SEX CATEGORIZATION FROM FACES: OTHER-RACE AND OTHER-SPECIES EFFECT

MERVE BULUT

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SEX CATEGORIZATION FROM FACES: OTHER-RACE AND OTHER-SPECIES EFFECT

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ABSTRACT

SEX CATEGORIZATION FROM FACES: OTHER-RACE AND OTHER-SPECIES EFFECT

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Master of Science in Experimental Psychology

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This thesis aimed to investigate whether or not human adults can categorize the sex of other-race and other-species faces and if so how they do it. In order to understand that, a sex categorization task with Caucasian, Asian and chimpanzee faces was performed by the participants. Results revealed that Caucasian observers could categorize all face categories at least more than chance level successfully, yet a strong *other-race* and *other-species effect* were observed in both accuracy and reaction time measurements. Consistent with previous literature, male faces categorized more accurately and quickly compared to female faces. Facial metric analysis revealed that eye (eye height, eye width, brow to eye distance) and nose measurements were significantly correlated with the participants' male or female responses during the task. Furthermore, in human (Caucasian and Asian) faces brow to eye distance, in chimpanzee faces eye height had the strongest correlations with the participants' response. The follow up eye-tracking study revealed that consistent with facial metric analysis, eye was the most informative area during the sex categorization task. In particular, the results showed that observers attended to the eye region more than other areas in all face categories. However, the eye was more dominantly fixated in own-species faces compared to other species. Furthermore, the nose was more attended in other-race and other-species faces compared to own-race and own-species faces. This finding suggests that other-race and other-species faces elicit different gaze pattern during sex categorization task.

Keywords: sex categorization, face, other-race, own-race, facial metric, eye-tracker

ÖZET

YETİŞKİN İNSANLARDA YÜZ ALGISININ AYNI VE FARKLI IRKTAN VE FARKLI TÜRDEN YÜZLERLE BİR CİNSİYET SINIFLANDIRMA GÖREVİ KULLANILARAK İNCELENMESİ

Bulut, Merve

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Bu tezde yetişkin insanların farklı ırk ve türe sahip olan yüzlerin cinsiyetini başarılı olarak kategorize edip edemediği ve eğer edebiliyorlarsa bunu nasıl gerçekleştirdikleri çalışılmıştır. Bunu anlamak amacıyla ilk deneyde, Kafkas (beyaz Avrupalı), Asyalı ve şempanze yüzlerini içeren bir cinsiyet belirleme görevi katılımcılara uygulanmıştır. Sonuçlar katılımcıların tüm kategorilerdeki yüzlerin cinsiyetini şans seviyesinden yüksek olacak şekilde belirleyebildiğini göstermiştir. Bununla birlikte katılımcıların Kafkas yüzlerde Asyalılara göre, Asyalı yüzlerde ise şempanzelere göre hem doğru yanıt, hem de yanıt süresi bakımından daha iyi performans gösterdikleri bulunmuştur. Ayrıca, daha önceki literatür bulguları ile tutarlı olarak erkek yüzlerin kadın yüzlere göre daha doğru ve daha hızlı şekilde kategorize edildiği ortaya çıkmıştır. Yüzlerdeki cinsiyete bağlı dimorfizmin (sexual dimorphism) katılımcıların yanıtları ile ilişkisini incelemek amacıyla, tüm uyarıcı setindeki yüzlerde, bir takım uzunluklar iki bağımsız değerlendirici tarafından ölçülmüştür. Daha sonra bu uzunluklar ve katılımcıların yanıtları (kadın, erkek) arasındaki ilişki bir korelasyon çalışması ile incelenmiştir. Sonuçlara göre göz (göz uzunluğu, göz genişliği ve kaş ve göz arasındaki mesafe) ve burun ölçümlerinin tüm yüz kategorilerinde, katılımcıların yanıtlarıyla korele olduğu gözlenmiştir. Dolayısıyla katılımcıların görev sırasında yüzleri kadın ya da erkek olarak kategorize ederken bu uzunluklara hassasiyet gösterdikleri düşünülmektedir. Dahası, insan yüzlerinde (Kafkas ve Asyalı) kaş ve göz arasındaki mesafe, şempanze yüzlerinde ise göz uzunluğu katılımcıların yanıtları ile en güçlü şekilde korele olan uzunluklardır. Buna ek olarak yürütülen ikinci deneyde aynı cinsiyet belirleme görevinin kullanıldığı göz-izleme çalışması, korelasyon analizi ile tutarlı olarak yüzlerdeki cinsiyetle ilgili en bilgilendirici bölgenin göz olduğunu bulmuştur. Katılımcılar tüm yüzlerde en çok göze bakmakla birlikte, bu bulgunun katılımcıların kendi türünden olan yüzlerde şempanzelere oranla daha yaygın olduğu gözlemlenmiştir. Buna ek olarak katılımcılar burun bölgesine Asyalı yüzlerde ve şempanze yüzlerinde Kafkas yüzlerine oranla daha fazla bakmışlardır. Bu bulgu, katılımcıların cinsiyet belirleme görevi sırasında farklı ırktan ve farklı türden olan yüzlerdeki fiksasyon paternlerinin aynı ırktan olan ve daha sıklıkla maruz kalınan yüzlere kıyasla farklılaştığını göstermektedir.

Anahtar Kelimeler: cinsiyet belirleme, yüz, ırk, tür, göz izleme, şempanze

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CHAPTER 1

INTRODUCTION

Face processing is one of the most complex and important perceptual skill. This highly advanced perceptual skill occupies a wide neural circuitry in the human brain. Haxby et al. (2002) examined the neural circuitry of face perception in two aspects. The core system, which is responsible for the perception of the structure of the faces (proportions of facial features) which is stable during facial movement (e.g. recognition) and the extended system, which is responsible for inferring meaning from faces and involves the perception of facial expressions (e.g. emotion). Brain imaging studies showed that lateral fusiform gyrus and superior temporal sulcus are the main areas of the brain that responds to faces (Haxby et al., 2000). Haxby et al. (2002) have demonstrated the dissociation between these two areas. They revealed that lateral fusiform gyrus, which is mainly related to the unchanging aspects of the face, responds more during face recognition. On the other hand, superior temporal sulcus activated more during emotional expression, lip movement or gaze direction, which are changing aspects of the face that includes facial movement. Facial movement perception is also distributed different brain areas that are not necessarily dedicated to face perception. For instance, intraparietal sulcus showed to be activated by gaze direction and emotional faces activate amygdala in the case of fear and insula in the case of disgust. (Haxby et al., 2002). This wide circuitry of face processing indicates the importance of face perception in humans (see Figure 1).

In humans, various aspects of face perception were studied that includes recognition (identifying individual faces), sex categorization (categorize a face as male or female), race categorization (name the race of a face such as Caucasian or Asian), as well

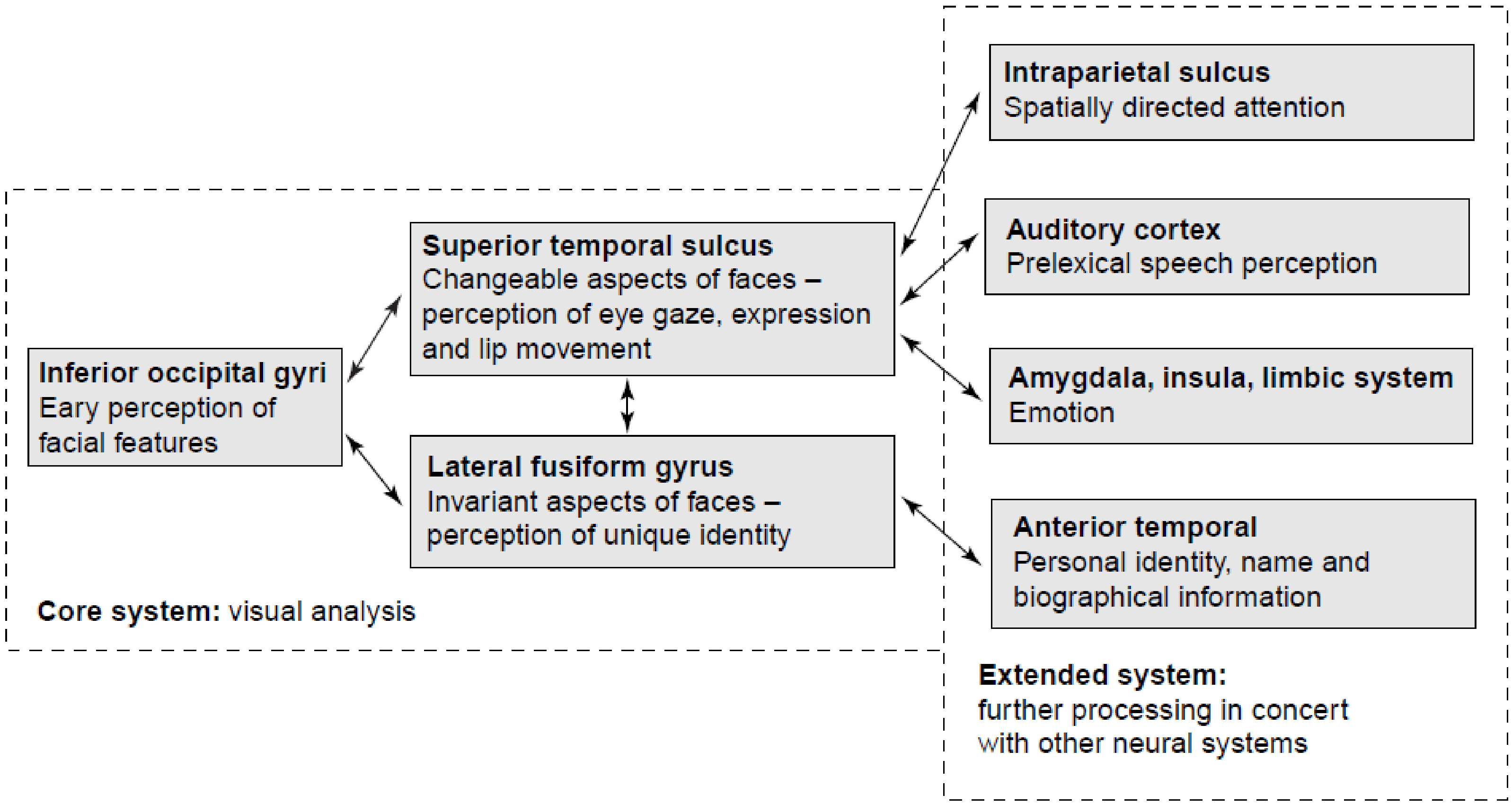

Figure 1. Human neural system distribution for the perception of faces. Reprinted from "The distributed human neural system for face perception by J.V., Haxby, E.A., Hoffman, and M.I., Gobbini, 2000, *Trends in Cognitive Sciences 4*(6), p.230.Copyright [2000]. Elsevier Science Ltd.

as emotion (categorize the emotion of a face as happy, sad etc.). In fact, in the early 1870s, Darwin (1872) proposed that face perception is not unique to humans. Several studies showed that not only humans but also numerous other mammalian species have face perception ability (Leopold & Rhodes, 2010). Among these species, sheep have the greatest visual acuity. Sheep can identify another conspecific from its faces even when the photographs of faces are disrupted (Tate et al., 2006). In addition to that bottlenose dolphin, (Marino et al., 2007), killer whales (Delfour & Marten, 2001), and elephants (Plotnik et al., 2006) have been reported to show signs of face perception ability. Studies strongly suggest that not only mammalians but also some vertebrates have face perception ability. For example, birds, (Bird & Emery, 2008), fish (Grosenick et al., 2007), reptiles (Van Dyk & Evans, 2007) have shown to be recognizing their conspecifics' faces. Furthermore, crows demonstrated that they are able to recognize humans from their face (Cornell et al., 2012). Evolutionary studies suggested that for the member of these species during the vertebra evolution gathering information from faces (identification, gaze, emotional expression etc.) and using the facial expressions in a social context might have increased the chance of survival (for a detailed review see Leopold & Rhodes, 2010). For instance, single neuron studies revealed that not only humans but also non-human primates have specialized neural circuitry that responds to faces (Hasselmo et al., 1989; Perrett et al., 1982; Pinsk et al., 2005). Some of these studies even showed that chimpanzee face processing system is so similar to humans that they show a conspecific advantage in face perception (Parr et al., 1998; Tomonaga, 2007; Parr et al., 2006). In the literature, this appears as the *other-race effect* in humans, which refers to the processing of faces from our own-race more efficiently than faces from other races (O'Toole et al., 1994).

