

EYE MOVEMENT PATTERNS FOR OWN- AND OTHER-RACE FACES

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Thesis Abstract

Ayşe Çağlar Taş, “Eye Movement Patterns for Own- and Other-race Faces”

The aim of this present thesis was to investigate where people direct their overt attention while learning and recognizing own- and other-race faces. Previous studies consistently found that people are better at recognizing own-race faces than other-race faces; a phenomenon mostly referred to as the “own-race bias”. Recent evidence also showed that own-race faces are processed more holistically than other-race faces. I predicted that Caucasian participants would process Caucasian faces holistically, and process Asian faces more analytically. In all of the experiments, I used an old/new recognition task to measure the own-race bias effect. In Experiments 1-4, the aim was to obtain own-race bias in a Turkish sample with various parametric manipulations. Contrary to what was expected, Turkish participants did not recognize own-race faces better than other-race faces in any of the experiments. In Experiment 5, similar results were obtained in a Dutch sample. In Experiment 6, eye movements were recorded as participants learned and recognized own and other face races. I mainly found that eye-movement patterns did not vary systematically as people encoded own versus other-race faces; however, there were individual differences in the extent to which people were categorized as holistic or analytical processors. In addition, using similar face processing strategies during encoding and recognition increased the likelihood of giving correct responses during recognition.

Tez Özeti

Ayşe Çağlar Taş, “Kendi- ve Diğer-Irk Yüzlerde Göz Hareketi Yapıları”

Bu çalışmanın amacı kişilerin kendi ırkından ve başka ırklardan yüzleri öğrenirken ve hatırlarken dikkatlerini nereye yönlendirdiklerini incelemektir. Önceki çalışmalar kişilerin kendi ırklarından olan yüzleri diğer ırkların yüzlerine göre daha iyi hatırladıklarını bulmuşlardır; genellikle “kendi ırk yanlılığı” olarak belirtilen olgu. Yeni bulgular, kendi ırk yüzlerin diğer ırk yüzlere göre daha holistik işlendiğini göstermiştir. Beyaz katılımcıların Beyaz yüzleri holistik işleyecekleri ve Asyalı yüzleri daha analitik işleyecekleri öngörülmüştür. Yapılan bütün deneylerde, kendi ırk yanlılığı etkisini ölçmek için eski/yeni tanıma testi kullandım. Deneyler 1-4 için, amaç Türk örnekleme farklı parametrik uygulamalarla kendi ırk yanlılığını bulmaktı. Beklenenin aksine Türk katılımcılar hiçbir deneyde kendi-ırk yüzleri diğer-ırk yüzlere göre daha iyi hatırlamamışlardır. Deney 5’te benzer sonuçlar Hollandalı bir örnekleme bulunmuştur. Deney 6’da katılımcıların kendi-ırk ve diğer-ırk yüzleri öğrenirken ve hatırlarken göz hareketleri kaydedilmiştir. Genel olarak, kişiler kendi-ırk ve diğer-ırk yüzleri kodlarken göz hareketi yapılarının sistematik olarak değişmediği bulunmuştur; fakat kişileri holistik ve analitik olarak kategorize edebilmemi sağlayan kişisel farklılıklar bulunmuştur. Ayrıca, kodlama ve tanıma süresinde benzer yüz işleme stratejisi kullanma tanıma sırasında doğru cevap verme olasılığını artırmıştır.

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CHAPTER 1

INTRODUCTION

Own-race bias is defined as the superiority of recognizing own-race faces over other-race faces during face processing tasks (Meissner & Brigham, 2001). This effect was mostly explained by differential experiences with own- and other-race faces (e.g. Tanaka, Kiefer, & Bukach, 2004; Walker & Hewstone, 2006; Wright, Boyd, & Tredoux, 2003). Since people are more exposed to own-race faces than other-race faces, they process own-race faces better than other-race faces. However, attentional processes that lead to this difference have not been thoroughly examined.

Face recognition is thought to be dissociable from other types of pattern recognition. Specifically, people process faces as “undifferentiated wholes” (Farah, Wilson, Drain, & Tanaka, 1998, p. 484); while object recognition requires more part-based processing. In addition, there is considerable evidence that people recognize faces from their own races better than faces from other races (Meissner & Brigham, 2001). Although there is recent evidence for different eye movement patterns for own- and other-race faces (Jack, Blais, Scheepers, Fiset, & Caldara, 2007), the primary aim of this thesis is to further investigate whether people can be categorized as being holistic processors or analytical processors according to their eye-movement patterns. Therefore, I specifically examined how people differed in their eye movement patterns (i.e. overt attention) while learning and recognizing faces from their own race and faces from another race.

Face Recognition

Face recognition is thought to be special because people process faces faster and more accurately than other types of objects. There are different propositions about representations of faces and objects. For example, Rhodes (1988; cited in Farah et al., 1998) suggested that faces are composed of two types of features: first order and second order features. First order features are the parts of a face (i.e. eye, nose etc.) whereas second order features are the configuration (i.e. the distance) between first order features. It is these second order features we specifically use for face processing and not for object processing. Similarly, Diamond and Carey (1986) proposed two types of properties: first order relational properties and second order relational properties. According to Diamond and Carey, first order relational properties refer to the spatial relations between the parts of an object (e.g. the eyes are above the nose) whereas second order relational properties refer to unique spatial relations between the parts relative to a prototypical object (e.g. the distance between the eyes in a unique face). In order for an object to have second order relational properties, its parts should have a general spatial configuration. Since all faces have the same first order relational properties, we rely on second order relational properties for face processing. On the other hand, we use first order relational properties for other types of object processing.

Although previous research has tried to conceptualize differential processing of faces and objects, the most recent and widely accepted view is that faces are processed holistically whereas other types of objects are processed analytically (e.g. Bartlett, Searchy, & Abdi, 2003; Peterson & Rhodes, 2003; Tanaka et al., 2004). While there is no consensus on the exact definition of what “holistic” processing is, a number of characteristics have been identified. According to Tanaka and Farah

(2003), an object is processed holistically if “exemplars of the object category share the same degree of visual complexity and structural similarity as faces” (p.67). In addition, the recognition of the object should be fast, accurate and specific. Tanaka and Farah (1993) initially suggested that holistic processing involves representation of the object as a whole; like a template. More specifically, they argued that the parts of an object should not be explicitly represented as different units in order to be processed holistically. Later on, Farah et al. (1998) specified that faces require less part decomposition than objects in order to be remembered. That is, while people try to recognize objects, they memorize parts of those objects. For example, in order to recognize a house, people need an explicit representation of some of its composites (e.g. door, windows, etc.). However, such explicit representations are not required for face recognition because faces are recognized as “undifferentiated wholes” (Farah et al., 1998, p. 484). Similarly, Bartlett et al. (2003) argued that facial features do not need to be coded independently because all faces have the same features with a similar configuration. That is, all faces have two eyes, a nose under the eyes, a mouth under the nose, and so on. In order to differentiate between two faces, the configurations formed between the features (e.g. the distance between the eyes) are more informative. Therefore, viewers do not code faces with their separate features but instead process them as wholes, with unique spatial configurations (i.e. spatial relations among the features).

Gauthier and Tarr (2002) proposed a different definition of holistic processing. They argued that there are three types of holistic processing: holistic-configural, holistic-inclusive, and holistic-contextual. Holistic-configural processing involves processing of the individual parts of an object in the original configuration, and therefore the performance for holistic-configural processing drops significantly when

the original configuration between the parts of the object changes. However, holistic-inclusive processing involves processing of the individual parts in the context of other individual parts. This type of processing does not depend on the original configuration but the existence of other parts of the object is necessary for holistic-inclusive processing. Lastly, holistic-contextual processing means processing individual parts in the presence of other parts rather than in isolation. For holistic-contextual processing, neither the configuration between the parts nor the context of other parts of the same object is necessary. According to the authors, the presence of similar parts from different objects can also increase holistic-contextual processing. Importantly, while holistic-configural and holistic-inclusive processing increase with expertise, holistic-contextual processing does not depend on the expertise level.

Despite the variations on how holistic processing is defined at least six types of common effects have been used to differentiate holistic face processing from analytical object processing: the face inversion effect (FIE) (Yin, 1969; Valentine, 1988), the Thatcher illusion (Thompson, 1980; cited in Michel, Caldara, & Rossion, 2006), the whole/part advantage (Tanaka & Farah, 1993), the caricature effect (Rhodes, Brennan, & Carey, 1989; cited in Michel, Caldara & Rossion, 2006), the face composite effect (Young, Hellawell, & Hay, 1987), and contrast reversal effect (Johnston, Hill, & Carman, 1992; Phillips, 1972). All of these effects are driven by the disruption of configuration between face features. For instance, Bartlett et al. (2003) argued that inversion of a face impairs configural encoding. Since configuration between face features is the main source in face recognition, inversion impairs face recognition dramatically.

Another line of evidence about the dissociation between faces and objects comes from studies investigating the neural basis of face recognition. For example, an area

in the ventral temporal cortex called the Fusiform Gyrus activates during face perception but not during object perception. Thus, the Fusiform Face Area (FFA) has been specified as the special face recognition area in the brain (Gauthier, Behrmann, & Tarr, 1999; Gauthier & Tarr, 2002). Although some researchers have argued that expert object recognition also increases the level of activation in the FFA, the effect of expertise has generally been shown to be relatively small and the results have been controversial (for a review, see McKone, Kanwisher, Duchaine, 2006). ERP studies have also shown that perception of faces and objects yield different patterns of brain activity. Specifically an occipito-temporal potential, N170, was shown to be larger while looking at faces than at other patterns (i.e. scrambled faces, cars, and scrambled cars). Further, an inversion procedure delayed the N170 potential for faces but not for objects (Bentin, Allison, Puce, Perez, & McCarty, 1996). Lastly, neuropsychological cases provide support for the dissociation between faces and objects. One type of agnosia, namely prosopagnosia, is a selective impairment of face recognition. Prosopagnosic patients have no difficulties in recognition of objects but they are not able to recognize faces (Farah, Levinson, & Klein, 1995). In addition, Gauthier, Behrmann, and Tarr (2004) presented a patient with object agnosia with intact face processing ability.

In addition to behavioral and neural evidence, a final piece of evidence for differential face and object processing comes from developmental studies. It is known that newborn infants demonstrate a preference for face-like patterns compared to non-face-like patterns (Valenza, Simion, Cassia, & Umiltà, 1996). In addition, there is also evidence that six-week-olds are able to differentiate their mothers' faces from a stranger's face using only internal parts (Bartrip, Morton, & de Schonen, 2001). Sangrigoli and de Schonen (2004) also found that face

discrimination starts as early as 3 months of age. To sum, there is considerable evidence that object and face processing are two different mechanisms with different neural basis; people are better at face recognition than object recognition.

There are two main explanations for why faces and objects are processed differently: the domain specificity hypothesis (Yin, 1969; Kanwisher, 2000; McKone et al., 2006) versus the expertise hypothesis (Diamond & Carey, 1986; Gauthier & Tarr, 1997; Gauthier et al., 1999). According to the different systems hypothesis, there are two distinct processes involved in the recognition of faces and objects; one exclusively responsible for face processing and another for other types of objects. In support of this view, McKone et al. (2006) concluded that there are two pieces of evidence supporting the notion of differential processing of faces and objects. One is that faces – but not objects – are processed holistically. Secondly, neural substrates for the perception of faces and objects are separate. In contrast, the expertise hypothesis suggests that people recognize faces better and easier than other objects not because faces are processed in a unique fashion but because people are more familiar with them. According to this view, people are by default “face experts” (Gauthier & Tarr, 1997, p. 1674).

