & Meissner, C. A. (2000). Social and cognitive factors affecting the own-race bias in whites. *Basic & Applied Social Psychology*, 22, 71-84.
- Snodgrass, J. G., & Corwin, J. (1988). Pragmatics of measuring recognition memory: Applications to dementia and amnesia. *Journal of Experimental Psychology: General*, 117, 34-50.
- Sporer, S. (2001). Recognizing faces of other ethnic groups. *Psychology, Public Policy and Law*, 7, 36-97.
- Tanaka, J. W., Kiefer, M., & Bukach, C. M. (2004). A holistic account of the own-race effect in face-recognition: Evidence from a cross-cultural study. *Cognition*, 93, B1-B9.
- Valentin, D., & Abdi, H. (1996). Can a linear autoassociator recognize faces from new orientations? *Journal of the Optical Society of America A*, 13, 1-11.
- Valentin, D., Abdi, H., & O'Toole, A. (1994). Categorization and identification of human face images by neural networks: A review of the linear autoassociative and principal component approaches. *Journal of Biological Systems*, 2, 413-429.
- Valentine, T. (1991). A unified account of the effects of distinctiveness, inversion, and race in face recognition. *Quarterly Journal of Experimental Psychology Human Experimental Psychology*, 43a, 161-204.
- Valentine, T., Chiroro, P., & Dixon, R. (1995). An account of the own-race bias and the contact hypothesis based on a 'face space' model of face recognition. In T. Valentine (Ed.), *Cognitive and computational aspects of face recognition* (p. 69-94). New York, New York: Routledge.
- Vokey, J. R., & Read, D. J. (1988). Typicality, familiarity and the recognition of male and female faces. *Canadian Journal of Psychology*, 42, 489-495.
- Wickens, T. D. (2001). *Elementary signal detection*. New York: Oxford University Press.
- Wright, D. B., Boyd, C. E., & Tredoux, C. G. (2001). A field study of own-race bias in South Africa and England. *Psychology, Public Policy and Law*, 7, 119-133.
- Wright, D. B., Boyd, C. E., & Tredoux, C. G. (2003). Inter-racial contact and the own race bias for face recognition in South Africa and England. *Applied Cognitive Psychology*, 17, 365-373.
- Wright, D. B., & Sladden, B. (2003). An own gender bias and the importance of hair in face recognition. *Acta Psychologica*, 114, 101-114.