Developmental studies with humans and non-human primates showed that individuals show no special face perception ability for their own-species faces over other-species until a certain age. Sugita (2008) showed that Japanese monkeys reared by humans and deprived of other monkey faces preferred to look longer at human faces compared the other objects or even other monkey faces. Newborns show a disposition to attend to faces over other objects (Johnson & Morton, 1991; Valenza et al., 1996; Macchi et al., 2004), but they do not show any preference for own-race faces (Kelly et al., 2005; but see Tham & Hay, 2015). Furthermore, they also do not show a human-specific preference for faces.

For example, Giorgio et al. (2011) revealed that when faces of the humans and primates' low-level perceptual properties were controlled, infants do not show any preference for human faces over monkey faces and recognize both human and monkey faces successfully. Furthermore, the same study showed that infants preferred to look longer at upright monkey faces rather than inverted ones (indicates the holistic face processing that adults show for human faces), which might indicate that newborns (aged 24 h to 72 h) process human and monkey faces in a similar way.

One of the theories that explain adult specialization for own-race and own-species faces is “perceptual narrowing” (Scott et al., 2007). Anzures et al. (2012) defined this process as "…an initially broadly tuned system becomes more specialized to process familiar and biologically relevant stimuli." (p.484). Perceptual narrowing phenomenon is observed in face perception as well. Pascalis et al. (2002) showed that 6 months old human babies can successfully discriminate both human and monkey faces whereas 9 months old and adults could not. Some studies also showed that when infants were trained early on with other species' faces, they keep this ability until 9 months of age (Pascalis et al., 2005; Scott & Monesson, 2009). Simpson et al. (2011) also showed that human babies (4-6 months old) could successfully discriminate sheep faces. Hayden et al. (2007) revealed that only after 4-6 months old newborns start showing signs of *other-race effect* in face perception. All these studies suggest that approximately by the age of 9 months, newborns are no more sensitive to the other-race and other-species faces and start processing these faces in a different manner than own-race faces. In years of experience by exposing numerous own-race faces, humans lose their the ability of identifying other-race and other-species faces and show a perceptual specialization in own-race faces (see also Bar-Haim et al., 2006; Kelly et al., 2007, 2009; Quinn et al., 2002). This adult perceptual specialization of faces is probably developed in order to maximize the perceptual ability with their own species and own-race faces.

Aforementioned studies indicate that most animals have the face perception ability (Leopold & Rhodes, 2010). Developmental studies with human and non-human primates suggest that face perception responds not specifically to own-species or own-race faces but also other-race and other-species faces as well during the first 6-9 months of age (Sugita, 2008; Pascalis et al., 2002). By exposing own-species and own-race faces with time, individuals develop a perceptual narrowing in their face perception ability in order to enhance their perception in own-race faces. In the literature, it was showed several times that humans could not perform face recognition tasks with other-race and other-species faces successfully after 9 months of age (Kelly et al., 2005; Tham & Hay, 2015). However, there is scarcity of research on other face perception tasks with other-race and other-species faces. This thesis is aimed to show that whether or not sex categorization, which is an important aspect of face processing system, is a face perception ability that humans can perform on both other-race and other-species faces successfully without any training.

The current study focuses on sex categorization particularly because it is thought that categorizing sex from faces is a different cognitive process than face recognition (Young & Burton, 2018). Young and Burton (2018) discussed that tasks such as categorization of sex, race, and age of faces should be examined separately than recognition, which is an extremely complex process. In fact, numerous studies showed that participants have difficulty in recognizing an unfamiliar face (a face not seen before) when the photographs were taken with different cameras and under different lightning (Bruce et al., 1999; Jenkins et al., 2011; Burton et al., 2010). However, participants easily recognize a familiar face (i.e. famous face or one seen before) from different angles, in different poses, under different lighting (Burton et al., 2016). Furthermore, humans do not show the *other-race effect* with familiar faces (Zhou & Mondloch, 2016). These studies indicate that humans are remarkably good at recognizing familiar faces but not unfamiliar faces. On the other hand, humans perform tasks such as categorizing sex, race, and age of a face very well independently from the familiarity of the faces (Sæther et al., 2010; Zhao & Bentin, 2008). Therefore, it is suggested in the current study that humans might perform well with other-race and other-species faces in a sex categorization task even though they had very few prior experiences with those faces.

1.1. Sex Categorization

Sex categorization of faces is an important aspect of the face processing ability. It was crucial for many primates in terms of mate selection, social life and survival during the evolutionary history (Burke & Sulikowski, 2010). Humans and many non-human primates have developed a sexually dimorphic face, which helps them to use visual information in order to identify the sex of others (Yamaguchi et al., 1995). Thus, we infer our first impressions, from whether a specific face is feminine or masculine, and secondly we make interpretations about the owner of that faces' personality, which is highly affected from the faces' femininity and masculinity traits (Walker & Wanke, 2017; Martin & Macrae, 2007; Willis & Todorov, 2006). As mentioned before, humans are remarkably good at sex categorization, even though external cues such as hair, make-up, facial hair are removed (Cellerino et al., 2004). In fact, several studies consistently showed that only very short appearance of a face (26 to75 ms) is enough for humans to categorize the sex of the face successfully (O'Toole et al., 1996; Reddy et al., 2004; Sergent & Hellige, 1986). It is an early process compared to recognition (Sergent et al., 1992). ERP studies showed that human brain potential latency for sex categorization from a face is extremely fast (approximately 150 ms) (Schendan et al., 1998). Cellerino et al. (2004) showed that participants who view faces with the cropped facial outline, that were pixilation filtered and Gaussian noise filtered, were often successful at categorizing the sex. The same study also found that male faces categorized more efficiently than female faces. Successful categorization of female faces fell to the chance level at 1792-pixel filtration, whereas male faces were categorized even at 112-pixel filtration.

Although much is known about sex categorization, the understanding of categorizing the sex of other-race is less clear. For example, O'Toole et al. (1996), using Caucasian and East Asian faces, found the *other-race effect* in sex categorization task but Zhao and Bentin (2008) found no such effect in their study with Chinese and Israeli participants. A possible reason for this inconsistency could be the variations in task difficulty. In O'Toole et al. (1996)'s study, faces presented for 75ms and followed by a 200ms mask before the response of the participant. On the other hand, in Zhao and Bentin's (2008) study, face stayed on the screen until participants responded. This suggests that *other-race effect* can be more pronounced when the task gets more difficult.

Sex categorization task with other-species faces has been studied less often compared to other-race studies. According to our knowledge, only Franklin et al. (2013) have revealed that humans successfully categorize sex of macaque monkeys faces without any training. Little et al. (2013) also found that even though humans show *other-species effect* in judging the sex-typicality (whether the face is masculine or feminine) of human and macaque faces (they were more successful in their own-species faces), they nevertheless show high accuracy (higher than chance level) on macaque faces as well. These studies indicate that humans might categorize other-species faces by their sex, yet this remains as an unexplored research area.

The current study aimed to address whether or not human adults can successfully perform sex categorization task with other-race and other-species faces. In order to reveal this issue, in the current thesis, a sex categorization task with own-race human, other-race human and non-human faces was conducted to the participants. The study conducted with Turkish university students. As an own-race face, Caucasian faces were used in the study. The reason for choosing Caucasian face as an own-race category is that majority of the Y-DNA (which is a chromosome only found in males and inherited from male ancestors) haplogroups found in Turkish people are shared with Caucasians (Cinnioğlu et al., 2004). For the other-race face category, East Asian (Chinese) faces were selected because Chinese facial sexual dimorphism is well documented before (Liu et al., 2014; Luximon et al., 2012; İscan et al., 1998). For non-human faces, *Pan Troglodytes* (common chimpanzee) were selected because sexual dimorphic pattern on chimpanzee faces were shown in detailed before (Schaefer et al., 2004; Wood et al., 1991) and it is the closest pattern to human faces compared to other ape species (Wood et al., 1991; Cobb & O'Higgins, 2007).

1.2. Sexual Dimorphism on Faces

Geometric morphometric measurement is a method that can be used to calculate craniofacial shape variations (Hennesy & Stringer, 2002). It measures both size and shape changes and allows researchers in-depth investigation of 3D planes. Craniofacial sexual dimorphism studies commonly utilize geometric morphometric methods. For example, Hennessy and Stringer (2002) showed that Caucasian males have a more anterior nasal bridge and have bigger nose compared to females. Furthermore, they showed that female lips are fuller and chin is more prominent (see also Rosas & Bastir, 2002). Mitteroecker et al. (2015) have applied masculinity morphometric on a set of human male faces. They found that the wider the faces, the more masculine they are perceived. Furthermore, nose and interorbital distance perceived as more masculine when they get wider. On the other hand, masculinity was related more to the thinner lips and larger lower face line. Also, consistent with previous studies they found that compared to females, males have closer and thicker eyebrows and smaller eyes. They also showed that males have larger lower jawline than females. Another morphometric study with Chinese 3-D faces found that males have wider noses and wider mouths. In contrast to Caucasian faces, Chinese faces have not sexually dimorphic eyes (Liu et al., 2014). Furthermore; Chinese male head and face found consistently larger compared to females (Liu et al., 2014; Luximon et al., 2012) and males have larger jaw than females (Gu et al., 2011). Finally, it was showed that Chinese faces are the least sexually dimorphic among East Asian faces in terms of cranial measurements (Iscan et al., 1998).

Several morphometric studies with *Pan Troglodytes* (common chimpanzee) showed that males and females have sexually dimorphic faces (Schaefer et al., 2004; Wood et al., 1991). Moreover, Wood et al. (1991) showed that centroid size of chimpanzees is significantly different for male and females. The greatest differences between males and females are interorbital distances and zygomatic regions (Cobb, O' Higgins, 2007). These measurements are larger in male chimpanzees and make their face appear wider. In addition, studies consistently found that facial height (vertical) relative to facial length (horizontal) are lower in males compared to females and males had larger jaws (Cramer, 1977, Lockwood, 1999), which results in a wider male face compared to females.

Along with geometric morphometric studies, many researchers use facial metrics from 2D photographs of faces in order to assess sexual dimorphism (masculinity and femininity). Generally, eye size, distance between eye and eyebrow (Penton-Voak et al., 2001), nose width, jaw width, mouth width, mouth height (Grammer & Thornhill, 1994) have used to measure the femininity and masculinity of the 2D face photographs (see also Fellous 1997; Enlow 1990; Gangestad & Thornhill, 2003) (see Figure 2). Most of these studies conducted with European faces and few with cross-cultural or cross-species. The only one study with European, Hadza (African hunter-gatherer group) and macaque faces, found a relationship between symmetry and sexual dimorphism across three face category by using facial metrics method (Little et al., 2008). Because the sexually dimorphic pattern of stimuli faces can affect the performance in sex categorization, facial metrics can be used to measure sexual dimorphism on stimuli faces in order to understand sex categorization ability of humans more efficiently.