In line with expertise hypothesis, Diamond and Carey (1986) found similar face and dog inversion effect for dog experts, and suggested that face-like holistic processing can be increased with expertise. However, Robbins and McKone (2007) failed to replicate this finding with dog experts in face inversion, face composite, and contrast reversal procedures. Furthermore, Tanaka and his colleagues also failed to find holistic processing for expert objects with the whole/part paradigm using experts of biological cells, automobiles, and Rottweiler dogs (Tanaka, Giles, Szechter, Lantz, Stone, Franks, & Vastine, 1996; cited in Tanaka & Farah, 2003). Although Diamond

and Carey's research was the only experiment done with expert objects that supports the expertise hypothesis, Gauthier and Tarr (1997) also found supportive evidence using artificial objects which have the same configuration with faces (i.e. Greebles). Extensive training with Greebles resulted in face-like holistic processing in part/whole task. Furthermore, Greeble experts also showed increased activation in the FFA for Greeble discrimination and recognition (Gauthier, Tarr, Anderson, Skudlarski, & Gore, 1999; Gauthier & Tarr, 2002).

To sum, previous findings suggest that faces and objects are processed differently. Specifically, faces are processed holistically and disruption of the face configurations reduces holistic processing. In addition, holistic processing can be also found with objects if they have the similar configuration with faces (e.g. Greebles).

Own-race bias

The own-race bias (ORB; also referred to as other-race effect, own-race effect or other-race disadvantage) refers to the phenomenon that people are better able to recognize faces of their own-races compared to those of other races (for a meta-analysis see Meissner & Brigham, 2001). Brain imaging studies also provide evidence for the existence of ORB. For instance, it has been demonstrated that own-race faces and other-race faces activate different brain regions. (Golby, Gabrieli, Chiao, & Eberhardt, 2001; Ito & Urland, 2003). Specifically, right fusiform regions became more active during the learning of own-race faces than other-race faces, whereas activity in the left fusiform regions increased during learning of other-race faces. This effect is explained by familiarity. That is, because people are exposed to faces of their own race more than faces of other races, their ability to recognize and discriminate own-race faces is better than other-race faces. In support of this view,

Wright, et al. (2003) showed that familiarization of undergraduates with other-race faces increases recognition performance for other-race faces; familiarization even eliminates the ORB. Further, there is also evidence that this bias starts in infancy. For example, Sangrigoli and de Schonen (2004) found that 3-month-old infants are able to discriminate faces of their own-race from faces of other races. In their second experiment, they showed that familiarization of 3-month-old infants with other-race faces increased memory performance for other-race faces which supports that ORB depends on expertise.

In line with the view that people process objects that are familiar in a more holistic fashion, there is also evidence that own-race faces are processed holistically whereas less-familiar, other-race faces are processed analytically. For example, Rhodes, Brake, Taylor, and Tan (1989) used a face inversion paradigm with European and Chinese participants. They found that inversion of own-race faces significantly disrupted recognition performance whereas inversion of other-race faces did not. In a more recent study, Michel, Caldara and Rossion (2006) tested Caucasian and Asian participants with a recognition task and the whole/part advantage paradigm. In the old/new recognition task, participants remembered own-race faces better than other-race faces. That is, both Caucasian and Asian participants showed a significant ORB. For holistic processing, they measured participants' performances with a two-alternative-forced-choice matching task using the whole/part paradigm. Participants were presented with a target face (or a target's feature) along with a distractor face (or a distractor's feature). The task was to identify the target face in the whole condition and the target face's feature in the part condition. In the whole/part paradigm, own-race faces were processed more holistically than other-race faces such that the participants were more accurate in the

whole condition than in the part condition for own-race faces. Although Asian participants showed a significant own-race bias in the recognition task, they were more accurate in the whole condition for both own-race and other-race faces, indicating that they processed both Asian and Caucasian faces holistically. This finding is in line with previous studies suggesting that East Asian people process different sets of stimuli more holistically than Westerners (e.g. Chua, Boland, & Nisbett, 2005; Nisbett, Peng, Choi, & Norenzayan, 2001). A second study by Michel and her colleagues supported holistic processing of own-race faces (Michel, Rossion, Han, Chung, & Caldara, 2006). They tested the participants in a face-composite paradigm in which the top part of a target face was attached to the bottom part of a distractor face. In the face-composite paradigm, the task is to identify the top part while ignoring the bottom part. In this paradigm, participants are typically slower when the top and bottom parts were aligned than when the top and bottom parts are misaligned. Aligning the top and bottom parts are thought to create a composite face which leads participants to process it holistically. However, when parts are misaligned, the face is no longer processed holistically. This results in faster part recognition performance (Young et al., 1987). As in their previous study, Michel et al. (2006) found that both Caucasian and Asian participants were faster and more accurate while recognizing faces from their own-race than faces from other-race. In addition, both groups showed a larger composite-face effect for own-race faces than other-race faces. That is, participants were faster and more accurate in the misaligned condition than aligned condition for their own-race faces, suggesting that own-race faces are processed more holistically than other-race faces.

Despite empirical demonstrations of the ORB, the mechanisms involved in the perception, learning, and recognition of own- and other-race faces have not been

thoroughly examined. One way to investigate the mechanisms involved in the perception, learning and recognition of own- and other race faces is to examine eye movement patterns during various face-related tasks. Eye movement patterns may help to identify whether allocation of attention is different for own-and other race faces. Specifically, eye movement patterns would show the parts of the faces where participants get information from while making their race decision.

Eye Tracking Studies

To study face and object perception, eye tracking devices enable us to record the number and trajectory of saccades, fixation lengths and locations, changes in pupil size and duration of gaze. In humans with intact vision, while looking at a scene visual resolution is highest at the center of gaze which diminishes through to the periphery. In order to scan a scene, the focus of gaze changes with rapid eye movements approximately 3 times per second, and perceptual information is acquired only during relatively stable fixations and enduring gazes (Henderson, 2003). These fixations are used as indicators of where people direct their over attention to.

Eye tracking studies of face recognition have consistently found that people with normal vision fixate first and mostly on the internal features of a face (e.g. Altoff & Cohen, 1999; Henderson, Williams, & Falk, 2005; Stacey, Walker, & Underwood, 2005, Williams & Henderson, 2007). For instance, Stacey et al. (2005) found that internal features received the most fixations for both familiar faces and non-familiar faces during face familiarity judgment, face recognition and matching tasks. In addition, studies of face learning also revealed that during learning, eye movements are directed to the internal features and eye movements play an important role in face learning. Specifically Henderson, Williams, and Falk (2005) compared viewers in

free versus restricted viewing conditions. In the free viewing condition, subjects were allowed to move their eyes freely during the learning phase. In the restricted viewing condition, subjects had to fixate their eyes in the center of the screen; otherwise the picture was replaced by a mask. The authors argued that if eye movements are important for face learning, then participants in the free viewing condition should perform better than participants in the restricted viewing condition. In a two-choice recognition task, memory performance indeed decreased from 81.3% to 52.2% when eye movements were restricted in the learning phase. Furthermore, all subjects in the free viewing condition were found to fixate at least once on the eyes, and many subjects were found to fixate on the nose and the mouth during face learning. Analyses also revealed that viewers fixated longest on the eyes; subjects spent over 4 sec. of the 10 sec. learning phase focusing on the eyes. However, viewers seldom fixated on the ears, the chin, and the cheeks.

Despite the general agreement on the importance of internal features during both face learning and recognition, the consistency of the eye movement patterns during face learning and recognition is not well established. Henderson et al. (2005) found that participants in the free-viewing condition changed their eye movement patterns between learning and recognition phases. They devoted more time fixating on the eyes and the nose, and less time on the ears, the chin, and the forehead during recognition compared to learning. Contrary to this finding, Williams and Henderson (2007) found that fixation duration on each face region was similar in learning and recognition. They investigated whether upright and inverted faces received different patterns of eye movements, and found that subjects processed upright and inverted faces similarly during both learning and recognition. That is, each facial feature was fixated on for about the same duration and received equal amount of fixations

regardless of the face's orientation. The authors indicated that if upright faces are processed holistically and inverted faces are not, then this holistic effect is not a result of where people collect information from. Since each face region was fixated on for a similar amount of time during learning and recognition, the authors suggested that eye movements cannot be used as an index of familiarity of faces. Mäntylä and Holm (2006) elaborated on this finding. They suggested that similar eye movement patterns during learning and recognition result in better performance in recollection judgments but not in familiarity judgments in a face recognition task.

Holistic face processing can also be identified by exploring eye movement patterns. For instance, Schwarzer, Huber, and Dümmler (2005) examined gaze patterns in a face-categorization task and tried to categorize subjects as being holistic or analytical. In order to label someone as an analytic processor as opposed to a holistic processor, the authors argued that there must be evidence that the s/he has made a higher number of fixations and that s/he has fixated longer on a specific area of the particular face feature than other areas. Specifically, subjects who fixated mostly and longest on one face feature were categorized as analytic processors. Holistic processors were characterized by fewer feature-specific fixations and a tendency to not focus upon one area to get the necessary information. The authors used schematically drawn faces in the Experiment 1, and found that most participants were analytical processors (2 eye-analytical, 2 nose-analytical, and 8 outline-analytical processors; and 5 holistic processors). This finding is in contrast to other studies that had reported face perception to be holistic. It should be noted that this finding changed when Schwarzer and her colleagues used real pictures: the number of holistic processors increased dramatically. In the second experiment, there were 12 holistic processors versus 4 analytical processors (2 eye-analytical, 1 nose-

analytical, and 1 outline-analytical). Both experiments showed that holistic processors spent most of their times looking at the eyes and the nose but analytical processors looked mostly and for the longest duration to the particular facial feature they used for further processing. In addition, in the second experiment holistic processors' gaze time was shorter than analytical processors' gaze time which is in line with the idea that holistic face perception is fast (Tanaka et al., 2004).

Following Schwarzer et al. (2005)'s findings, I reasoned that if own-race faces are processed holistically and other-race faces are processed analytically then participants can be categorized as being holistic for own-race faces and analytical for other-race faces according to their eye movement patterns. In a recent study, Jack et al. (2007) conducted an experiment in order to investigate eye movement patterns for own- and other-race faces. They used Western Caucasian and East Asian participants and compared their eye movement patterns during learning, recognition, and categorization by race tasks for Western Caucasian and East Asian faces. They found a significant ORB for both groups in accuracy (d') scores but not in reaction time scores during recognition. More importantly, the results suggested that Western Caucasian and East Asian participants showed different eye movement patterns for own- and other-race faces. Specifically, during learning, recognition, and categorization by race Western Caucasian participants fixated mostly on the eyes whereas East Asian participants fixated mostly on the nose. More importantly, both groups showed the same pattern for both own- and other-race faces which may be the main reason why they failed to recognize other-race faces. It can be inferred that there may be different effective eye movement strategies for recognizing faces of different races (e.g. fixating mostly on eyes for Caucasian faces and nose for Asian faces). Since people use similar strategies for all faces regardless of the race, the

effective strategy for their own race may not lead to a good performance for the other race because the effective strategy for the other race is different.

Although there is recent evidence indicating different eye movement patterns for own- and other-race faces (Jack et al., 2007), a primary aim of this study is to categorize the participants as being ‘holistic processors’ or ‘analytical processors’ based on their fixation patterns as they are trying to learn and remember own- and other-race faces. This kind of a categorization would help me investigate the holistic account of own-race faces. This proposal states that own-race faces are processed holistically whereas other-race faces are processed analytically (Michel, Caldara & Rossion, 2006; Michel et al., 2006; Tanaka et al., 2004).