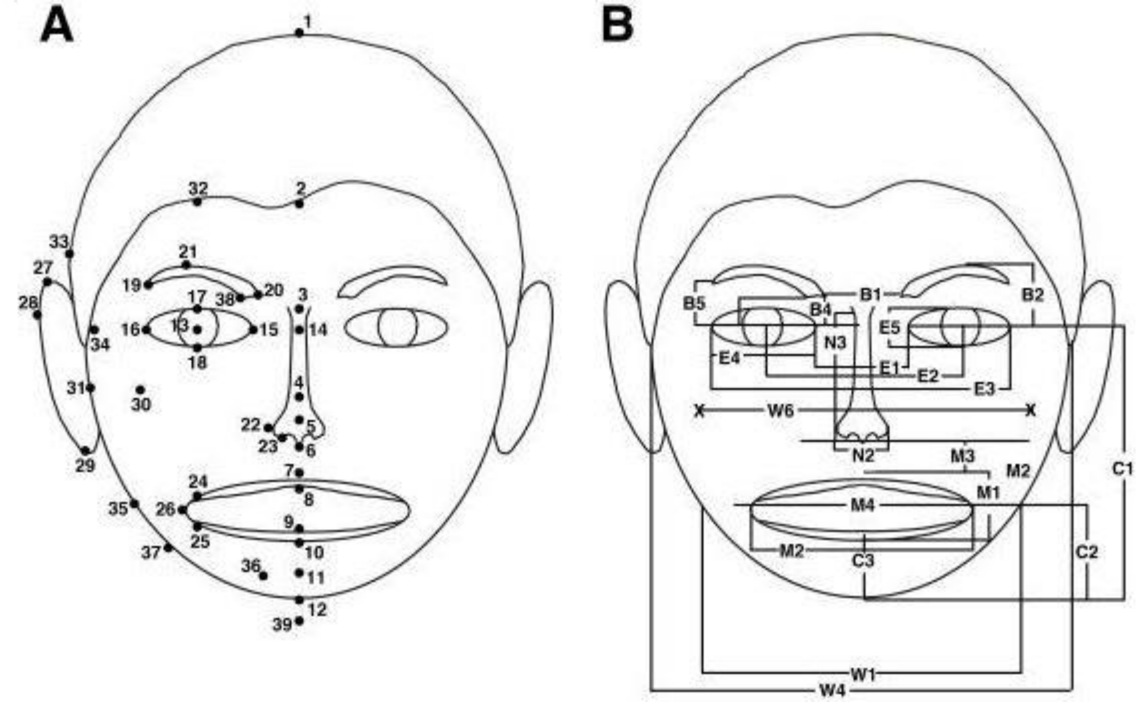

Figure 2. A demonstration of a typical facial metric measurement process. First, two or more raters specify landmark points (such as two corner of the eye) (Picture A). Later, the length between specified landmarks are measured (Picture B). Adapted from "Skin and bones: The contribution of skin tone and facial structure to racial prototypicality ratings by M.A. Strom, L.A. Zebrowitz, S. Zhang, P.M. Bronstad, & H.K. Lee, 2012, *PLoS ONE 7*(7), e41193.Copyright [2012]. Strom et.al.

1.3.Gaze Behavior in Face Perception

While studying face-processing tasks such as sex categorization, it is important to gather information about how humans extract a representation of such complex visual stimuli in a very short time and perform the task efficiently. Specifying the visually attended parts in the face helps us to speculate that a given task is related to the visually attended part of the face. For example, humans tend to attend to eyes of angry faces (Perez-Moreno et al., 2016) which might indicate that the expression of anger would be more apparently displayed in the eye region. Therefore, examining the gaze pattern of observers is common among face perception studies. Before proceeding to discuss the literature on this issue, holistic perception/ processing of the faces is a subject that needs to be mentioned. Because holistic perception studies reveal how humans extract the complex information on the face in a very short time. In addition to that, these studies show that an attended part of the face by the observer when performing a face perception task cannot be always a diagnostic part for that specific task.

1.3.1. Holistic processing of faces

Several studies (Richler et al., 2011; Goffaux & Rossion, 2006; Farah et al., 1998) revealed that when we recognize a face, we're processing it holistically. Holistic processing indicates that processing of the relationships between facial features and integrate all parts as a whole (Watson & Robbins, 2014). Holistic processing helps observer to maximize their recognition performance with minimum fixations on a face. It is thought to be the underlying mechanism of quick perception of faces with a representation that includes extensive information. Studies on holistic face perception indicate that a human face is not perceived as gathering the individual face parts together. Perception of each individual part is strongly affected by the whole face (for a review see Rossion, 2013). Understanding the underlying mechanism of holistic processing is important for gaze behavior studies because when an observer looks into a face, it is not clear whether the observer looks for a specific feature or region on the face (e.g. nose) or he/she fixates to that region to process the whole face efficiently. Most commonly, holistic face processing is studied with composite face illusion. This illusion showed for the first time by Young et al. (1978). In their study with famous people's face, they separate the faces as top and half with a line in the middle and then change bottom part of faces with the bottom part of other faces. One interesting finding was that observers perceived faces as unfamiliar to them even though all face parts (top and bottom) belong to famous people. Because two halves of different familiar (famous) face composed an unfamiliar (new) face, participants found difficult to identify familiar faces. Inversion effect is also commonly used as a demonstration of holistic perception of faces. Because, when faces are given to the observers in an inverted position, composite face illusion disappears (Young et.al., 1987) and humans start processing faces in a feature-based manner rather than holistically. A face in an inverted position is no longer perceived as a whole by the observer. Another task that shows holistic processing of faces is the part/whole task. The rationale behind this task is that individual parts of the face are more easily recognized by observers in whole face condition compared to the isolated condition. Because the observer perceives the face holistically, it is easier for one to recognize an individual part when other parts are also present. Tanaka and Farah (1993) showed that humans showed better performance in whole face condition when recognizing individual parts of faces than isolated condition, whereas the advantage of the whole condition was absent for house images. Participants did not show any increased performance for whole house condition than isolated part condition while recognizing individual parts of the houses (door, window etc.) All these studies show that holistic perception of faces is a robust finding in face perception studies.

Holistic perception of faces is also studied with other-race faces. In order to explain the other-race effect in face perception, some researchers claimed that because we are processing own-race faces more holistically than other races, the recognition of the own-race performance is higher than other-race faces (for a review see Rossion & Michel, 2011). Some studies report *other-race effect* in holistic processing with parts/whole task (Tanaka et.al., 2014), face inversion task (Hancock & Rhodes, 2008) or face composite task (Michel et.al., 2006). Tanaka and Farah (2003) found that Caucasian participants show a better performance on recognition of Caucasian face parts in the whole face context than isolated condition compared to Asian faces. Hancock and Rhodes (2008) also used Caucasian and Asian participants. They revealed that inversion effect was more disruptive for own-race faces compared to other-race faces. Michel et al. (2006) showed the *other-race effect* in holistic processing by composite face task. When observers were presented with composite faces of two different faces in both own-race and other-race condition, disruption of the recognition of top halves of the faces were greater for own-race faces than other-race faces. All these behavioral studies point out that, humans tend to process faces that belong to own-race more holistically than other-race faces.

There is no consistent information about the most informative area in the face during sex categorization. Some studies consistently point out that eye is the most Pearson et.al. 2003) informative and diagnostic area (Schyns et al., 2002), but several eye-tracking studies that indicate that observers gaze firstly and mostly attended to the nose and other regions (Sæther et al., 2010; Peterson and Eckstein 2012) rather than eyes. Regarding the holistic processing of faces, one should consider the fact that humans may tend to make their first fixations towards the regions that allow them to process the whole face efficiently. Therefore, a fixation region on the face does not always indicate whether that specific part is diagnostic for the related task or it is a fixation region that helps observer to process the whole face. In order to discuss this issue in more detail, eye-tracking studies on face perception will be reviewed.

1.3.2. Eye tracking studies on face perception

For face perception studies, it is crucial to know the location of the gaze, first fixation location, fixation duration and gaze pattern in order to understand the underlying mechanism of face perception in every aspect. Henderson et al. (2005), showed the importance of eye movements on face learning. In their study, observers who had restricted vision on the center of the faces showed impaired recognition performance. Bruce and Young (1986) were hypothesized that visual scanning of faces is based on the gathering optimal information from the diagnostic parts of the face. Therefore, the gaze pattern can change in different face perception tasks. Pearson et al. (2003) revealed that eye movements of observers changed depending on the task they were performing. They found that when categorizing the sex of faces, observers attend longer at the eyes whereas their gaze turned towards to mouth when they were asked to specify the mood of the face images. In the face recognition task, however, observers displayed a more distributed fixation pattern. In general, the upper part of the face is known to be more informative than the bottom part. For example, Caldara et al. (2006) showed that humans show greater activity in fusiform face area when they are presented with upper part of the face which contains higher contrasting elements. Therefore, it is not surprising that observers attend more at the eyes, nose and upper part of the face in most of the face processing tasks.

Sex categorization task is studied often by monitoring the gaze of the observers. Bindemann et al. (2009) showed that humans tend to towards their first fixation at the center of gravity of the face (distributed to the eyes and nose area in frontal and cheeks in profile pictures) and then direct their gaze to the eye region predominantly followed by nose and to a lesser extent mouth region. Peterson and Eckstein (2012) showed in their study that the point just beneath the eyes is optimal for gathering the maximum information for face perception tasks (identity, emotional state, sex). Sæther et al. (2010) similarly showed that when categorizing the sex of the faces, participants firstly attended an area between the eyes and the nose. When they disintegrate this part into fine-grids, they found out that the lower side of the eye socket (corresponds to the infraorbital margin) appeared to be the most attended part by participants (see, Figure 3). In fact, this area (infraorbital margin) is not sexually dimorphic (Sæther et al., 2010). However, it might allow participants to easily process more diagnostic features (eyes, nose) of the face with minimum fixations. Therefore, it is not clear which part of the face helps observer to categorize the sex as male or female since most of the time observers perceive the face as a whole. However, because the infraorbital margin is closer to the eyes and nose, these areas probably more informative areas compared to others in sex categorization task. In addition to that, eyes were repeatedly showed to be the diagnostic feature on the face for sex categorization task in behavioral experiments. For example, Schyns et al. (2002) have found that only showing the eyes of the faces for enough participants to categorize the sex of the faces. Furthermore, earlier studies suggested that eyes and nose were the most important features because disguising them increased the reaction time and decreased the accuracy of participants while categorizing the sex of the face (Roberts & Bruce, 1988; Bruce et al., 1993).

Numerous eye-tracking studies revealed that gaze pattern is highly affected by culture. Humans who are raised in East Asian culture process information more holistically, and humans from Western cultures more analytically (see, Miyamoto et al., 2006; Masuda & Nisbett, 2001; Norenzayan et al., 2002) This indicates that East Asians tend to perceive their environment by processing the context and the relationships between

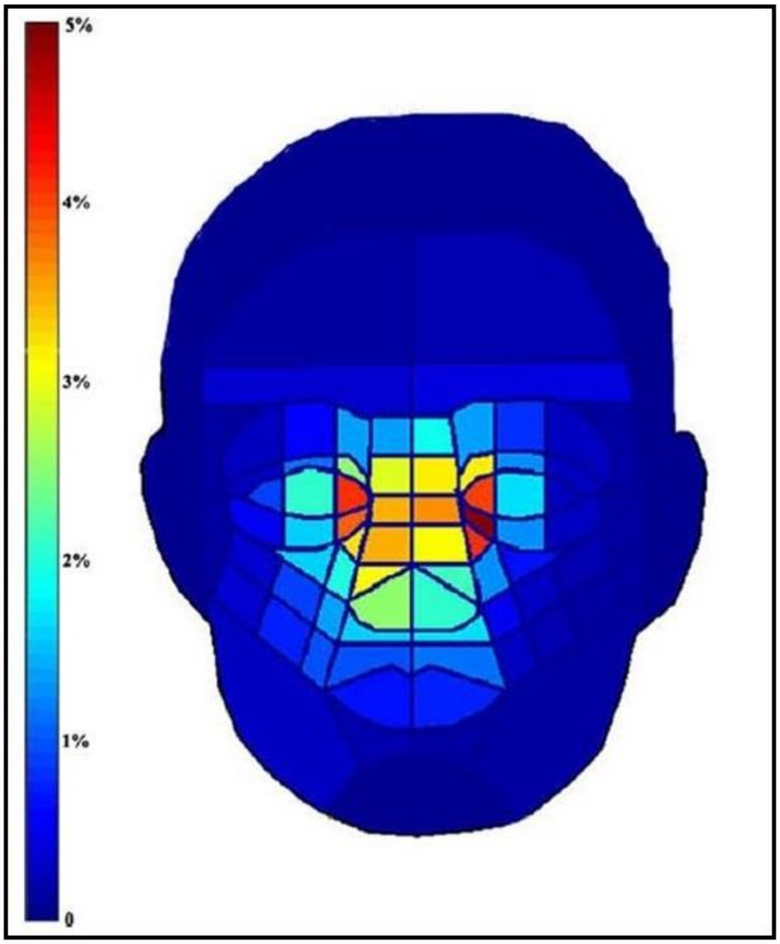

Figure 3. A demonstration of most attended parts during sex categorization task. Lower nasal eye part of the left eye of the face (painted in dark red) represents the infraorbital margin. Color scale on the left side represents the percentage of time spent in each area. Adjusted from "Anchoring gaze when categorizing faces' sex: Evidence from eye-tracking data by Sæther et.al., 2009, *Vision Reseach 49*, p. 2870-80. Copyright [2009]. Elsevier Science Ltd.

individual parts. On the other hand, humans from Western cultures focus more on the salient features and objects and use some categorical perception rules when perceiving their environment.