Present Study

As noted above, people identify faces of their own-race more accurately and faster than faces of other races. In addition, there is some evidence that people could be categorized as being holistic or analytical processors based on their eye movement data when they are trying to categorize faces as either a child’s face or an adult face (Schwarzer et al., 2005). Although many researchers suggest that people process own-race faces more holistically than other-race faces, there is no study in which participants’ eye movement patterns were categorized as being holistic or analytical for own- and other-race faces. Therefore, the primary aim of the present study was to elaborate on Schwarzer et al. (2005)’s findings and categorize participants as holistic and analytical face processors for own- and other-race faces. The prediction was that Caucasian subjects will process Caucasian faces holistically and Asian faces analytically. According to Schwarzer et al. (2005), holistic face processing refers to combining facial features into a gestalt whereas analytical face processing refers to processing facial features individually and not combining these features in a face. In

this thesis, holistic and analytical face processing were defined according to Schwarzer et al. (2005). That is, subjects who fixated most and longest on one face feature were identified as analytical processors. In contrast, subjects whose fixation patterns did not show any distinctive patterns (i.e. there was not a part of a face which was fixated most and longest) were classified as holistic processors. Although there is contrary evidence that holistic and analytical faces could be processed similarly (e.g. Williams & Henderson, 2007), there could be at least two different conceptualization of 'holistic face processing'. Specifically, people could use similar eye-movement strategies while processing upright (i.e. holistic) and inverted (i.e. analytical) faces but their eye-movement strategies could differ for faces of different races.

In line with Jack et al. (2007)'s reasoning, the second aim of this thesis was to look at eye movement patterns as people learned and recognized faces of different races. More precisely, the aim was to look at whether there was a difference in the fixation patterns, fixation durations, and fixation numbers of Caucasian subjects while making race decisions for Asian and Caucasian faces.

In order to establish the ORB, I ran 5 experiments varying parameters systematically. For all of these experiments, the goal was to find the own-race bias: Specifically, Caucasian subjects were expected to remember Caucasian faces faster and more accurately than Asian faces. The task was a simple yes/no recognition test in which subjects tried to identify Asian and Caucasian faces previously seen in the learning phase.

Hypotheses

The hypotheses of the eye tracking experiment (Experiment 6) were as follows:

1. In recognition task, most of the subjects would be categorized as holistic processors for own-race faces but as analytical processors for other-race faces according to their eye movement patterns (Schwarzer et al., 2005). Holistic processors would show no distinctive eye movement patterns whereas analytical processors would show specific eye movement behavior regarding their analytic face area (e.g. eye, nose, mouth).
2. If holistic face processing requires examining the faces as a whole and analytical face processing requires more part-based examinations (Farah et al., 1998), then faces processed holistically (i.e. own-race faces) would receive shorter fixation durations and fewer fixations than faces processed analytically (i.e. other-race faces) during recognition.
3. The eye movement patterns would be similar during encoding and recognition for both holistic and analytical processors (Williams & Henderson, 2007). For example, a person who processed a face analytically during encoding would also process it analytically during recognition.
4. In line with the literature, people would fixate mostly on internal regions of the faces (i.e. eyes, nose and mouth) during both encoding and recognition and regardless of their categorization (e.g. Altoff & Cohen, 1999).

CHAPTER 2

EXPERIMENTS 1 – 5

Experiment 1A

Although most previous studies investigating the own-race bias have used 3 sec as the encoding time (e.g. Meissner, Brigham, & Butz, 2005; Michel, Caldara, & Rossion, 2006; Michel et al., 2006; Wright et al., 2003), in their meta-analysis Meissner and Brigham (2001) found that reducing study time increases the magnitude of the own-race bias. However, previous research has not explored this effect using the same exact design. Therefore, in Experiment 1A I compared accuracy levels across three encoding times (i.e. 2 sec, 3 sec, and 5 sec) to determine the ideal conditions to observe this effect. Since participants did not have sufficient time to process the whole face, shorter encoding time (i.e. 2 sec) may result in judgments based on familiarity during recognition. In turn, familiarity judgments could result in higher own-race bias because participants need to have more time to individuate unfamiliar (i.e. other-race) faces than familiar (i.e. own-race) faces. However, shorter encoding times may not be sufficient to process even the familiar faces. If so, then longer encoding times (i.e. 5 sec) would result in higher own-race bias effect.

Method

Participants

Fifty-five Caucasian Boğaziçi University students (20 male and 35 female) participated in this experiment. Their ages ranged between 18 – 26 ($M=20.44 \pm 1.73$). They were given course credit for their participation.

Materials

Out of 159 photographs from the database generated and used by Michel, Caldara and Rossion (2006), 80 full-face grayscale photographs (40 Caucasian and 40 Asian) were randomly selected (see Appendix C for examples of Caucasian and Asian photographs). Half of the photographs were female and the other half were male. None of the faces had any outstanding features (beards, hair, jewellery, glasses, make-up etc.).

Design and Procedure

The design was a 3 (Encoding Time) x 2 (Race of the Target Face) mixed factorial design in which Encoding Time was a between subject variable, and Race of the Target Face was a within subject variable. Participants were tested individually and they were randomly assigned to one of the three encoding conditions: 2-sec encoding, 3-sec encoding or 5-sec encoding. Before the experimental phase, participants were told that they would be seeing some faces and that their task was to learn them for a later recognition test. They were also instructed that in the recognition test, they would be asked to indicate their decision by pressing one of two keyboard keys, and that both accuracy and reaction time would be recorded. In order to make sure that participants understood which key was to be pressed for old and new photographs respectively, they were initially given 10 practice trials (5 old and 5 new). They were asked to press the letter “J” for the word “yeni” (new) and “F” for the word “eski” (old). Then, they were given practice trials that consisted of 4 photographs for encoding and 8 photographs (4 old and 4 new) for recognition, different from those used in the experimental conditions.

In the learning phase, they were presented with 40 photographs (20 Asian and 20 Caucasian) for either 2, 3 or 5 sec. In the recognition phase, they were shown 80 photographs (40 Asian and 40 Caucasian), half of which was new. In order to eliminate any possible priming effect, the photographs were ordered such that no more than two successive Asian or Caucasian photographs or no more than two successive male or female photographs followed each other in both the learning and the recognition phases. In addition, no more than two successive new or two successive old photographs were shown to the participants during the recognition task.

Each study trial in the learning phase began with a green dot (1 sec.) and was followed by a red dot (1 sec.) which was then followed by a photograph. So, the inter-stimulus interval was 2 sec. Participants were told that the red dot indicated that a new photograph was about to appear and therefore they should direct their attention to the center of the screen.

In the recognition phase, participants were instructed to make an old/new judgment for each photograph. That is, they were asked to indicate whether they had seen the face in the learning session by pressing one of the two keyboard keys. They were instructed to respond as accurately and as fast as possible. As in the learning phase, each recognition trial began with a green dot that was presented for 1 sec. which was then followed by a red dot presented for 1 sec. During the recognition phase, participants were explicitly told that each face would remain on the screen for a maximum of 2 sec. and they had to respond within that duration.

Results

For each participant, I separately calculated d' values for Caucasian and Asian photographs. Table 1 shows average hit rates, false alarm rates, d' , and reaction times

for Caucasian and Asian faces. Data from seven participants were eliminated from the analyses because they had a d' value less than 0 which indicated that these participants were not able to distinguish new photographs from old ones better than chance (Stanislaw & Todorov, 1999). A repeated-measures analysis of variance (ANOVA) test was performed on d' data with the remaining 48 participants (15 in 2-sec condition, 15 in 3-sec condition, and 18 in 5-sec condition). The results showed that neither the main effect for race nor the race X encoding time interaction were significant ($F_s < 1$). However, the main effect for encoding time was significant ($F(2, 45) = 11.405, MSE = 0.083, p < .000, \eta_p^2 = .336$). Post-hoc Tukey's HSD tests showed that participants in the 3 and 5 seconds encoding time conditions performed significantly better than those in the 2 second condition ($MD = .363$ and $MD = .464$, respectively). There was no difference between the 3-sec and 5-sec encoding groups ($MD = -.101$).

For all reaction time analyses in this thesis, I first removed outliers. The individual reaction times which were 3 standard deviations longer or shorter than the average reaction time for a race were eliminated from the analyses. For example, a reaction time made by a subject for the first Asian photograph was eliminated if it was 3 standard deviations longer or shorter than the average Asian reaction time of all subjects. A repeated-measures analysis of variance (ANOVA) showed that the main effect for race and the race X encoding time interaction were not significant ($F_s < 1$). Contrary to the accuracy results, the main effect for encoding time was not significant, either ($F < 1$).

Discussion

Contrary to the findings reported in the own-race bias literature, the results revealed that Caucasian students did not recognize own-race faces better or faster than Asian

faces. The aim for including three different encoding times was to find the most effective encoding time for own-race effect. Although the overall performance rate was significantly higher than the chance level in all conditions both for Asian faces ($t(14) = 6.850, p < .001$ for 2-sec., $t(14) = 9.224, p < .001$ for 3-sec, and $t(17) = 9.636, p < .001$ for 5-sec), and Caucasian faces ($t(14) = 8.151, p < .001$ for 2-sec., $t(14) = 8.111, p < .001$ for 3-sec, and $t(17) = 9.445, p < .001$ for 5-sec) it was lower than indicated in the literature (e.g. Henderson et al., 2005). It is very unlikely that this low performance can be as a result of overall face recognition deficit of Turkish participants. Participants' face recognition performance may be affected by the characteristics of the photographs (i.e. grayscale with no hair). However, I reasoned that even with low performance participants may show own-race bias if they are forced to use face recognition strategies.

Experiment 1B

Since participants in the 2-sec condition performed worse than the other two conditions and most of the literature¹ was based on 3 seconds of encoding, I used 3 seconds of encoding in all of the remaining experiments. Furthermore, in Experiment 1B, I increased the memory load by presenting viewers with 159 photographs. Since it might be harder for viewers to remember 80 photographs rather than 40, they may be more likely to make similarity judgments during the recognition test. Therefore, increasing task demands and forcing the participants to remember the photographs implicitly may lead to an own-race bias because of a familiarity effect. That is, since participants are more familiar with own-race faces, they might remember them better.

¹ Own-race bias was found using different paradigms and within different racial groups. Most of the recognition studies on own-race bias used 3 seconds of encoding time. A summary of most recent own-race bias studies was presented in Appendix D.

Method

Participants

Twenty Caucasian Boğaziçi University students (7 male and 13 female) participated in the experiment. Their ages ranged between 18 and 22 ($M=20.38 \pm 1.12$). They were given course credit for their participation.

Materials

In this experiment, I used all the available photographs from the database used in Experiment 1A. There were 79 Asian photographs (40 males and 39 females), and 80 Caucasian photographs (40 male and 40 female).

Design and Procedure

The procedure was the same as the procedure used in Experiment 1A except this time participants were presented with 80 photographs (40 Asian and 40 Caucasian) for 3 seconds in the learning phase. In the recognition phase, they were given 159 photographs (79 Asian and 80 Caucasian), half of which was new.

Results

Table 1 shows accuracy and reaction time for Caucasian and Asian faces. Data from seven participants were eliminated from the analyses because they had a d' value less than 0. A paired samples t-test was carried out on d' data. The result showed that subjects did not perform better for own-race faces than for other-race faces ($t(12) = .958, p > .05$).

In line with the accuracy results, subjects did not perform faster for own-race faces than for other-race faces ($t(12) = 1.839, p = .091$). Considering the small sample size used in this experiment, there was a marginal own-race bias regarding RT. There was a trend for own-race faces being recognized faster than other-race faces.

Discussion

The results showed that Caucasian subjects did not show an own-race bias when task demand was increased. It was quite difficult for subjects to remember 80 photographs, and as can be seen in Table 1 the overall accuracy mean for Experiment 1B was lower than the overall accuracy means of each condition in Experiment 1A. An independent samples t-test showed that participants in the 3-sec condition of Experiment 1A recognized significantly more photographs than participants in Experiment 1B for both Asian and Caucasian faces ($t(38) = 2.513, p < .05$ and $t(38) = 2.091, p < .05$, respectively). Another independent samples t-test was carried out for d' scores separately for Asian and Caucasian faces. The results showed that participants in the 3-sec condition of Experiment 1A had higher d' scores than participants in Experiment 1B for both Asian and Caucasian faces ($t(38) = 2.008, p = .052$ and $t(38) = 2.253, p < .05$, respectively). As can be seen in the Appendix D, previous studies used fewer photographs than used in Experiment 1B. The aim of Experiment 1B was to force the participants to make old/new judgments based on familiarity. Contrary to what was expected, increasing memory load resulted in poorer face recognition performance.

Experiment 2

Some researchers who have reported the own-race bias had blocked the photographs by race rather than presenting them in a mixed order (e.g. Michel et al., 2006, Jack et al., 2007). In addition, Meissner and Brigham (2001) found that using a blocked order design results in an increase in the own-race bias magnitude. It is possible that blocking photographs by race rather than presenting them in a mixed list allows people to adopt different strategies for processing own versus other race faces. There could be some specific face processing strategy for each race. If this was the case,

participants would effectively use their ‘race-specific’ strategies if they were presented each race one at a time. Consequently, different race-specific strategies would not interfere with each other during both encoding and recognition which might increase face recognition performance. Therefore, in Experiment 2, I investigated whether blocking photographs by race as opposed to presenting them in mixed order would yield an own-race bias. I hypothesized that if the participants would see the pictures with a blocked order, their performances could increase because they will concentrate only on one race within each block. A second aim of Experiment 2 was to increase overall performance. In both Experiment 1A and 1B, the mean accuracy was very low for both Asian and Caucasian faces compared to the literature but as in Experiment 1A they were significantly higher than the chance level ($t(12) = 4.553, p < .01$ for Asian faces and $t(12) = 7.637, p < .001$ for Caucasian faces). So, in Experiment 2 the photographs were blocked by race and participants encoded and recognized Asian and Caucasian faces separately.

Method

Participants

Forty-five Caucasian Boğaziçi University students (21 male and 24 female) took part in this experiment. Their ages ranged between 17 – 31 ($M = 20.47 \pm 2.25$). They were given course credit for their participation.

Materials

I used the same set of photographs as in the previous experiments. For one group (Blocked 1), 80 photographs were randomly selected from the database but all photographs were used for the other group (Blocked 2). For each group, half of the photos were Caucasian and the rest were Asian.

Design and Procedure

The design was a 2 (Group: Blocked 1 and Blocked 2) x 2 (Race of the Target Face: Asian and Caucasian) mixed factorial design in which Group was a between subject variable, and Race of the Target Face was a within subject variable. The procedure was identical to previous experiments except that in Experiment 2 participants were randomly assigned one of the two conditions: Blocked 1 and Blocked 2. Participants in the Blocked 1 group encoded 40 photographs (20 Asian and 20 Caucasian) and they were tested on 80 photographs (40 Asian and 40 Caucasian). The Blocked 2 group participants encoded 80 photographs and were tested with 159 photographs. In both groups, participants were randomly assigned to one of the two conditions: approximately, half of the participants received Asian photographs first (18 in Blocked 1 and 6 in Blocked 2) and the remaining received Caucasian photographs first (13 in Blocked 1 and 8 in Blocked 2).

Results

Table 2 shows accuracy and reaction time for Asian and Caucasian faces. There were initially 31 participants in Blocked 1 group and 14 participants in Blocked 2 group. However, data from seven participants (3 in Blocked 1 and 4 in Blocked 2) were eliminated from the analyses because their d' values were below 0.

For each group, Bonferroni corrected independent sample t-tests were carried out for both accuracy and reaction time data to look at whether the presentation order (i.e. Asian first or Caucasian first) had any effect. For both groups, there was no significant difference between presentation order in terms of hit rates, false alarm rates, d' levels and reaction time ($ps > .05$). The presentation order did not affect performance levels. This result was true for both Asian and Caucasian faces, and

Blocked 1 group and Blocked 2 group. Therefore, I collapsed the data for further analyses.

A repeated-measures analysis of variance (ANOVA) test on with Group as a between-subject factor and Race of the Target Face as a within-subject variable showed that the main effect for race and the race X group interaction were not significant ($F(1, 36) = 1.778, p > .05, \eta_p^2 = .047$, and $F(1, 36) = .050, p > .05, \eta_p^2 = .001$, respectively). However, the main effect for Group was significant ($F(1, 36) = 5.047, p < .05, \eta_p^2 = .123$), suggesting that participants in the Blocked 1 ($M = .94 \pm .38$) group performed significantly better than participants in the Blocked 2 group ($M = .64 \pm .33$).

The performances in Experiment 2 did not increase to the expected levels. Overall recognition performances were again significantly above the chance level both in the Blocked 1 group ($t(27) = 13.282, p < .001$ for Asian faces and $t(27) = 10.364, p < .001$ for Caucasian faces) and in the Blocked 2 group ($t(9) = 4.738, p < .01$ for Asian faces and $t(9) = 6.101, p < .001$ for Caucasian faces) but mean d' scores were still very low compared to the previous studies in the literature. For participants in the Blocked 1 group, mean d' was 1.00 (.72 in Blocked 2) for Asian faces and .89 (.56 in Blocked 2) for Caucasian faces.

A repeated-measures analysis of variance (ANOVA) test was conducted on the RT data. The main effect for race was not significant ($F(1, 36) = 1.059, p > .05, \eta_p^2 = .029$). In addition, the main effect for group and the race X group interaction were also not significant ($F_s < 1$).

Discussion

The aim of Experiment 2 was twofold. One, I wanted to investigate whether presentation order (blocked as opposed to mixed) of photographs during learning

would result in a bias in performance such that participants would favor their own race. However, as in Experiment 1A and 1B, results showed that Caucasian participants did not show an own-race bias. My second aim was to increase recognition accuracy. If people use a specific strategy for own-race faces and another strategy for other-race faces, then participants would not need to switch their strategies when pictures are blocked, and this could result in better face recognition performance. Contrary to what was expected, participants' accuracy also did not increase as expected.

Experiment 3

The aim of the Experiment 3 was similar to that of Experiment 2 such that I tried to increase participants' face recognition accuracy. Their low performances in the previous experiments could have been a result of the high number of photographs they were asked to learn and recognize. Therefore, in Experiment 3, I decreased the number of photographs in order to decrease the task demand. Also, contrary to the previous experiments I adopted a between subjects design such that two different groups of participants were presented Asian and Caucasian faces separately. I investigated whether this manipulation would result in superior face recognition performance for Caucasian faces.

Method

Participants

Thirty-seven Caucasian Boğaziçi University students (10 male and 27 female) participated in this experiment. Their ages ranged between 18 – 27 ($M=20.05 \pm 1.53$). They were given course credit for their participation.

Materials

Forty Asian and 40 Caucasian photographs (half of which were male) were selected from the same database used in the previous experiments.

Design and Procedure

The procedure was the same as one used in the previous experiments. Participants in Experiment 3 were randomly assigned one of the two groups: Asian or Caucasian. Participants in Asian group were presented with 20 Asian photographs (half of which were male) in the learning phase for 3 sec. and tested with 40 Asian photographs in the recognition phase. Similarly, participants in Caucasian group were presented with 20 Caucasian photographs (half of which were male) in the learning phase for 3 sec. and tested with 40 photographs.

Results

Table 3 shows accuracy and reaction time for Asian and Caucasian faces. As in the previous experiments, participants who had d' values lower than 0 were eliminated from the analyses. An independent samples t-test was performed on the data from the remaining 34 participants (18 in Asian group and 16 in Caucasian group). The Caucasian group did not perform better than the Asian group ($t < 1$). Thus, I found no evidence for an own-race bias, consistent with my previous findings.

In order to look at whether performance improved in Experiment 3, independent samples t-tests were carried out to compare face recognition accuracy and sensitivity (d') for Asian and Caucasian faces. The results showed that in Experiment 3, participants' performances were significantly better than that in 3-sec condition of Experiment 1A for Caucasian faces ($t(35) = 2.135, p < .05$) but not for Asian faces ($t(38) = 1.115, p > .05$). Participants in Experiment 3 performed better than that in Experiment 1B for both Asian and Caucasian faces ($t(38) = 3.278, p < .05$ and $t(35)$

= 4.059, $p < .01$, respectively). The same results between Experiment 3 and Experiment 1A and 1B were obtained for d' values for Asian photographs ($t(38) = 1.249$, $p > .05$ and $t(38) = 2.971$, $p < .01$, respectively), and d' values for Caucasian photographs ($t(35) = 2.059$, $p < .05$ and $t(35) = 3.997$, $p < .01$, respectively). These results suggest that the between subjects design increased memory performance for Caucasian faces but not for Asian faces. In addition, comparisons with Experiment 1B supported the previous findings that increasing memory load resulted in poorer performance. There was no significant difference between Experiment 3 and Blocked 1 condition of Experiment 2 in terms of participants' performances for Asian and Caucasian faces ($t(49) = .715$, $p > .05$ and $t(46) = 1.352$, $p > .05$, respectively), and d' values for Asian and Caucasian faces ($t(49) = .551$, $p > .05$ and $t(46) = 1.377$, $p > .05$). However, participants in Experiment 3 performed better than participants in Blocked 2 condition of Experiment 2 for both Asian and Caucasian faces ($t(32) = 2.802$, $p < .01$ and $t(29) = 1.908$, $p = .066$, respectively). The same differences were also found for d' values for Caucasian faces but not for Asian faces ($t(29) = 3.203$, $p < .01$ and $t(32) = 1.339$, $p > .05$, respectively). In line with previous explanations, between subjects design alone is not enough to increase memory performance but presenting the participants with fewer photographs increased memory performance regardless of the experimental design.

An independent samples t-test was performed to compare RT to correctly identify Caucasian and Asian faces. In line with the accuracy result, the groups did not significantly differ from each other ($t(32) = 1.373$, $p > .05$).

Discussion

Contrary to my expectations, once again Caucasian participants did not show a significant bias for own-race faces. The results of the experiments presented here are

inconsistent with those reported in the literature. It seems that Turkish participants in these experiments performed more poorly than other participants in the literature as their d' values seem significantly worse than d' values found in other studies. In the previous three experiments, average d' values ranged from -0.25 to 2.49 for Asian photographs ($M = .75 \pm .52$), and from -0.39 to 2.32 ($M = .66 \pm .53$) for Caucasian photographs. For example, in Michel, Caldara and Rossion (2006)'s experiment Caucasian participants' average d' values were 1.88 for own-race faces and 1.35 for other-race faces. In Michel et al. (2006)'s experiment these values were 2.2 for own-race faces and 1.34 for other-race faces. In addition, although Jack et al. (2007) did not give the exact d' values for their experiment, Caucasian participants' average d' values were approximately 1.6 for own-race faces and 1.2 for other-race faces.

The photographs used in these experiments were generated and used by Michel and her colleagues who found significant results with Belgian participants. The reason for Turkish participants' poor performance could be that they perceive Belgian faces also as if they belong to another race (or faces from another culture; i.e. European), although both Belgian and Turkish faces are categorically Caucasian. If this is the case, then culture and/or familiarity with particular facial features rather than race per se may be playing an important role in face recognition.

Experiment 4

To test whether Turkish participants perceive both Chinese and Belgian faces as other-race (or other-culture), I included Turkish faces in addition to Belgian and Chinese faces in the last two experiments. If Turkish participants categorize Belgian and Chinese faces as "other", then their performance should be better for Turkish faces than for both Belgian and Chinese faces. In addition, if this were the case, then

it would indicate that the own-race bias is not exclusively about processing own-and other races (i.e. Caucasian); rather, it could merely be an effect of culture.