Blais et al. (2008) showed the cultural processing difference on face perception. They revealed that while learning and recognizing own- and other-race faces, Caucasian observers attended more internal features of the face (eyes, nose, and mouth) and produced a triangular pattern while Asian observers attend more on the nose and central region of the face. Kelly et al. (2010) also showed that humans use culture-specific gaze strategies in human, sheep and greeble faces in both learning and recognition conditions. Their finding indicates that participants did not change their gaze pattern across tasks and different face categories. On the other hand, Blais et al. (2008) found in their above-mentioned study, during race categorization, Caucasian observers attend more at the eye region of own-race faces, whereas they focused more at the nose and mouth region of Asian faces. Asian observers, on the other hand, attended mostly to nose region in both Asian and Caucasian faces. Brielman et al. (2014) showed similarly that Europeans fixate more to the eyes on Caucasian faces, whereas they fixate to the nose on Asian faces when categorizing the race of the face (see also, Goldinger et al., 2009; Fu et al., 2012). These studies indicate that the processing of own and other-race faces might be dissimilar in different face perception tasks. These studies propose that because we are using our cultural-based gaze strategies at own-race faces most of the time, we cannot use them with other-race faces. Another possibility that researchers argue is that when we are presented with an other-race face, we focus on the racial marker of the face rather than its identity, which causes different gaze pattern for other-race faces.

According to our knowledge, participants' gaze pattern while categorizing the sex of other-race and other -species faces have not studied so far. It was discussed in thesis before that sex categorization task is different and an earlier process than recognition (Young & Burton, 2018). Even though face recognition studies indicate a similar gaze pattern with other-race and other-species faces, this pattern can be different for sex categorization task. When humans are presented a face, race categorization automatically occurs (Levin, 1996), before any further processes (sex, age categorization, identification). Therefore, even though participants were not instructed to categorize the race or species of the faces, only seeing other-race or other-species faces would start a different visual scanning. When participants are employed to categorize the sex of the faces, one possibility is that they would continue to focus on femininity and masculinity cues as with own-race faces and would not change their gaze pattern across different face categories (own-race, other-race, other-species). Another possibility is that independent from the sex categorization task, other-race, and other-species faces would cause observers to display different gaze pattern. In order to reveal this issue, current thesis aimed to show the gaze pattern of participants while categorizing the sex of own- and other races as well as other-species faces.

1.4. The aim of the Thesis

This thesis study aimed to show whether sex categorization ability of humans, is an ability that humans can be expanded to other-race and other-species faces.

In the first study of this thesis, Caucasian (own-race), Asian (other-race), and chimpanzee (other-species) faces were presented to the participants. Sex categorization performance of participants evaluated according to their accuracy and reaction time. If sex categorization ability from faces is not species- or race-specific, we would expect that participants show accuracy at least higher than the chance level in the sex categorization task across three face categories. Furthermore, even though participants would categorize the sex of other-race and other-species faces correctly, their performance would be higher in own-race condition because of their expertise in these faces.

Furthermore, in order to see the effect of masculinity and femininity properties of faces on sex categorization, some facial metrics which are:

(i) head length
(ii) face width,
(iii) jaw height,
(iv) jaw width,
(v) interorbital distance,
(vi) nose width,
(vii) mouth width,
(viii) mouth height,
(ix) eye height,

(x) eye width,

(xi) brow to eye distance,

(xii) inter-pupillary distance

were measured for each individual face in three stimuli sets (Caucasian, Asian, and chimpanzee). Furthermore, the correlation between the rated sex by participants and each metric was examined in order to see which measurement was more related to the response of participants in Caucasian, Asian and chimpanzee faces. Therefore, we develop following hypotheses:

Hypothesis 1: All face categories (Caucasian, Asian, and chimpanzees) were correctly categorized by their sex at least more than chance level.

Hypothesis 2: Caucasian faces will be categorized by their sex in higher accuracy than Asian faces, and Asian faces will be categorized in higher accuracy than chimpanzee faces.

Hypothesis 3: Reaction time of correct categorization of Caucasian faces will be faster than Asian faces and reaction time of correct categorization of Asian faces will be faster than chimpanzee faces.

In addition to the above-stated hypotheses, we asked:

Research Question 1: Which of the aforementioned metrics will significantly correlated with response (either female o male) of the observers across Caucasian, Asian and chimpanzee faces?

Research Question 2: Which of the aforementioned metrics will be related to the female response of observers across Caucasian, Asian and chimpanzee faces?

Research Question 3: Which of the aforementioned metrics will be related to the male response of observers across Caucasian, Asian and chimpanzee faces?

In the second study, gaze pattern of participants examined via an eye-tracking device while they were categorizing the sex of Caucasian, Asian and chimpanzee faces. Specific area of interests was defined (eyes, nose, mouth, cheeks, jaw) and proportion of fixation number, fixation duration and first fixation in these areas were compared across three face categories (Caucasian, Asian, chimpanzee).

According to our knowledge, gaze behavior in sex categorization task with other-race and other-species faces has not been studied so far. When participants who are employed to categorize the sex of faces were presented with other-race and other-species faces, one possibility is that they would focus on femininity and masculinity cues as with own-race faces and would not change their gaze pattern across different face categories. Another possibility is that independent from the sex categorization task, other-race, and other-species faces would elicit category based visual scanning and would cause observers to display different gaze pattern for other-race and other-species faces. Based on the previous research, we developed further hypotheses for Caucasian faces:

Hypothesis 4: Eyes will be the most frequently fixated area compared to other parts of Caucasian faces.

Hypothesis 5: Nose will be second most frequently fixated area compared to other parts of Caucasian faces.

Hypothesis 6: Eyes will be the longest fixated area compared to other parts of Caucasian faces.

Hypothesis 7: Nose will be the second longest fixated area compared to other parts of Caucasian faces.

Hypothesis 8: Eyes will be more frequently the first fixated area than other parts of Caucasian faces.

In addition to the above-stated hypotheses, we asked further:

Research Question 4: Do participants display a different gaze pattern than own-race faces when they are presented with other-race faces during sex categorization task ?

Research Question 5: Do participants display a different gaze pattern than own-species faces when they are presented with other-species faces during sex categorization task ?

CHAPTER 2

EXPERIMENT 1

In the first study, a sex categorization task was conducted to the participants with Caucasian, Asian and chimpanzee faces. Accuracy and reaction time of correct categorizations were recorded. It was hypothesized that all face categories (Caucasian, Asian, and chimpanzees) were correctly categorized by their sex at least more than chance level. Furthermore, it was hypothesized that Caucasian faces will be categorized by their sex more accurately than Asian faces, and Asian faces will be categorized more accurately than chimpanzee faces. Similarly, it was expected that the reaction time of correct categorization of Caucasian faces will be faster than Asian faces and Asian faces will be faster than chimpanzee faces.

Furthermore, in order to see the effect masculinity and femininity of faces on the sex categorization, some facial metrics which are: head length, face width, jaw height, jaw width, interorbital distance, nose width, mouth width, mouth height, eye height, eye width, brow to eye distance, and inter-pupillary distance were measured for each individual face in three stimuli sets (Caucasian, Asian and chimpanzee). The correlation between the responded sex (female or male) by observers and each metric of the face (e.g. eye width) was examined in order to see which metric is more related to the response of observers in Caucasian, Asian and chimpanzee faces.

2.1. Method

2.1.1. Participants

Total of 46 undergraduate and graduate Turkish students (23 males, 23 females) from Izmir University of Economics voluntarily participated in the Study I in return for course credits. Mean age of the participants was 21.22 (*SD* = 3.46) with a range of 18 to 37 years. None of the participants reported having a neurological or a psychiatric disorder and using any drugs. All of the participants have normal or corrected to normal vision and were dominantly using their right hands (Edinburg Handedness Inventory, Oldfield, 1971). Furthermore, none of them reported being in an East Asian country more than six months or any familiarity with East Asian culture or East Asian people (such as having East Asian friends etc.).

2.1.2. Stimuli selection

For own-race category, a total of 28 (14 males, 14 females) frontal looking photographs of Caucasian human faces with a neutral expression was selected from Radboud University, Radboud Face Database (Langner et al., 2010). The reason for choosing Caucasian face as an own-race face category was that, the majority of the genetic haplogroups found in Turkish people are shared with Caucasians (Cinnioğlu et al., 2004). For other-race category, 28 (14 males, 14 females) photographs of East-Asian (Chinese) students in a frontal pose with a neutral expression were selected from CUHK Face Sketch Database (CUFS) (Wang & Tang, 2009). For non-humans, chimpanzee faces were selected from James & Other Apes (Mollison, 2004), which consist of 18 chimpanzee photographs. All of the photographs were taken from the frontal view, and provide animals' age and sex information. Chimpanzee were closer as other species category because sexual dimorphic pattern on chimpanzee faces has been well established (Schaefer et al., 2004; Wood et al., 1991) and it has the closest pattern to human faces compared to other ape species (Wood et al., 1991; Cobb & O'Higgins, 2007)

In order to rule out the effect of facial expression in chimpanzee faces, a pilot study was conducted. In the pilot study, 5 (2 males, 3 females) graduate students from the Izmir University of Economics (between 24 to 26 years old, *M* = 25, *SD* = 0.71) were rated the emotional expressions of the 18 chimpanzee faces. Faces (in size 13.9cm high and 10.02 wide) were presented in SuperLab (Version 4.0, Cedrus, Inc.) program with a black background and a Likert scale from 1 to 7 (1 = negative, 4 = neutral and 7 = positive). Inter-rater reliability analysis (two-way mixed-effects model, multiple raters/measurements, consistency) revealed excellent reliability between raters, *ICC*= .75, *p* < .001. Mean of all ratings was 4.02 (*SD* = 0.68). Faces rated lower than 3.50 and higher than 4.50 (4 is being neutral) were excluded from the dataset. Furthermore, in chimpanzees sexually dimorphic features start appearing after the eruption of the second permanent molar (Cobb & O'Higgins, 2007) which corresponds to approximately 3 years of age (Smith et al., 2013), therefore, chimpanzees under 3 years old were also removed from the dataset. Remaining 8 chimpanzee faces (4 females, 4 males) were further used as stimuli in the experiment.

In order to confirm that Caucasian faces that were taken from Radbaud Face Database (Langner et al., 2010) were more familiar to Turkish population than other stimuli, another pilot study was conducted with 32 participants (16 females, 16 males) from Izmir University of Economics (between 20 and 24 years old, $M = 21.69$, $SD = 1.06$) who rated each face according to the familiarity with their own race. Faces (in size 13.9 cm high and 10.02 cm wide) were presented in SuperLab program, and participants used a 7-point Likert scale from 0 to 6 (0 = not familiar at all, 6 = very familiar) in order to rate each face. One-way repeated measures ANOVA revealed that there was a main effect of face category, $F\ (2, 62) = 96.79$, $p < .001$, *partial* $\eta^2 = .76$. Simple contrasts confirmed the grater familiarity of Caucasian faces ($M = 3.59$, $SE = .19$) compared to Asian ($M = 0.96$, $SE = .16$), $F\ (1, 31) = 132.62$, $p <.001$, $r =.90$ and chimpanzee faces ($M = 0.52$, $SE = 0.19$), $F\ (1, 31) = 133.82$, $p <.001$, $r =.90$.