Method

Participants

Eighteen Caucasian Boğaziçi University students (13 male and 5 female) participated in this experiment. Their ages ranged between 17 – 22 ($M=19.17 \pm 1.42$). They were given course credit for their participation.

Materials

For Chinese and Belgian photographs, the same database was used. Turkish photographs were collected from Bogazici University's yearbooks. Only male photographs with a neutral expression were selected and used in this experiment because most females in the yearbooks had make-up, and had mostly a positive, smiling expression. Selection was made so that none of the photographs had any discriminating feature. All photographs were cropped under the hairline with the Adobe® Photoshop® program, and converted to grayscale with the Irfanview software. A total of 114 photographs were used for this experiment (38 Chinese male, 38 Belgian male, and 38 Turkish male).

Design and Procedure

The procedure was the same as that used in Experiment 1A except that participants were presented with three types of stimuli: Chinese faces, Belgian faces and Turkish faces. In the learning phase, participants saw 19 Chinese, 19 Belgian and 19 Turkish faces with a mixed order for 3 seconds. In the recognition phase, they were tested with 114 photographs, half of which were new.

In order to eliminate any possible priming effect, the photographs were ordered such that no more than two consecutive Chinese, Belgian or Turkish photographs

were presented during both learning and recognition. In addition, no more than two consecutive old or new photographs were presented in the recognition.

Results

Table 4 shows accuracy and RT results for the recognition of Chinese, Belgian and Turkish faces. Nine participants were excluded from the analyses due to their low d' scores (below 0). A repeated measures analysis of variance (ANOVA) test was performed with the remaining nine participants. The main effect for race was significant ($F(2, 16) = 4.493, p < .05, \eta_p^2 = .360$). Pairwise comparisons showed that participants performed better on Chinese and Belgian faces than Turkish faces ($MD = .570$ and $MD = .454$, respectively). Chinese and Belgian faces did not differ from each other ($MD = .116$). Two additional ANOVAs were carried out in order to compare participants' proportion of hits and proportion of false alarms for Chinese, Belgian, and Turkish faces. There were no significant difference between hit rates of Chinese, Belgian and Turkish faces ($F < 1$). However, there was a significant difference in terms of false alarm rates ($F(2, 16) = 5.324, p < .05, \eta_p^2 = .400$). Pairwise comparisons showed that participants made more false alarms for Turkish faces than for Belgian faces ($MD = .208$). Turkish and Chinese faces, and Chinese and Belgian faces were not significantly different from each other ($MD = .133$ and $MD = .074$, respectively).

Another repeated measures analysis of variance test was performed on the RT for reaction time data. The main effect for culture was not significant ($F < 1$).

Discussion

Interestingly, the results showed that Turks performed better on faces from other cultures. In line with previous experiments, there was no significant difference in the recognition of Chinese and Belgian photographs. Therefore, the low performance

was not a cultural effect such that Turkish participants perceived the Belgian photographs as ‘other race’ or ‘other culture’. The low performance on Turkish photographs could be explained by the differences in how the photographs were cropped. That is, Turkish photographs used in this experiment were cropped with a standard elliptical fashion whereas Chinese and Belgian photographs’ crop styles were unique for each photograph. This eliminated the overall contour information more in Turkish photographs than in Belgian and Chinese photographs. Therefore, participants may have used Chinese and Belgian photographs’ crop style as an index of recognizing them instead of looking at the individuating facial features.

In order to further test the hypothesis that culture may play an important role in own-race bias, I also carried out an experiment with Dutch participants. I used Dutch participants because they are more exposed to European faces like Belgian faces than Turkish participants. So, they can perceive Belgian faces as own-race faces.

Experiment 5

The aim of Experiment 5 is to test whether Dutch participants would perceive Belgian faces as ‘own-race’ and show ORB for these faces.

Method

Participants

Twenty-one Caucasian volunteers from University of Leiden (12 male and 8 female) took place in this experiment. Their ages ranged between 17 – 25 ($M = 20.18 \pm 1.55$).

Materials

The same photographs used in Experiment 1A was used in this experiment.

Design and Procedure

The design was the same 3-sec encoding time design used in Experiment 1A.

Results

Mean accuracy (d') and RT scores are presented in Table 5. Nine participants were eliminated from the analyses because of their low d' scores (lower than 0).

Bonferroni corrected paired samples t -tests were used for overall performance (proportion of photographs recognized correctly), proportion of hits, proportion of false alarms, and accuracy (d'). None of the tests reached significance ($ts < 1$). In addition, I also compared Dutch participants' and Turkish participants' (Experiment 1A's 3-sec condition) overall performances, proportions of hits, proportion of false alarms and accuracy scores separately for each race (i.e. Caucasian and Asian). I ran eight Bonferroni corrected independent samples t -tests, and none of them reached significance, either ($ps > .05$). Similar to Experiment 1A's 3-sec condition, performances were low but significantly higher than the chance level for both Asian and Caucasian faces ($t(11) = 6.506, p < .001$ and $t(11) = 10.503, p < .001$, respectively).

The same analyses were carried out for RT data. The culture of the participant had no effect on RT; recognition RTs were similar for both groups ($ts < 1$).

Discussion

Contrary to what was expected but in line with previous results of Turkish participants, Dutch participants did not show a significant ORB for Caucasian (i.e. Belgian) faces. Although Dutch people are more exposed to European faces than Turkish people, they were not better at recognizing Caucasian faces than Asian faces. In addition, similar to the previous experiments with Turkish participants, their overall recognition performances were very low for both Caucasian ($M = .64 \pm .06$) and Asian ($M = .64 \pm .07$) faces. Therefore, it can be assumed that ORB is not a cultural effect, and maybe even not a universal finding.

Although previous studies (see Meissner & Brigham, 2001 for a meta-analysis) consistently found that people recognize own-race faces better than other-race faces, I did not find any effect of race or culture in the 5 experiments reported. More importantly, participants' performances were very low (average d' accuracy levels were ranged from .51 to 1.13 and from .44 to 1.04 for own- and other-race photographs, respectively). This low performance could be due to the characteristics of the photographs because the photographs used in these experiments were grayscale, and none of them had hair. Although the same photographs were previously used by Michel and her colleagues, the reason Turkish participants did not recognize them as the expected level could be a cultural effect. However, it is very unlikely that Turks' face recognition performances could be below average. Alternatively, removal of hair and color may have decreased face recognition performance more than expected (e.g. O'Donnell & Bruce, 2001).

CHAPTER 3

EXPERIMENT 6

Although previous experiments did not reveal a significant own-race bias among Turkish undergraduates, it is possible that there may be differences in eye movement patterns for own- and other-race faces. That is, people may differ in which parts they focus on while they try to learn and recognize own- versus other-race faces. These strategic differences revealed by eye-movement patterns may still lead to similar levels of accuracy for own and other race faces in a recognition task.

The primary aim of this experiment was to investigate whether participants differed in the distribution of eye-movements and fixations for own and other race faces. Following Schwarzer et al. (2005)'s categorizations, I examined fixation patterns of participants during recognition to determine whether they could be categorized as holistic processors for own-race faces (i.e. Caucasian faces) and analytical processors for other-race faces (i.e. Asian faces) (Hypothesis 1). Also, in line with holistic face processing literature (e.g. Farah et al., 1998), if people process own-race faces holistically as undifferentiated wholes whereas analytical processing of other-race faces requires more feature-based analyses, then I expected participants to make fewer fixations on own-race faces as well spend relatively less time overall while encoding own versus other race faces (Hypothesis 2).

There is evidence that people use similar strategies during encoding and recognition (Williams & Henderson, 2007), and similar eye movement patterns during encoding and recognition facilitate face recognition performance (Mäntylä & Holm, 2006). Following these findings, I investigated whether participants showed

similar eye movement patterns during encoding and correct and incorrect responses during recognition, independent of what they were processing (own- or other-race faces) (Hypothesis 3). If similar face processing strategies during encoding and recognition does increase the performance then I expected similar eye movement patterns during encoding and correct recognition trials but not between encoding and incorrect recognition trials.

Lastly, previous studies have shown that people fixated mostly and longest on the internal features of a face while learning and recognizing faces (Altoff & Cohen, 1999; Henderson et al., 2005; Stacey et al., 2005). Specifically, Stacey et al. (2005) found that people fixated mostly on internal features during recognition of both familiar and unfamiliar faces. Therefore, I tried to elaborate on this finding by investigating the areas fixated for own-race (familiar) and other-race (unfamiliar) faces. I investigated whether the eyes, the nose, and the mouth region received a greater proportion of fixations during learning and recognition of own- and other-race faces (Hypothesis 4).

Method

Participants

Ten Boğaziçi University students (8 male, 2 female) participated in this experiment in exchange for course credit. Their ages ranged from 20 to 24 ($M=21.6 \pm 1.33$). All participants had normal or corrected-to-normal vision. In addition, in order to eliminate calibration errors, women participants did not wear eye make-up during the experiment.

Materials and Apparatus

The procedure and materials were identical to those in Experiment 1A except for the differences noted. In Experiment 6, I used the same set of photographs I had used in

Experiment 1A. Eye movements of participants were recorded using a Tobii 1750 eye tracker (sampling at 50 Hz, with an accuracy 0.5 degrees and a 17" TFT monitor) and analyzed by the ClearView 2.0 analysis software.

Participants' heads were rested on a chin holder, positioned approximately 60 cm away from the screen, to restrain head movements during the experiment. Both before the learning and recognition phases, the eye tracker was calibrated for both the right and left eye. Participants were instructed to fixate on a red dot appearing at the center of the screen before each photograph. This red dot appeared in a location corresponding to the midpoint of the two eyes in the upcoming target photographs for 1 second. This allowed me to eliminate consecutive fixations between two photographs. Otherwise it would be hard to determine whether a person looked at a particular region because they happened to be looking at the region in the previous photograph or because they actually wanted to gather information by looking at that region. Presenting this warning prior to the presentation of each photograph ensured that participants started exploring each photo from approximately the same area (i.e. midpoint of the two eyes); on most occasions they had to make additional eye movements in order to process the faces in more detail. Each session (encoding + recognition) lasted approximately 30 minutes.

Results

Accuracy and Reaction Time

Mean accuracy (d') and RT scores are presented in Table 6. Three participants were eliminated from the analyses because of their low d' scores. Bonferroni corrected paired samples t-tests were carried out for proportion of hits, proportion of false alarms, and accuracy (d') comparing performance on own-and other race faces. None of these comparisons reached significance ($ts < 1$). Although overall performances

were not as high as presented in the literature (e.g. Henderson et al., 2005), they were significantly better than chance level for both Asian and Caucasian faces ($t(6) = 11.148, p < .001$ and $t(6) = 7.309, p < .001$, respectively). However, recognition performances of Asian and Caucasian faces were not significant. ($t(6) = 1.451, p = .197$).

Analyses revealed that there were no RT differences in recognizing Asian and Caucasian faces, ($t(6) = 1.780, p = .125$).

Eye Movements

Fixation Count

I initially analyzed the eye-movement patterns recorded during the recognition phase. For all analyses, I examined whether eye-movements differed for hits, false alarms, correct rejections, and misses because I wanted to explore whether participants' eye movement strategies were different for correct and incorrect responses. It is possible that participants used similar processing strategies for hits and correct rejections (for correct responses) and another set of strategies for false alarms and misses (for incorrect responses). If this were the case, then I could conclude that there are effective and ineffective strategies for learning and recognizing own- and other-race faces. That is, participants might have inadvertently used a strategy that might have allowed them to correctly identify a photograph as old or new; another less effective strategy may have resulted in incorrect responses.