2.1.3. Facial metrics

One of the most common arguments on sex categorization is that certain facial metrics such as lip size are different in males and females and these metrics might be effective on the perception of femininity and masculinity of faces (Fellous, 1997; Lefevre et al., 2013). Therefore, we considered that facial metrics could affect the male and female response of observers in the sex categorization task. In order to conduct facial metric analysis, we performed the following pre-processing steps to face stimuli. Firstly, based on previous research (Rosas & Bastir, 2002; Green & Curnoe, 2009; Cobb & O’Higgins, 2007) 24 landmark points were selected and distances between these landmarks were measured by two independent raters. These distances were taken from 12 regions which were as follows:

(i) head length (HL),

(ii) face width (FW),

(iii) jaw height (JH),

(iv) jaw width (JW),

(v) inter-orbital distance (IOD),

(vi) nose width (N),

(vii) mouth width (MW),

(viii) mouth height (MH),

(ix) eye height (EH),

(x) eye width (EW),

(xi) brow to eye distance (BED),

(xii) inter-pupillary distance (IPD) (Figure 4, 5, 6).

The landmark identification and measurement process have conducted using Adobe Photoshop CS6. Due to asymmetrical ratios between two halves of the faces during calculation of facial metrics, average distances were calculated for mouth height, jaw height, eye height, eye width and brow to eye distances. Measured distances from two raters were averaged and distances on horizontal axis were normalized by pupil distances. In addition to that distances on the vertical axis were normalized by the head length (Franklin et al., 2013; Hodges-Simeon et al., 2016).

2.1.4. Apparatus and stimulus presentation.

First, all face stimuli were cropped from their natural facial outline and placed to a black background with a greyscale (454 x 340 pixels). SuperLab (Version 4.0, Cedrus, Inc.) program was used to present faces to participants via a desktop computer (TECHNO PC 750 GB HDD/ 4 GB RAM /AMD FX-6100 3,3 GHz/ 1GB VGA) on a 20-inch LCD monitor (TECHNO MONITOR HKC). Caucasian, Asian and chimpanzee faces were presented as separate blocks (with within blocks randomization) in SuperLab. The blocks order was counterbalanced prior to the experiment. Before starting each experimental trial, a fixation cross was presented at the center of the screen for 500ms. Participants were instructed to categorize in 5 seconds, otherwise, next stimuli appeared on the screen. Each facial stimuli were presented at the center of the screen on a black background. Response keys (M and N) used to collect participants' responses, which were also counterbalanced between participants (Figure 7).

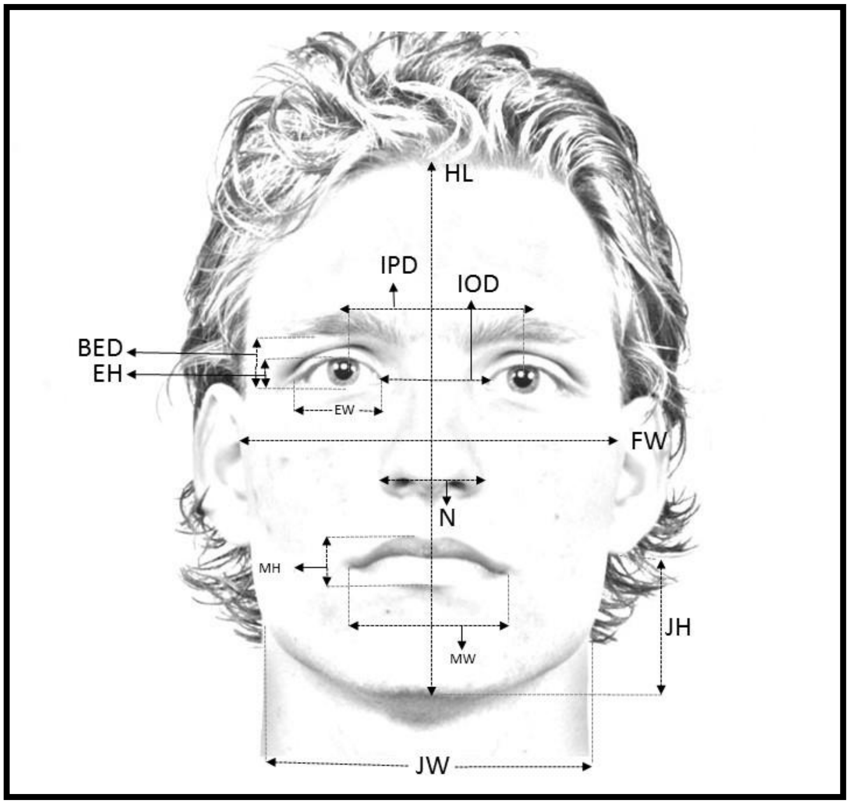

Figure 4. Facial metrics on a Caucasian face

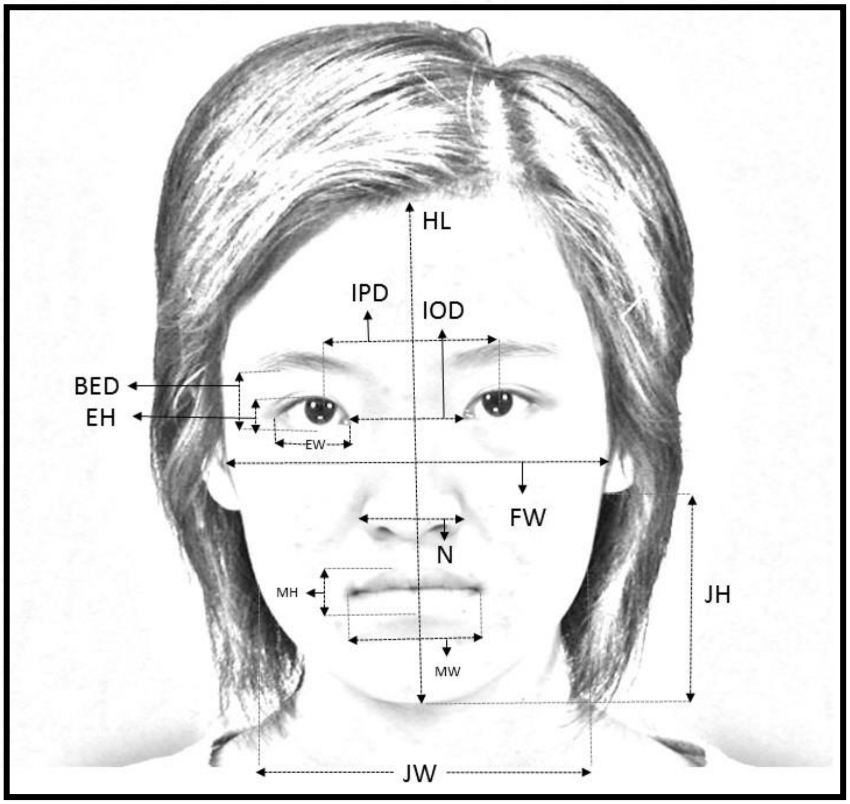

Figure 5. Facial metrics on an Asian face

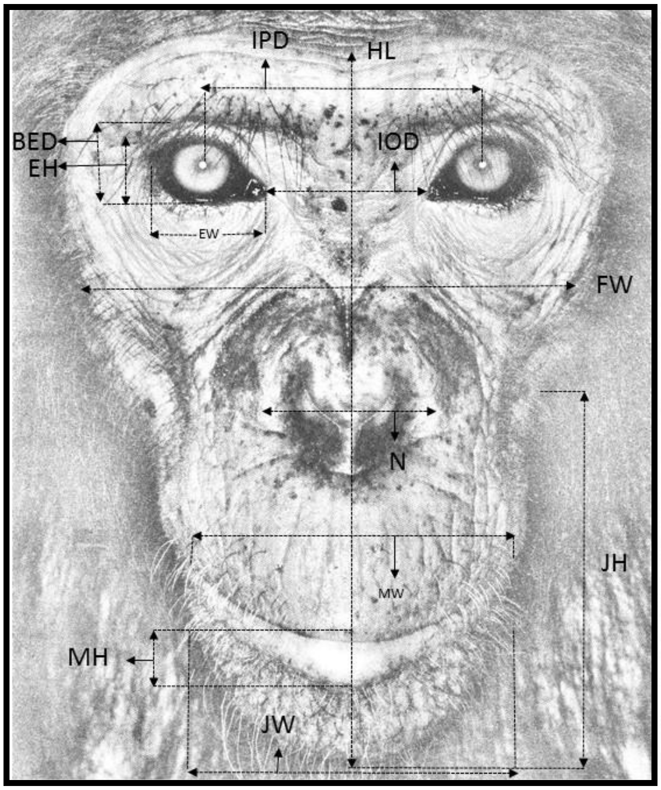

Figure 6. Facial metrics on a chimpanzee face

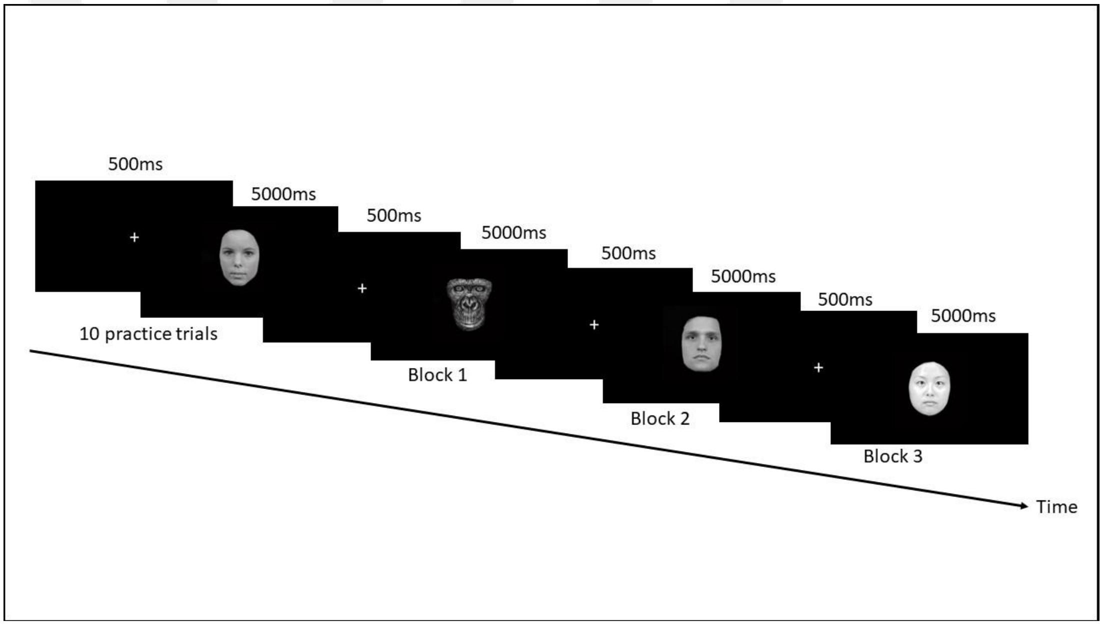

Figure 7. Example visual display during sex categorization in Experiment 1

2.1.5. Materials and Procedure

Before the experiment, all participants were briefly informed about the study and signed an informed consent form, which states that their participation was voluntary and they could quit the experiment at any time without giving any reason (Appendix A). They also gave information about their age, sex, medical situation etc. (Appendix B) and filled out the Turkish version of Edinburgh Handedness Inventory (Oldfield, 1971) (Appendix C). After that, they were instructed that there would be Caucasian, Asian and chimpanzee faces on the screen and their task was categorizing the sex of the face by using a keyboard with their right index finger and they were required to respond as quickly and as accurate as possible. In order to avoid ceiling effect, maximum response time determined as 5 seconds since humans are able to rapidly process a face with only one or two fixations (Hsiao & Cotrell, 2008). Before the actual experiment, all participants practiced with a shorter version of the experiment to learn the keys. All participants were given a debriefing form about the study after the experiment.

2.2. Results

2.2.1. The effect of observer's gender, sex of the face and face category on accuracy

Firstly, in order to check whether categorization accuracy is significantly higher than chance level (50 %), one sample t-test was applied to all face categories. Results showed higher than chance level sex categorization performance for Caucasian, (M = 95.87, SE = 0.49, $t(45)$ = 91.94, $p < .001$, r = .99), Asian (M = 80.90, SE = 1.10, $t(45)$ = 28.09, $p < .001$, r = .97) and chimpanzee (M = 59.24, SE = 2.68), $t(45)$ = 3.45, $p < .01$, r = .21) faces.

A 2 (gender of the observer; female, male) X 2 (sex of the face; female, male) X 3 (face category; Caucasian, Asian, chimpanzee) three-way ANOVA (mixed design) was conducted on the percentage of accuracy in the sex categorization task. Gender of the observer was used as between-subjects variable whereas sex of the face and face category were used as within-subject variables. In order to check for sphericity assumption, Mauchly's test was performed prior to ANOVA. Results showed that assumption of sphericity had been violated for both face category ($\chi^2(2)$ = 41.74, $p < .001$, e = .62) and sex of the face X category of the face interaction ($\chi^2(2)$ = 42.55, $p < .001$, e = .64) therefore Greenhouse-Geisser corrected results will be reported for these effects.

ANOVA results showed that the main effect of face category was statistically significant, $F(1.23, 54.28) = 119.52$, $p < .001$, $\eta_p^2 = .73$. Repeated contrasts revealed that Caucasian faces ($M = 95.87$, $SE = 0.49$) were categorized by their sex more accurately than Asian faces ($M = 80.90$, $SE = 1.10$), ($F(1, 44) = 165$, $p < .001$, $r = .89$) and Asian faces were categorized by their sex more accurately than chimpanzee faces ($M = 59.24$, $SE = 2.68$), ($F(1, 44) = 53.04$, $p < .001$, $r = .74$) (Figure 8). Furthermore, accuracy was not affected by gender of the observer, $F(1, 44) = 1.03$, $p > .05$. Face category *X* gender of the observer interaction effect was not statistically significant, $F(2, 88) = 0.12$, $p > .05$. On the other hand, accuracy was affected by the sex of the face, $F(1, 44) = 79.43$, $p < .001$, $\eta_p^2 = .64$. Male faces ($M = 88.65$, $SE = 1.11$) were categorized with greater accuracy than female faces ($M = 68.69$, $SE = 1.83$) (Figure 9). However, the gender of the observer did not interact with sex of the face significantly, $F(1, 44) = 1.33$, $p > .05$. On the other hand, sex of the face *X* face category interaction was significant, $F(1.23, 54.05) = 31.17$, $p < .001$, $\eta_p^2 = .42$. Repeated contrasts revealed that lower accuracy for female faces compared to male faces were significantly greater for Asian faces than Caucasian faces, $F(1, 44) = 21.45$, $p < .001$, $r = .77$. In a similar way lower accuracy for female faces compared to male faces were significantly greater for chimpanzee faces than Asian faces, $F(1, 44) = 16.30$, $p < .001$, $r = .72$ (Figure 10). Lastly, three-way interaction of category of the face *X* sex of the face and *X* gender of the observer was not statistically significant, $F(2, 88) = 1.09$, $p > .05$.

2.2.2. The effect of observer’s gender, sex of the face and face category on reaction time

A 2 (gender of the observer; female, male), *X* 2 (sex of the face; female, male) *X* 3 (face category; Caucasian, Asian, chimpanzee) three-way ANOVA (mixed design) was conducted on the response time of correct categorization of observers. In order to check the assumption of sphericity, Mauchly's test was conducted before the analysis. Results showed that sphericity assumption is violated for face category and face category *X* sex of the face interaction, $\chi^2(2) = 34.75$, $p < .001$, $e = .62$; $\chi^2(2) = 8.59$, $p < .05$, $e = .90$, respectively. Therefore, Greenhouse-Geisser corrected results will be reported for face category effect and Huyn-Feldt corrected results will be reported for face category *X* sex of the face interaction effects.

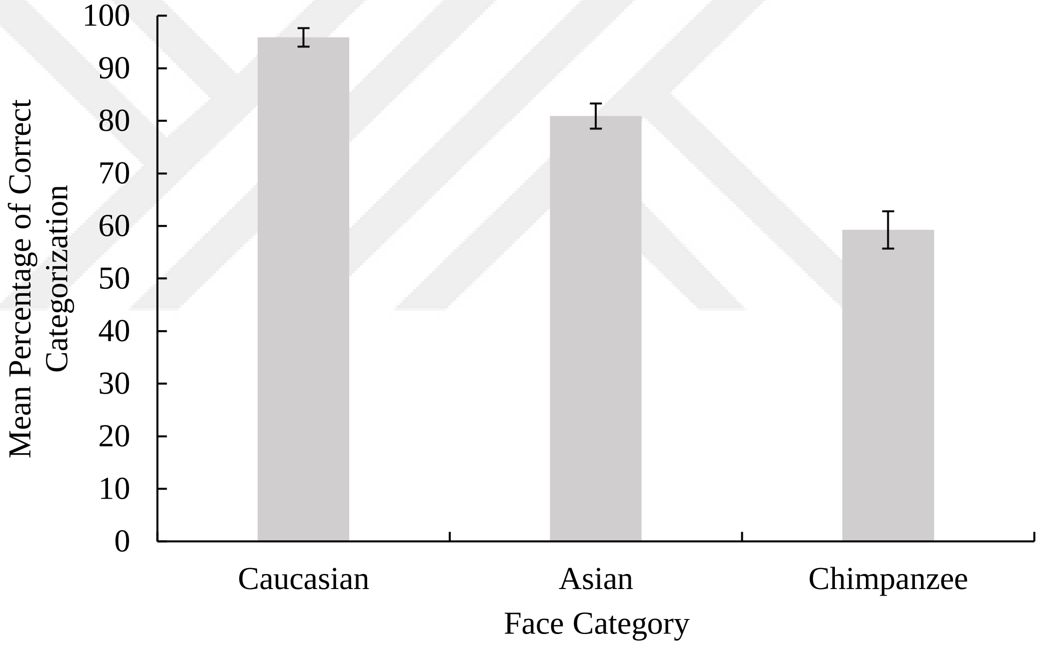

Figure 8. Mean (with 95 % within-subject CI) percentage of correct categorization for Caucasian, Asian, and chimpanzee faces

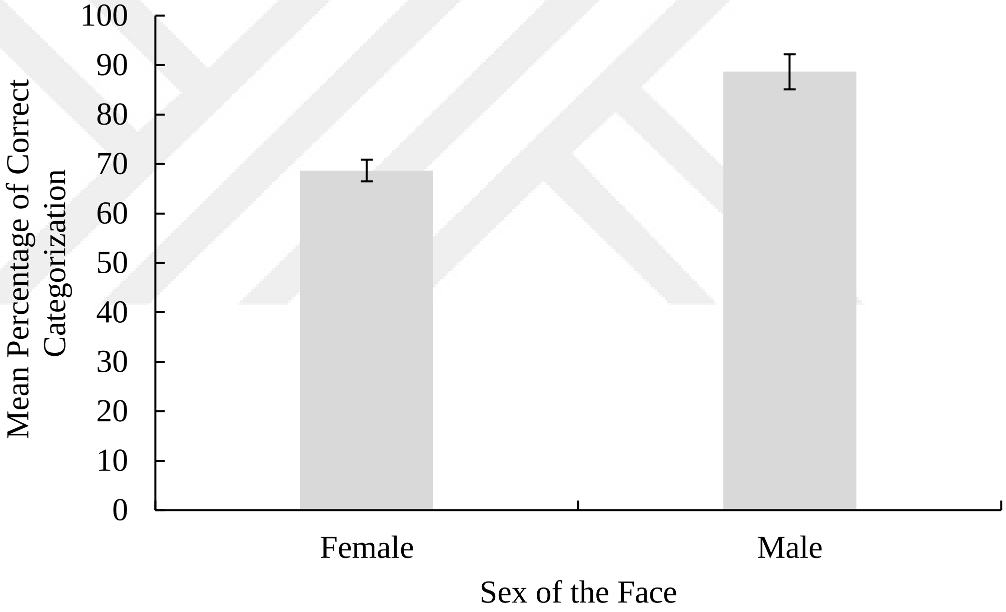

Figure 9. Mean (with 95 % within-subject CI) percentage of correct categorization for female and male faces

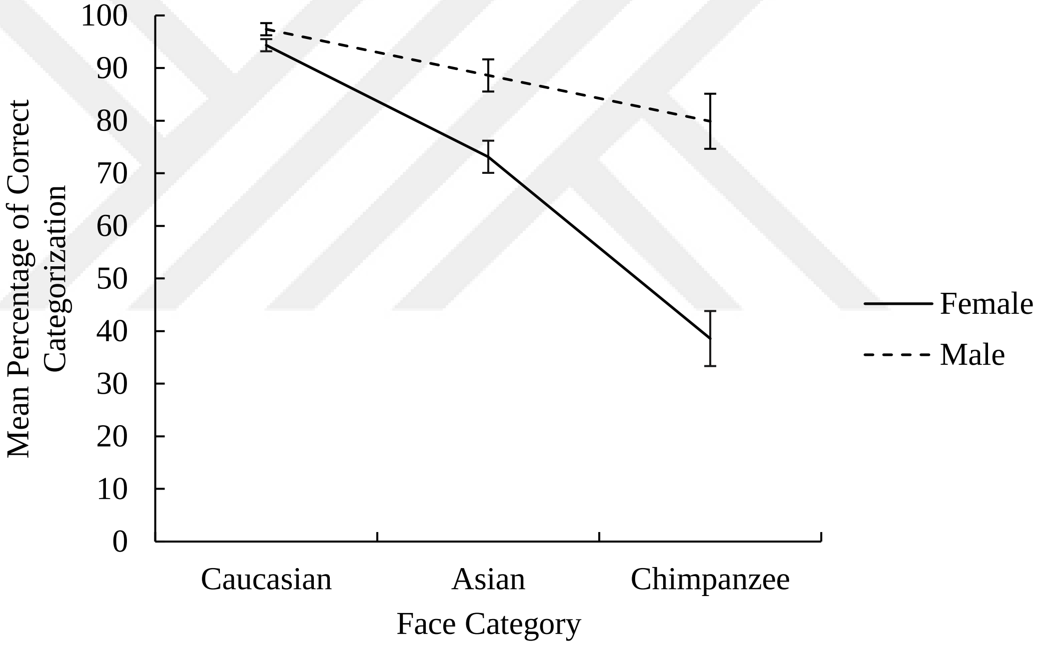

Figure 10. Mean (with 95 % within-subject CI) percentage of correct categorization of male and female faces in different face categories.

ANOVA results revealed that there was a statistically significant main effect of face category, $F(1.29, 56.62) = 35.79$, $p < .001$, $\eta_p^2 = .45$. Repeated contrasts revealed that observers categorized Caucasian faces ($M = 1042.73$, $SE = 36.78$) faster than Asian faces ($M = 1158.37$, $SE = 39.00$), ($F(1, 44) = 14.61$, $p < .001$, $r = .50$) and Asian faces faster than chimpanzee faces ($M = 1493.54$, $SE = 68.70$) , $F(1, 44) = 23.39$, $p < .001$, $r = .67.39$ (Figure 11). Gender of the observer did not affect the reaction time, $F(1, 44) = 0.02$, $p >.05$. Gender of the observer *X* face category interaction was also not statistically significant, $F(2, 28) = 0.80$, $p > .05$. However, reaction time of observers was affected by the sex of the face, $F(1, 44) = 12.43$, $p < .01$, $\eta_p^2 = .22$. Male faces ($M = 1177.65$, $SE = 36.97$) were categorized faster than female faces ($M = 1285.45$, $SE = 46.04$) (Figure 12). There was no significant interaction between the sex of the face *X* gender of the observer, $F(1, 44) = 0.12$, $p >.05$. Face category *X* sex of the face interaction significantly affected reaction time of observers, F (1.69, 74.51) = 3.24, $p = .05$, $\eta_p^2 = .07$. Simple contrasts showed that increased reaction time for female faces compared to male faces was significantly greater for chimpanzee faces than for Caucasian faces, $F(1, 44) = 5.25$, $p < .05$ $r = .33$ (Figure 13). However, increased reaction time in female faces was not statistically different in Asian compared to chimpanzee faces, $F(1, 44) = 2.93$, $p > .05$, $r = .25$ (Figure 14). Finally, interaction effect of face category *X* sex of the face *X* gender of the observer was not statistically significant, $F(2, 88) = 0.35$, $p > .05$.