To carry out the planned analyses, I first calculated the proportion of fixations received per location. I used proportions rather than raw counts because participants' fixation counts were different for each face, and for each facial region. Each face was divided into 4 non-overlapping areas of interests (AOIs): eyes, nose, mouth, and the area between the eyes. Although Schwarzer et al. (2005) defined 7 AOIs, I only

included the internal parts of the faces in the analyses because according to the literature the internal parts are the most informative parts during both learning and recognition of the faces (e.g. Stacey et al., 2005). Stacey et al. (2005) defined the internal part of a face as the combination of eyes, nose, and the mouth. In addition, Altoff and Cohen (1999) defined four areas; left-eye, right-eye, nose, mouth, and other. I did not separately analyze the left and right eye but considered them as one area of interest as this has been commonly used approach in the literature (e.g. Henderson et al., 2005; Jack et al, 2007; Stacey et al., 2005). One participant was eliminated from eye movement analyses due to calibration problems which resulted in poor eye movement data. Therefore, eye movement analyses were done with the remaining 6 participants.

In order to test whether participants showed a holistic eye movement pattern for own-race faces and an analytical pattern for other-race faces (Hypothesis 1), separate Bonferroni corrected one-way analyses of variances (ANOVAs) were conducted for each participant. If a participant had a holistic strategy, then s/he would have been expected to fixate on these areas evenly. In other words, a participant was categorized as a holistic processor if s/he had not fixated significantly more on one specific area. On the other hand, an analytic strategy would result in a higher proportion of fixation in one of these four areas of interest. For example, an eye-analytical processor would fixate mostly on the eyes compared to both the mouth and the nose. Pairwise comparisons showed that, for both correctly recognized and rejected faces (i.e. hits and correct rejections) 4 participants were categorized as holistic processors for Asian faces. For Caucasian faces, 3 participants processed correctly recognized faces holistically whereas 5 participants processed correctly rejected faces holistically. In the case of incorrect responses, all participants

processed both Asian and Caucasian faces they failed to recognize (i.e. misses) holistically. For Asian incorrectly recognized faces (i.e. false alarms), all participants were categorized as holistic processors. However, only 3 participants showed holistic eye movement patterns for Caucasian incorrectly recognized faces. In sum, for both correct and incorrect responses, most of the participants were categorized as holistic processors regardless of the race of the face.

Since participants had to fixate on a red dot before each photograph, and this fixation fell on the area between the eyes, this area received the greatest proportion of fixations and people fixated longest on this area. Although fixating on this area could be informative because participants could gather information covertly while their overt attention is directed here, since my main goal was to specifically indicate the areas from which participants *overtly* gathered information, I investigated the distribution of fixation in the remaining 3 areas. Therefore, the same analyses were also carried out with three AOIs (i.e. eyes, nose, and mouth). Table 7 presents the number of holistic and analytical processors for each condition. None of the participants were categorized as mouth-analytical. The mouth region received significantly less fixations than both eyes and the nose. The analyses for this result will be presented later. In line with what Schwarzer et al. (2005) reported, it was possible to identify distinctive eye movement patterns in our sample. Contrary to what was expected, participants did not show holistic face processing for Caucasian faces and analytical face processing for Asian faces. Holistic and analytical processing tendencies differed across participants and whether the trial was correctly identified as old or new (e.g. hits, correct rejections, etc.). However, as can be seen in Table 7, most of the participants were categorized as holistic processors for Asian faces. For Caucasian faces, there were an equal number of holistic and nose-

analytical processors. Therefore, the first hypothesis predicting that participants would be holistic processors for own-race faces and analytical processors for other-race faces was not supported.

Even though the hypothesis that participants used holistic strategies for own-race faces and analytical strategies for other-race faces was not supported, I nevertheless tested whether own-race faces received fewer and shorter fixations than other-race faces for correct trials only (i.e. hits and correct rejections). I compared the mean proportion of number of fixations and the mean fixation duration per fixation for Asian and Caucasian faces using separate paired samples t-tests. There was no difference between correctly recognized (i.e. hits) Asian and Caucasian faces in terms of the mean number of fixations and the average fixation durations ($t_s < 1$). In addition, correctly rejected Asian and Caucasian faces did not differ in terms of the mean number of fixations and the mean fixation duration ($t(5) = -1.976, p > .05$ and $t(5) = -405, p > .05$, respectively). That is, Asian and Caucasian faces received equal amounts of fixations and were fixated on for approximately the same durations.

In order to test whether participants showed similar eye movement patterns during encoding and recognition regardless of the race of the photograph they were processing, I categorized participants as being either holistic or analytical processors during both encoding and recognition, and determined whether their strategies remained identical across the two phases. Table 8 shows the number of analytical and holistic processors during encoding. As can be seen in the table, most participants were categorized as a holistic processor for both Asian and Caucasian faces. Table 9 shows participants' categorizations during both encoding and recognition for Caucasian and Asian faces separately. As can be seen in the table, participants did not use the same strategy for encoding Asian or Caucasian faces. For

correctly recognized faces (i.e. hits), most of the participants used the same strategy during encoding and recognition. However, for incorrect responses (i.e. misses) half of the participants changed their processing strategies between encoding and recognition. In sum, using the same strategy during both encoding and recognition increased the likelihood of giving correct responses while changing the strategy led to incorrect responses. This pattern was true regardless of whether an Asian or a Caucasian face was being processed and whether people relied on a holistic or an analytic strategy.

The same categorizations were made for unseen (i.e. new) faces during recognition in order to investigate whether participants' eye movement strategies were different for new faces as opposed to old faces during recognition (see Table 10). For correctly rejected faces, all participants used the same strategy for Asian and Caucasian new faces. For instance, a participant who used a holistic strategy for Asian faces also used a holistic strategy for Caucasian faces. For incorrectly recognized faces (i.e. false alarms), only 2 participants used the same strategy for both Asian and Caucasian faces. It seems that if participants used the same strategy for both Asian and Caucasian unseen faces, they were more likely to make correct responses. However, using a specific information gathering strategy for Asian unseen (new) faces and a different strategy for Caucasian unseen faces during recognition led to incorrect responses. I have run separate paired samples t-tests in order to investigate whether participants were faster for correct rejections than for false alarms. For Caucasian faces, there was not a significant reaction time difference between false alarms and correct rejections ($t < 1$). However, participants were faster for Asian correct rejections than for Asian false alarms ($t(5) = 3.184, p < .05$).

In addition, I also compared categorizations for hits and false alarms (i.e. old judgments during recognition), and misses and correct rejections (new judgments during recognition) to see whether participants used different strategies for old and new judgments. If they use different strategies for old and new judgments then it could be argued that participants processed familiar and unfamiliar faces differently. As can be seen in the tables, 5 participants used the same strategy during making old judgments for Asian and Caucasian faces. More importantly, none of the participants changed his/her strategy while making new judgments regardless of their accuracy. Specifically, participants who used a holistic (or an analytical) strategy for correct rejections also used a holistic (or an analytical) strategy for misses. These patterns of results suggest that participants used the same strategy while making ‘old’ decisions, and another strategy while making ‘new’ decisions regardless of whether they responded correctly or not. That is, familiar (i.e. old judgments) faces and non-familiar (i.e. new judgments) faces were processed differently.

The final set of analyses I carried out investigated the distribution of eye-movement patterns within the integral parts of faces. In line with previous findings in the literature (e.g. Henderson et al., 2005; Stacey et al., 2005) eye movements were directed to the internal regions of the faces. Ninety-five percent of fixations during encoding and 98% of fixations during recognition fell into the internal regions of the faces (i.e. eyes, mouth, and nose). Figure 1 shows total number of fixations during encoding and recognition. As can be seen in the figure, the mouth region received significantly fewer fixations than both eyes and the nose during encoding for both Asian and Caucasian faces ($F(2,59) = 52.303, p < .001$ and $F(2,59) = 101.556, p < .001$, respectively). In addition, the mouth region received significantly fewer fixations than the eyes and the nose for both Asian and Caucasian correctly

recognized faces (i.e. hits) ($F(2,59) = 52.303, p < .001$ and $F(2,59) = 22.037, p < .001$, respectively) and for correctly rejected Asian and Caucasian faces (i.e. correct rejections) ($F(2,59) = 31.753, p < .001$ and $F(2,59) = 36.703, p < .001$, respectively).

Fixation Duration

I also calculated proportion of fixation durations per location and carried out the same analyses. Table 11 shows the number of analytical and holistic processors for each recognition condition. In line with fixation count analyses, most of the participants were categorized as holistic processors for Asian faces during recognition. For Caucasian faces, almost equal numbers of participants were categorized as eye-analytical, nose-analytical, and holistic processors.

Table 12 presents the number of analytical and holistic processors for hits and misses during encoding. There were equal numbers of eye-analytical, nose-analytical, and holistic processors for Asian faces but most of the participants were categorized as eye-analytical during encoding for Caucasian faces. As can be seen in Table 13, most of the participants showed similar eye movement patterns during encoding and recognition for Caucasian hits, and half of the participants used similar eye movement strategies during encoding and recognition for Asian hits. For incorrect responses (i.e. misses), most of the participants' categorizations were different during encoding and recognition for both Asian and Caucasian faces. That is, in line with fixation count results a categorization match during encoding and recognition led to correct responses while changing the processing strategy resulted in incorrect responses. For new faces during recognition, only one participant used different strategy for Asian and Caucasian correct rejections but most of the participants were categorized differently for Asian and Caucasian false alarms during recognition (see Table 14). This finding was similar to fixation count results.

Comparisons of categorization for old and new judgments during recognition showed that 4 participants' categorizations were the same for Asian hits and false alarms (i.e. old judgments), and 5 participants' categorizations were the same for Caucasian hits and false alarms. For new judgments, 5 subjects showed same eye movement patterns for Asian and Caucasian correct rejections and misses. That is, most of the participants showed similar eye movement patterns for both correct and incorrect old judgments. They also showed similar eye movement patterns for both correct and incorrect new judgments. For all eye movement analyses, both fixation duration and fixation count comparisons revealed similar results for Asian and Caucasian faces.

To recap, I found evidence that participants tended to use the same strategy while they processed Asian and Caucasian faces. In this experiment, own-race faces were not specifically processed in a holistic fashion and other race faces were not processed in an analytical fashion. Actually, most of the participants were categorized as holistic processors for Asian faces during recognition. For Caucasian faces, there were an equal number of holistic and nose-analytical processors during recognition. On correct trials during recognition, Asian and Caucasian faces received equal amounts of fixations and were fixated on for approximately similar durations. In addition, it was found that showing similar eye movement patterns during encoding and recognition led to correct responses. However, if participants did not use the same strategy during encoding and recognition they were more likely to give incorrect responses. During recognition, if participants used the same strategy for newly seen Asian and Caucasian faces then they were more likely to make correct responses. Lastly, participants used a specific strategy for their new judgments and another strategy for their old judgments regardless of their accuracy. Specifically, they processed familiar and non-familiar faces differently.

CHAPTER 4

GENERAL DISCUSSION

This thesis was designed to investigate eye movement patterns for own- (i.e. Caucasian) and other-race (i.e. Asian) faces during face learning and recognition. Of particular interest was whether people could be categorized as holistic processors for own-race faces and analytical processors for other-race faces.

In the first five experiments, I tried to establish the own race bias (ORB) in a Turkish sample. Previous studies consistently found that people are better at categorizing and recognizing own-race faces than other-race faces (see Meissner & Brigham, 2001 for a meta-analysis). Contrary to what was expected, none of the experiments demonstrated a significant bias for own-race faces. In Experiment 1A, varying encoding time did not change low recognition performance. Although Meissner and Brigham suggested that reducing encoding time significantly increases ORB, participants in 2-sec condition were not better at discriminating own-race faces. The only significant finding was that increasing encoding time resulted in better recognition performance. However, it should be noted that in all three conditions (i.e. 2-sec, 3-sec, and 5-sec) overall recognition performances were slightly above chance level (.62, .65, and .67, respectively). As can be seen in Table 1, d' scores indicates that participants were not good at discriminating old photographs from new photographs for both Asian and Caucasian faces. In Experiment 1B, I reasoned that maybe participants would remember own-race faces better than other-race faces when the task was made to be relatively hard for them.