2.2.3. Facial metrics analysis

In order to understand whether or not two independent raters measuring the distances on faces were in agreement, inter-rater agreement analysis (two-way mixed-effects model, multiple raters/measurement, absolute agreement), was conducted for each facial metric. For all metrics 2 independent raters showed acceptable agreement (*ICC* values between .60 and .97 and all *p*'s < .05) (Table 1). Therefore, two raters' measurements for distances were averaged and used in the analysis. In order to understand which facial metrics are significantly correlated to the response of observer, 10 distances on all face stimuli were correlated with observer responses. Initially, for each observer series of point-biserial correlation analyses were conducted with each facial metric and the response of the observer (coded as 0 for female, 1 for male). This procedure repeated for all observers and revealed a set of r_{pb} values for each correlation.

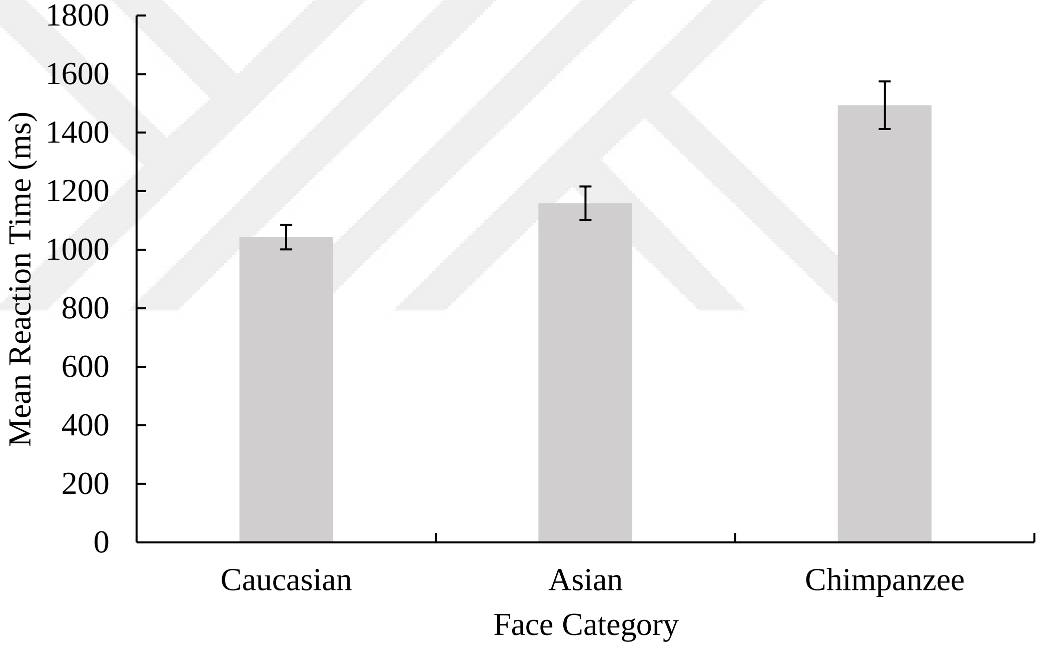

Figure 11. Mean (with 95% within-subject CI) reaction time in Caucasian, Asian, and chimpanzee faces

Figure 12. Mean (with 95 % within-subject CI) reaction time in female and male faces.

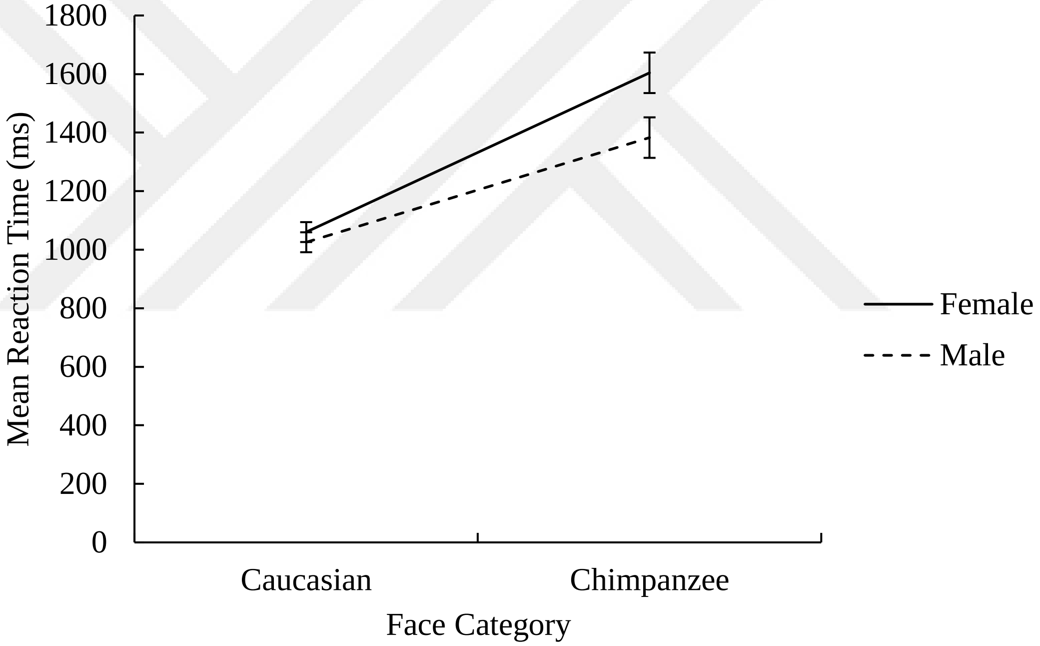

Figure 13. Mean (with 95 % within-subject CI) reaction time of female and male faces in Caucasian and chimpanzee faces

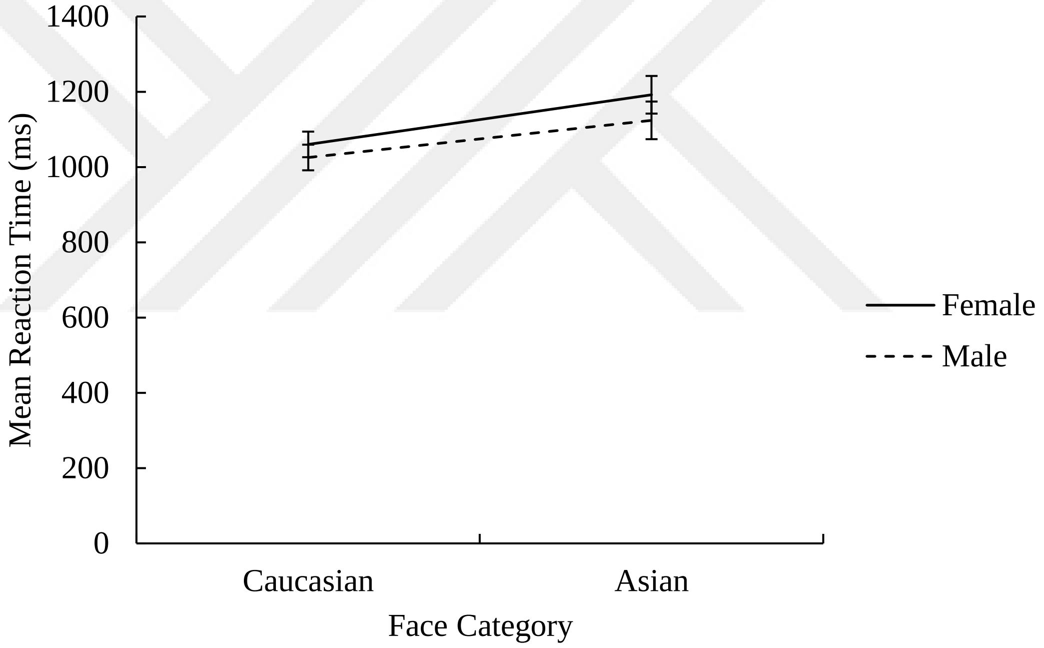

Figure 14. Mean (with 95 % within-subject CI) reaction time of female and male faces in Caucasian and Asian faces

Table 1

Reliability between two independent raters

	Caucasian Faces		Asian Faces		Chimpanzee Faces	
Metric Distances (cm)	*ICC*	*p*	*ICC*	*p*	*ICC*	*p*
Face Width	.92	.000***	.97	.000***	.82	.001**
Jaw Height	.60	.000***	.55	.000***	.62	.030*
Jaw Width	.88	.000***	.96	.001**	.91	.000***
Interorbital Distance	.88	.000***	.86	.000***	.97	.000***
Nose Width	.80	.000***	.86	.000***	.89	.001**
Mouth Width	.90	.000***	.87	.000***	.78	.009**
Mouth Height	.76	.000***	.93	.000***	.86	.001**
Eye Height	.74	.000***	.73	.001**	.85	.000***
Eye Width	.69	.002**	.69	.000***	.85	.002**
Brow to Eye Distance	.85	.000***	.76	.000***	.95	.000***

Note 1. Above *ICC* values are average measures using absolute agreement (Two-way mixed-effects model).

Note 2. *p* values *p < .05, **p < .01, ***p < .001.

Because sampling distribution of *r* value is not normally distributed, obtained r_{pb} values were normalized with Fisher-*Z* transformation for each observer (Franklin et al.,2013; Franklin & Adams, 2009). Finally, mean of *Z* values were compared to zero by conducting one sample *t*-test in order to show which facial metrics were significantly related to the response of observers (Table 2). Females coded as 0 and males as 1 in the point-biserial correlation analysis. Therefore, negative correlations mean that those metrics were longer in faces categorized more frequently as female. Positive correlations mean that those metrics were longer in faces categorized more frequently as male. For example, mouth height in Caucasian faces has a negative significant correlation with responses. This means that a higher mouth height of a Caucasian face is generally categorized as female by observers. On the other hand, jaw height in Caucasian faces has a positive correlation with observers' responses, indicating that longer jaw height in a Caucasian face is associated with the male response.

According to the correlation analysis, a greater face width, longer jaw height and jaw width associated with male response in Caucasian faces. On the other hand, a wider face and wider and longer jaw were associated with female response in Asian faces. Furthermore, there was no significant correlation between face width, jaw height and jaw width measurements and observers' responses to chimpanzee faces.

Greater mouth width significantly related to male response in both Caucasian and Asian faces. Mouth height was greater in those Caucasian faces categorized more frequently as female and in Asian faces categorized more frequently as male. No significant correlations were found in mouth measurements of chimpanzee faces.

Interorbital distance significantly correlated with female faces in both Caucasian and Asian faces. No significant correlation was found for chimpanzee faces in this measurement.

Nose width, eye height, eye width and brow to eye distance measurements significantly correlated observers' responses across three face categories. Faces with greater nose width were categorized more frequently as the male in all face categories. Eye width, eye height, and brow to eye distance measurements were greater in faces categorized more frequently as female.

Table 2

Correlations with facial metrics and observer responses

	Caucasian Faces		Asian Faces		Chimpanzee Faces	
Metric Distances (cm)	Mean Z Value	*p*	Mean Z Value	*p*	Mean Z Value	*p*
Face Width	0.35	.000***	-0.08	.000***	0.0006	.99
Jaw Height	0.12	.000***	-0.30	.000***	-0.04	.45
Jaw Width	0.52	.000***	-0.16	.000***	-0.07	.39
Interorbital Distance	-0.16	.000***	-0.29	.000***	-0.01	.74
Nose Width	0.53	.000***	0.14	.000***	0.19	.001**
Mouth Width	0.33	.000***	0.28	.000***	-0.01	.89
Mouth Height	-0.23	.000***	0.13	.000***	0.04	.54
Eye Height	-0.08	.000***	-0.43	.000***	-0.26	.000***
Eye Width	-0.04	.006**	-0.22	.000***	-0.14	.028*
Brow to Eye Distance	-0.76	.000***	-0.74	.000***	-0.12	.008**

Note 1. Female coded as 0 and male as 1 in the correlation.

Note 2. r_{pb} values were Fisher Z transformed to normalize them.