However, the overall performance was again close to chance level (.59) and there was no significant advantage for own-race faces.

In their meta-analysis, Meissner and Brigham (2001) also suggested that blocking the photographs by race resulted in a greater ORB than presenting the photographs in a mixed order. Therefore, in Experiment 2, I tried to find the ORB by blocking photographs by race. Participants were successively presented with either 40 or 80 photographs during encoding. In line with Experiment 1A and Experiment 1B, this manipulation turned out to be ineffective, and no ORB was observed. However, participants who were presented with fewer photographs in encoding performed significantly better. The findings of Experiment 1B and Experiment 2 suggest that increasing memory load has a deteriorating effect on face recognition performance. In addition, blocking the photographs alone is not sufficient to get the bias. In all previous experiments the overall recognition performance was not high as suggested in the literature (e.g. Bartlett et al., 2003; Tanaka & Farah, 2003). I reasoned that maybe processing two races at the same time would result in switching encoding strategies which may then decrease recognition performance. In Experiment 3, I tried to increase overall recognition performance by presenting different sets of viewers with different race photographs. Still, the recognition performance was not as high as expected (.68 for Asian faces and .70 for Caucasian faces), and there was not a significant ORB.

In previous experiments, the Asian and Caucasian photographs were taken from the database generated by Michel and her colleagues. Although they had shown a significant ORB with these photographs in Belgian samples, I was not able to replicate this finding in our Turkish sample. In their old/new recognition tasks, they presented the participants with 20 photographs for encoding and tested the

participants with 40 photographs. Although the task and encoding times were the same as Michel and her colleagues' experiments, I varied the number of photographs presented. More importantly, Turkish people's performances were very low and different presentation methods were not enough to increase their face recognition performance. All previous studies used photographs from their own culture as own-race faces. It is possible that the effect these researchers reported as a race effect is in fact a culture effect. That is people recognize faces from their own culture better than faces from other cultures. For example, Turkish people may perceive Belgian faces as European which may have led them to encode these faces as 'other'. To test this hypothesis, I have run two experiments. In Experiment 4, I included Turkish photographs in addition to Belgian and Chinese ones. Interestingly, Turkish participants recognized Turkish photographs significantly worse than both Belgian and Chinese photographs. When I asked the participants their recognition strategies, most of them indicated that Belgian and Chinese photographs were cropped differently which made them more recognizable. Since I tried to make Turkish photographs to look as even as possible, all photographs were cropped with the same elliptical shape. So, the reason for this contradictory finding could be an artifact of how photographs were prepared. Regardless, in this experiment overall performance was still very low for all cultures (.47 for Chinese, .64 for Belgian, and .56 for Turkish). In order to eliminate the explanation that culture affects face recognition performance, I also ran an experiment with Dutch participants. If the reason for Turkish participants' inability to recognize Belgian faces was because they perceive them as European faces, then Dutch participants were expected to perform better for Belgian faces because they are more exposed to European faces than Turkish participants. However, Dutch participants did not show a significant ORB for

Belgian faces. Importantly, comparisons of Dutch participants with Turkish participants revealed that both groups performed equally well. Their recognition performance was similar to Turkish participants' performance (.64 for Belgian faces and .64 for Chinese faces).

In all these experiments, face recognition performance was found to be quite low. This contrasts to what has been typically reported in the literature. For example, Henderson et al. (2005) showed that participants' face recognition performance was .81 in their free viewing condition. Further, Michel, Caldara and Rossion (2006) found that in the old/new recognition task Caucasian participants' mean d' values were 2.2 for own-race faces and 1.34 for other-race faces. One reason for low face recognition performance we reported may have to do with the characteristics of the photographs. All photographs used in the previous experiments were cropped below the hairline and converted to grayscale. It can be the case that hair and skin tone are the necessary characteristics in order to individuate the faces. Indeed, O'Donnell and Bruce (2001) showed that hair plays an important role when people try to recognize unfamiliar faces but not familiar faces. In previous experiments, all photographs were unfamiliar to the participants. Therefore, removal of hair and skin tone may have decreased the performance. Future studies should try to find the effects of hair and skin tone on ORB.

One consistent finding in all the experiments I have carried out is that the previously reported findings of own-race bias may not be a universal one. Regardless of face recognition performance, participants did not show a bias for own-race faces. In addition, including Turkish faces also did not change this similarity. In all experiments, participants accuracy levels (d' values) were very similar for own-race faces and other-race faces. Further, when I compared participants' hit and false alarm

rates, there were no significant differences between own- and other-race faces. The lack of own-race bias could be a result of low face recognition performance. One speculative explanation could be that Turkish participants are exposed to both Caucasian and Asian faces similarly. Although European faces are very similar to each other regarding facial features, Turkish faces are very variable. Due to this variability, Turkish people may have the ability to process faces from different races similarly. Another speculative explanation could be that there are no social divisions based on race in both Turkey and Netherlands as in some other countries such as in the USA.² Therefore, it is possible that Turkish people are not good at identifying faces with their racial information which would lead to no bias for own-race faces. In addition, the bias is also not a cultural bias shown in Experiment 5 and Experiment 6. Further experimentation is necessary to investigate this issue in different cultures and with different sets of photographs.

In line with previous holistic face processing and ORB studies, I reasoned that people would show different eye-movement patterns for own- and other-race faces. Specifically, I hypothesized that people would be categorized as holistic processors for own-race faces and as analytical processors for other-race faces. There are four important findings of Experiment 6. First, it is possible to categorize people as either holistic or analytical processors according to their eye movement patterns. Schwarzer, et al. (2003) found that most people are categorized as holistic processors in a face categorization task. Although the authors categorized their participants based on fixation duration, I did the same categorization by looking at each participant's proportion of fixations per area of interest. In the present thesis, most

² According to the CIA's The World Factbook, there are two main ethnic groups in Turkey (80% Turkish and 20% Kurdish) and three main ethnic groups in Netherlands (83% Dutch, 8% Western origin, and 9% non-Western origin) but these categorizations were not based on race. However, in the USA 81.7% of the population was categorized as White, 12.9% was Black, 4.2% was Asian, and the remaining was Amerindian, Alaska native, Hawaiian native or other Pacific islander.

participants were categorized as holistic processors during recognition and furthermore this categorization was regardless of the race of the photographs processed. Contrary to what was expected, during recognition there were more holistic processors for Asian faces than Caucasian faces (see Table 7). In line with this finding, Asian and Caucasian faces received equal amounts of fixations and equal fixation durations, suggesting that overall Asian and Caucasian faces were not processed differently during recognition.

Secondly, I also categorized participants as holistic or analytical processors during encoding, and compared these categorizations with how they were categorized for the recognition phase. For correctly recognized faces (i.e. hits), 5 out of 6 participants used the same strategy during encoding and recognition whereas for incorrectly responses (i.e. misses) faces half of the participants changed their processing strategy between encoding and recognition. That is, switching processing strategy (from holistic to analytical or vice versa) between encoding and recognition resulted in poorer performance.

Third, when I compared participants' categorizations for unseen faces during recognition (i.e. correct rejections and false alarms), participants were more likely to give correct responses when they used the similar eye movement patterns for Asian and Caucasian faces. However, if they used different eye movement patterns for Asian and Caucasian faces (e.g. holistic for Asian faces and nose-analytical for Caucasian faces), they were more likely to make false alarms.

Lastly, face processing categorizations were mostly the same for faces labeled as 'old' (i.e. hits vs. false alarms) and for faces labeled as 'new' (i.e. correct rejections vs. misses) in each race. Specifically, a participant who processed Asian hit faces in a holistic fashion also processed Asian false alarm faces holistically. Participants'

processing categorizations also matched for correctly rejected and missed faces (i.e. faces that thought to be new). For instance, a participant who was categorized as an eye-analytical processor for Caucasian correct rejections was also categorized as an eye-analytical processor for Caucasian misses. However, there was no consistency in the categorizations between old-labeled and new-labeled faces. This result indicates that people use a strategy for familiar faces (i.e. faces thought to be old) and another strategy for unfamiliar faces (i.e. faces thought to be new) regardless of their accuracy.

There is evidence that own- and other-race faces receive different fixation patterns (Jack et al., 2007) but this thesis is the first study that categorized people as holistic or analytical processors for own- and other-race faces. Further studies should replicate these findings. In addition, due to both poor recognition performance and the lack of a significant ORB effect further work is needed to test whether people are categorized as holistic processors for own-race faces but as analytical processors for other-race faces based on the eye movement patterns.

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APPENDICES

APPENDIX A: TABLES

Table 1. Means and Standard Deviations (in parentheses) of Accuracy rates and Reaction Time for Experiment 1A and Experiment 1B

	Condition	Asian Faces				Caucasian Faces			
		Hit-rate	FA-rate	d'	RT	Hit-rate	FA-rate	d'	RT
Experiment 1A	2-sec	.30 (.08)	.18 (.08)	.44 (.27)	1026.48 (152.95)	.26 (.07)	.14 (.07)	.51 (.27)	1030.11 (141.51)
	3-sec	.67 (.15)	.36 (.11)	.86 (.39)	1049.89 (148.58)	.58 (.16)	.30 (.15)	.81 (.41)	1037.23 (130.66)
	5-sec	.63 (.16)	.28 (.12)	.97 (.44)	1007.64 (214.04)	.61 (.15)	.29 (.13)	.90 (.40)	989.44 (190.32)
Experiment 1B	3-sec	.55 (.12)	.38 (.13)	.45 (.38)	1038.74 (96.06)	.53 (.08)	.33 (.09)	.52 (.26)	1022.32 (92.51)

Table 2. Means and Standard Deviations (in parentheses) of Accuracy and Reaction Time for Experiment 2

Condition	Asian Faces				Caucasian Faces			
	Hit-rate	FA-rate	d'	RT	Hit-rate	FA-rate	d'	RT
Blocked 1	.65 (.12)	.28 (.09)	1.00 (.44)	1005.78 (123.13)	.61 (.12)	.29 (.12)	.89 (.50)	1027.53 (125.49)
Blocked 2	.53 (.13)	.33 (.12)	.72 (.38)	1026.35 (165.62)	.51 (.12)	.26 (.09)	.56 (.38)	1040.72 (182.53)

Table 3. Means and Standard Deviations (in parentheses) of Accuracy and Reaction Time for Experiment 3

	Hit-rate	FA-rate	d'	RT
Asian Faces	.65 (.15)	.28 (.12)	1.04 (.57)	1063.42 (103.45)
Caucasian Faces	.64 (.13)	.25 (.11)	1.13 (.60)	1001.75 (156.00)

Table 4. Means and Standard Deviations (in parentheses) of Accuracy and Reaction Time for Experiment 4

	Hit-rate	FA-rate	d'	RT
Chinese Faces	.60 (.22)	.33 (.17)	.89 (.56)	976.41 (123.18)
Belgian Faces	.53 (.21)	.25 (.10)	.77 (.38)	966.46 (121.64)
Turkish Faces	.58 (.16)	.46 (.18)	.32 (.15)	984.26 (144.82)

Table 5. Means and Standard Deviations (in parentheses) of Accuracy and Reaction Time for Experiment 5

	Hit-rate	FA-rate	d'	RT
Asian Faces	.61 (.16)	.38 (.15)	.67 (.37)	1084.90 (245.14)
Caucasian Faces	.68 (.11)	.41 (.11)	.73 (.26)	1026.96 (209.83)

Table 6. Means and Standard Deviations (in parentheses) of Accuracy and Reaction Time for Experiment 6

	Hit-rate	FA-rate	d'	RT
Asian Faces	.61 (.08)	.24 (.09)	1.02 (.27)	1456.65 (335.87)
Caucasian Faces	.61 (.09)	.29 (.07)	.86 (.33)	1564.91 (371.08)

Table 7. Number of Analytical and Holistic Processors during Recognition based on the Proportion of Fixation Counts (EA = Eye-analytical, NA = Nose-analytical, H = Holistic)

	Asian Faces			Caucasian Faces		
	EA	NA	H	Ea	NA	H
Hits	0	2	4	2	2	2
Correct Rejections	1	2	3	1	2	3
False Alarms	0	1	5	2	3	1
Misses	1	2	3	1	2	3

Table 8. Number of Analytical and Holistic Processors during Encoding for Correctly and Incorrectly Recognized Faces based on the Proportion of Fixation Counts (EA = Eye-analytical, NA = Nose-analytical, H = Holistic)

	Asian Faces			Caucasian Faces		
	EA	NA	H	EA	NA	H
Hits	2	2	2	2	1	3
Misses	1	1	4	1	1	4

Table 9. Participants' Eye Movement Categorizations during Encoding and for Correctly and Incorrectly Recognized Trials during Recognition for Asian and Caucasian Faces based on the Proportion of Fixation Counts (EA = Eye-analytical, NA = Nose-analytical, H = Holistic)

	Asian Faces				Caucasian Faces			
	Hit		Miss		Hit		Miss	
	Encoding	Recognition	Encoding	Recognition	Encoding	Recognition	Encoding	Recognition
Sbj1	EA	H	H	H	EA	EA	H	H
Sbj2	H	H	H	H	H	H	H	H
Sbj3	EA	H	EA	H	H	H	EA	H
Sbj4	NA	NA	NA	NA	NA	NA	NA	NA
Sbj5	NA	NA	H	NA	H	NA	H	NA
Sbj6	H	H	H	EA	EA	EA	H	EA

Table 10. Participants' Eye Movement Categorizations for Unseen Asian and Caucasian Faces during Recognition based on the Proportion of Fixation Counts (EA = Eye-analytical, NA = Nose-analytical, H = Holistic)

	Correct Rejections		False Alarms	
	Asian	Caucasian	Asian	Caucasian
Sbj1	H	H	H	EA
Sbj2	H	H	H	H
Sbj3	H	H	H	NA
Sbj4	NA	NA	H	NA
Sbj5	NA	NA	NA	NA
Sbj6	EA	EA	H	EA

Table 11. Number of Analytical and Holistic Processors during Recognition based on the Proportion of Fixation Durations (EA = Eye-analytical, NA = Nose-analytical, H = Holistic)

	Asian Faces			Caucasian Faces		
	EA	NA	H	Ea	NA	H
Hits	1	2	3	2	2	2
Correct Rejections	2	2	2	1	2	3
False Alarms	0	1	5	2	3	1
Misses	1	2	3	2	2	2

Table 12. Number of Analytical and Holistic Processors during Encoding for Correctly and Incorrectly Recognized Faces based on the Proportion of Fixation Durations (EA = Eye-analytical, NA = Nose-analytical, H = Holistic)

	Asian Faces			Caucasian Faces		
	EA	NA	H	EA	NA	H
Hits	2	2	2	3	2	1
Misses	2	2	2	3	2	1

Table 13. Participants' Eye Movement Categorizations during Encoding and for Correctly and Incorrectly Recognized Trials during Recognition for Asian and Caucasian Faces based on the Proportion of Fixation Durations (EA = Eye-analytical, NA = Nose-analytical, H = Holistic)

	Asian Faces				Caucasian Faces			
	Hit		Miss		Hit		Miss	
	Encoding	Recognition	Encoding	Recognition	Encoding	Recognition	Encoding	Recognition
Sbj1	EA	H	EA	H	EA	EA	H	EA
Sbj2	H	H	H	H	H	H	H	H
Sbj3	EA	H	EA	H	EA	H	EA	H
Sbj4	NA	NA	NA	NA	NA	NA	NA	NA
Sbj5	NA	NA	NA	NA	H	NA	H	NA
Sbj6	H	EA	H	EA	EA	EA	EA	EA

Table 14. Participants' Eye Movement Categorizations for Unseen Asian and Caucasian Faces during Recognition based on the Proportion of Fixation Durations (EA = Eye-analytical, NA = Nose-analytical, H = Holistic)

	Correct Rejections		False Alarms	
	Asian	Caucasian	Asian	Caucasian
Sbj1	EA	H	H	EA
Sbj2	H	H	H	H
Sbj3	H	H	H	NA
Sbj4	NA	NA	H	NA
Sbj5	NA	NA	NA	NA
Sbj6	EA	EA	H	EA

APPENDIX B. FIGURES

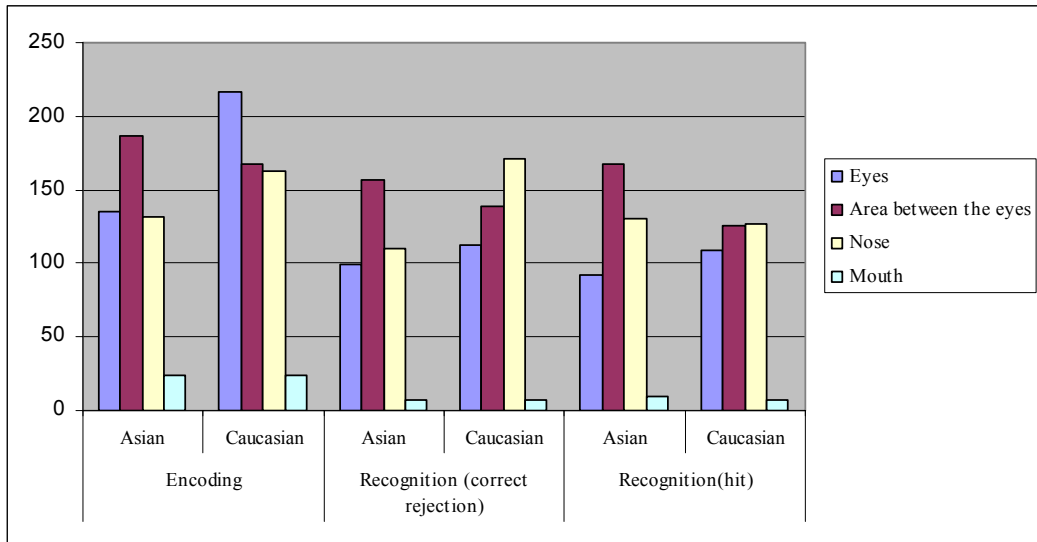


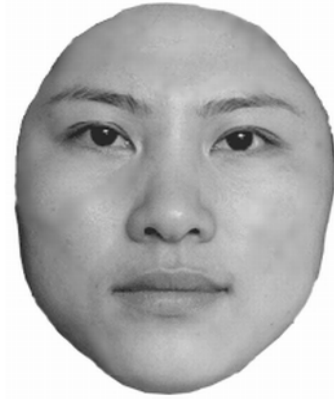
Figure 1. Total Number of Fixations Made during Encoding and Recognition for Asian and Caucasian Faces

APPENDIX C. EXAMPLES OF PHOTOGRAPHS USED IN EXPERIMENTS 1-6

CHINESE MALE



CHINESE FEMALE



BELGIAN MALE



BELGIAN FEMALE



TURKISH MALE



APPENDIX D: CURRENT RESEARCH FINDINGS OF OWN-RACE BIAS

Source	Participants	Materials	Method	Procedure	Results
MacLin, MacLin, & Malpass (2001) (Experiment 1)	84 Hispanic	30 Black 30 Hispanic (all males, colored)	Learning: 20 Black 20 Hispanic Recognition: 20 Black 20 Hispanic *Mixed race order	Encoding times: either 0.5-sec or 5-sec. with 2-sec of ISI 2 delay conditions: no delay and 30 min. delay Recognition: Old/new judgment after seeing each face for 5-sec; with 8-sec of ISI	Measure: A' Own-race faces (.84) were more accurately recognized than other-race faces (.71). 5-sec encoding time resulted in better performance (.87 and .77 for Hispanic and Black faces, respectively) than 0.5-sec encoding time (.81 and .66 for Hispanic and Black faces, respectively) No effect of delay time on recognition performance
Wright, Boyd, & Tredoux (2003)	50 White English, 50 White South African, 50 Black South African	30 White 30 Black (all males, black-and-white)	Encoding: 15 White 15 Black Recognition: 30 White 30 Black *Mixed race order	Encoding time: 3-sec. with 2-sec of ISI Recognition: Faces were presented until key press	Measure: d' All participants (White English, White South African, and Black South African) recognized White faces (approx. 1.5, 1.5, and 1.1, respectively) more accurately than Black faces (approx. .90, .80, and .80, respectively) – explained by interracial contact hypothesis
Meissner, Brigham, & Butz (2005) (Experiment 2)	32 White 32 Black	80 White 80 Black (all males, colored)	Encoding: 20 White 20 Black Recognition: 40 Black 40 White *Mixed race order	Encoding time: 3-sec. Recognition: Old/new judgment after seeing each face for 7-sec.	Measure: A' Own-race faces (.81) were recognized better than other-race faces (.75).
Johnson & Frederickson (2005)	89 White	28 White 28 Black (gray scale)	Learning: 14 White 14 Black Recognition: 28 White 28 Black *Mixed race order	Encoding time: 500 msec. with 2-sec ISI Recognition: Faces were presented until key press *Before encoding, 3 types of emotion induction (joy, fear, neutrality)	Measure: d' Both fear and neutrality induction groups recognized own-race faces (approx. 1.3 and 1.4, respectively) were more accurately than other-race faces (approx. .90 and .90, respectively). There were no difference between own-race faces (approx. 1.35) and other-race faces (approx. 1.30) for joy induction group.

Michel, Rossion, Han, Chung, & Caldara (2006)	30 White 30 Asian	20 White 20 Asian (half males, colored)	Encoding: 20 White 20 Asian Recognition: 20 White 20 Asian *Blocked race order	Encoding time: 3-sec. with 1-sec of ISI Recognition: Faces were presented until key press or max. of 2-sec	Measures: d' and RT Own-race faces (2.2 for White and 2.06 for Asian participants) were more accurately recognized than other-race faces (1.34 for White and 1.22 for Asian participants) Own-race faces (968ms for White and 896ms for Asian participants) were recognized faster than other-race faces (1.008ms for White and 971ms for Asian participants)
Michel, Caldara, & Rossion (2006)	22 White, 24 Asian	24 White 24 Asian (half males, colored)	Encoding: 20 White 20 Asian Recognition: 20 White 20 Asian *Blocked race order	Encoding time: 3-sec. with 1-sec of ISI Recognition: Faces were presented until key press or max. of 2-sec	Measures: d' and RT Own-race faces (1.88 for White and 1.97 for Asian participants) were more accurately recognized than other-race faces (1.35 for White and 1.21 for Asian participants) No differences were found for RT.
Jack, Blais, Scheepers, Fiset, & Caldara (2007)	14 White 14 Asian	56 White 56 Asian (half males)	Encoding: 28 White 28 Asian Recognition: 56 White 56 Asian *Blocked race order	Encoding time: 5-sec. Recognition: Faces were presented until key press	Measures: d' and RT Own-race faces (approx. 1.6 for White and 1.7 for Asian participants) were more accurately recognized than other-race faces (approx. 1.2 for White and 1.4 for Asian participants) No differences were found for RT.