Note 3. p values $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

2.3. Discussion

Human adults are very well at categorizing the sex of own-race faces (Cellerino et al., 2004). The purpose of this study was to show whether or not human adults can categorize the sex of other-race and other-species faces successfully without any training. In order to see that a sex categorization task with Caucasian (own-race), Asian (other-race) and chimpanzee (other-species) faces were conducted to the participants. Most of the studies in the literature suggest that humans are born with a broadly tuned face perception system that can recognize other-race and other-species faces as well as own-race faces and lose this ability at an early age because of extensive exposure to own-race faces (Anzures et al., 2012; Pascalis et al., 2002; Pascalis et al., 2005; Scott & Monesson, 2009). Even though human adults cannot recognize other-race and other-species faces as well as own-race faces (O'Toole et al., 1994), we suggested that they might perform sex categorization task which is a lot earlier and simple process compared to recognition (Young & Burton, 2018). Therefore, in hypothesis 1, it was hypothesized that human adults can categorize the sex of Caucasian, Asian and chimpanzee faces correctly at least higher than chance level. According to the results, hypothesis 1 was confirmed. This finding is consistent with Franklin et al. (2013), which found that participants could successfully categorize the sex of macaque faces with 60.9 % of accuracy. The current study found a similar mean percentage of accuracy, 59.24%. However, it is important to note that even though accuracy rates are significantly higher than the chance level in both studies, the evidence is not strong enough to suggest that humans can successfully categorize other-species faces and results should be evaluated with caution. There were only eight faces in chimpanzee category in the current study; the stimuli may not be able to represent the chimpanzee population. However, the result of both studies suggests that sex categorization ability of human adults might be processed differently than other face perception tasks and might apply to the categorization of other-species sex from their face.

Even though humans successfully categorize the sex of faces in all face categories, in hypothesis 2, it was hypothesized that Caucasian faces will be categorized more accurately than Asian faces and Asian faces will be categorized more accurately than chimpanzee faces. Results confirmed the hypothesis 2. Furthermore, in hypothesis 3 it was hypothesized that Caucasian faces will be categorized faster than Asian faces and

Asian faces will be categorized faster than chimpanzee faces. Results of the current study also confirmed the hypothesis 3. These results indicate that participants demonstrate a strong *other-race*, and *other species-effect* on Asian and chimpanzee faces compared to Caucasian faces in both accuracy and reaction time measurement. This finding is consistent with O'Toole et al.'s study (1996) in which they conducted a sex categorization task with Caucasian and East Asian participants and showed an *other-race effect* in both accuracy and reaction time measurements. On the other hand, Zhao and Bentin (2008) found no significant difference in reaction time measurement during a sex categorization task with own- and other-race faces. One possible reason for these findings, as discussed earlier, might be task difficulty. In O'Toole et al.' (1996) study faces presented for 75ms and followed by a 200ms mask and a response screen. On the other hand, in Zhao and Bentin's (2008) study, when participants have presented the faces, they had no time restriction to respond. Task difficulty might reveal *other-race effect* in sex categorization task especially in reaction time measurements. Own-race faces are not affected by the time restriction since in this case sex categorization is an extremely fast process (26-75ms, O'Toole et al., 1996). However, categorizing accurately other-race faces by their sex might require longer time. In the current study, participants had 5 seconds to respond, although longer than O'Toole et al.'s (1996) study, might not be enough for participants to process other-race and other-species faces as efficient as own-race faces. Furthermore, Zhao and Bentin (2008) revealed that both Chinese and Israeli participants were more accurate in Israeli faces than Chinese faces in the sex categorization task. This finding suggests that faces of some human races could be easier to categorize as male or female due to high level of sexual dimorphism. Numerous studies support this idea. For example, Hopper et al. (2014) revealed that most sexually dimorphic face among humans belongs to the Caucasian race (see also, Green & Curnoe, 2009). Furthermore, Chinese face showed to be the least sexually dimorphic face compared to other East Asian faces (İscan et al., 1998). In other words, the different sexual dimorphic pattern of different races can influence *other-race effect*.

Male faces categorized more accurately and faster than female faces in the current study. Male face advantage in sex categorization task has been previously reported (Wild et al., 2000). Researchers also found in the study that participants had a male response bias when categorizing the sex of the face. They suggest that categorizing a male face as a female can be more costly than the reverse. It is possible that the need to detect a threat might induced male perception bias in sex categorization. Another study that showed the male advantage was that of Cellerino et al. (2004), which showed pixilation filter (in order to blur the faces) elicit worse performance in female faces compared to male faces. This study showed that participants could categorize the faces as a male with a minimum visual information. Overall, the findings of the current study and others suggest that less information is needed for humans to detect a male face compared to the female face. In the current study, female faces percentage of accuracy decreased towards the other-race and other-species faces, whereas for male faces it did not change substantially. In fact, for chimpanzee faces accuracy rate was not higher than chance level in female faces. This finding supports the idea that humans have a tendency to categorize a face as male. On the other hand, only in chimpanzee faces the reaction time of female and male faces differ significantly, sex of the face had no effect on the reaction time of participants in Caucasian and Asian faces. These findings suggest that in reaction time measurements male face advantage occurred only in other-species faces. Overall, male faces were categorized more accurately than female faces in human faces (Caucasian and Asian) but the reaction time of correct categorization between male and female faces was not statistically significant. In chimpanzee faces, males were categorized faster and more accurately than female faces.

Considerable research has conducted with masculinity and femininity measurements of faces (Penton-Voak et al., 2001; Fellous 1997; Enlow 1990; Gangestad & Thornhill, 2003). In the current study, some facial metrics showed as sexually dimorphic before, were specified and measured. After that, it was examined whether these metrics have been related to the response of participants (either female or male). Point-biserial correlation analysis of the facial metrics revealed that when the presented Caucasian faces have greater face width, jaw height, and jaw width, participants were more likely to categorize them as male. This finding is consistent with Mitteroecker et al.'s study (2015) in which they revealed that wider faces and larger jawline are perceived as more masculine. On the other hand, participants were more likely to respond as female when these measurements were longer in Asian faces in the current study. Even though males have larger jaw (Gu et al., 2011) and larger face (Liu et al., 2014), participants' female response was correlated with these measurements in Asian faces. This reverse effect might be due to the different craniofacial features in Caucasian and Asian faces. For example, Gu et al. (2011) revealed that Chinese female faces have longer anterior lower face height (named as jaw height in the current study) compared to Caucasian females. Generally, longer jaw height is related to the masculinity in Caucasian faces (Mitteroecker et al., 2005). Therefore, Chinese female face might be perceived as more masculine by observers. Larger jaw and wider face of males compared to females is also a consistent finding in chimpanzee sexual dimorphism (Cramer, 1977, Lockwood, 1999) yet the current study finds no correlation between the response of participants and these measurements in chimpanzee faces.

Furthermore, greater mouth width was significantly related to male response in both Caucasian and Asian faces and not correlated in chimpanzee faces in the current study. Furthermore, Caucasian faces with longer mouth height categorized more frequently as female. Henesssy et al. (2002) found that Caucasian female lips are fuller than females. Consistently, Mitteroecker et al. (2015) have revealed that thinner lips are perceived as more masculine. For the Asian faces, greater mouth height was related to the male response. The underlying reason might be that Chinese males have more protrusive lips than females (Gu et al, 2011). No significant correlations were found in mouth measurements of chimpanzee faces.

The nose width, eye height, eye width and brow to eye distance measurements commonly correlated significantly, with the response of participants across three face categories. Faces with greater nose width categorized more as the male in all face categories. Previous studies found that males have wider and bigger nose compared to females in Caucasian and Asian faces (Hennessy & Stringer, 2002; Liu et al., 2014). For chimpanzee faces, studies revealed no significant nose difference in craniofacial measurements between male and female faces (Cobb & O'Higgins, 2007). On the other hand, the male face looks wider than female in chimpanzees (Lockwood, 1999); as a result, the male nose might be perceived as larger and more masculine by the observers.

Eye width, eye height, and brow to eye distance measurements were larger in faces categorized more frequently as female. Mitteroecker et al. (2015) similarly found that males eyebrow were closer to the eyes and their eyes were smaller than females. Chinese and chimpanzee's eyes, on the other hand, are not sexually dimorphic (Liu et al, 2014; Cobb & O'Higgins, 2007) yet significantly correlated with the female response of the observers in a similar way with Caucasian faces. These findings of the current study indicate that participants might use the sexually dimorphic metrics in own-race faces as a cue to categorize the sex of the face, in other-race and other-species faces as well. For the Caucasian and Asian faces, highest correlations were brow to eye distances and for the chimpanzee faces eye height. Overall, results suggest that eyes and brow to eye distance are the most important areas in sex categorization task in Caucasian, Asian and chimpanzee faces.

The facial metric analysis suggests that the eye height, brow to eye distance and nose width are the most important areas in sex categorization. However, a correlational study does not certainly indicate that the participants attended and gathered information from those areas and respond correspondingly. Therefore, in the second study, the sex categorization task with own-and other-race human and other-species faces was repeated with this time monitoring the gaze behavior of observers.

CHAPTER 3

EXPERIMENT 2

In the second study, gaze pattern of participants recorded via an eye-tracking device while they were categorizing the sex of Caucasian, Asian and, chimpanzee faces. Specific area of interests (AOI) was defined (eyes, nose, mouth, cheeks, jaw) and proportion of fixation number, fixation duration and first fixation in these areas were compared across three face categories (Caucasian, Asian, and chimpanzee). It was hypothesized that eyes will be the most frequently, the nose will be second most frequently fixated area compared to other parts in Caucasian faces. It was further hypothesized that eyes will be the longest and nose will be the second longest fixated area compared to other parts in Caucasian faces. It was also hypothesized that eyes will be more frequently the first fixated area than other parts in Caucasian faces.

When participants who are employed to categorize the sex of faces were presented with other-race and other-species faces, one possibility is that they would focus on femininity and masculinity cues as with own-race faces and would not change their gaze pattern across different face categories. Another possibility is that independent from the sex categorization task, other-race, and other-species faces would elicit category based visual scanning and would cause observers to display different gaze pattern for other-race and other-species faces. Therefore, we investigated whether participants display a different gaze pattern in other-race and other-species faces compared to own race faces in a sex categorization task.

3.1. Method

3.1.1. Participants

16 naive students (8 females, 8 males) from Izmir University of Economics participated in the study in exchange for course credits. Mean age of participants was 22.31 (*SD* = 3.59) with a range of 20 to 33. None of the participants had a neurological or psychiatric disorder and they were not under the effect of any drug. All participants were right-handed (Edinburg Handedness Inventory, Oldfield, 1971) and had normal vision. Furthermore, none of them reported being in an East Asian country more than six months or any familiarity with East Asian culture or East Asian people. Participants who were using eyeglasses or contact lenses were excluded from the study. In order to avoid calibration problems, we asked participants not to wear any eye makeup during the day of the experiment.

3.1.2. Apparatus and Stimulus Presentation.

The face stimuli that were used in Experiment 1 were also used in Experiment 2. In a similar way with the first study, faces placed to a black background with a greyscale. SMI Experiment Center version 3.4 (Sens Motoric Instruments, GmhbH. http://www.smivision.com) was used to present faces to participants via a desktop computer (TECHNO PC 750 GB HDD/ 4 GB RAM /AMD FX-6100 3,3 GHz/ 1GB VGA) on a 22-inch (DELL TFT MONITOR) monitor. In order to allow participants to lead their first fixation themselves, faces appeared in one of four equally divided quadrants of the screen randomly (Figure 15). Faces presented to participants in separate blocks (in a counterbalanced order) and faces in each block were randomized for each participant. Participants had 5 seconds to respond, otherwise next stimuli appeared. In a similar way with the first study, participants responded by using the keyboard.

3.1.3. Eye tracking

While participants performing the sex categorization task, their eye movements were tracked at a sampling rate of 250 MHz with the Remote Eye-Tracking Device (RED 250, SensoMotoric Instruments, Inc., Boston, MA, USA). iView X system (SensoMotoric Instruments, GmhbH. http://www.smivision.com) was used to record gaze data. The experimental chamber was soundproof and observed by a camera during the experimental session. Participant's eyes were arranged to 60-65 cm distance from the monitor, which is

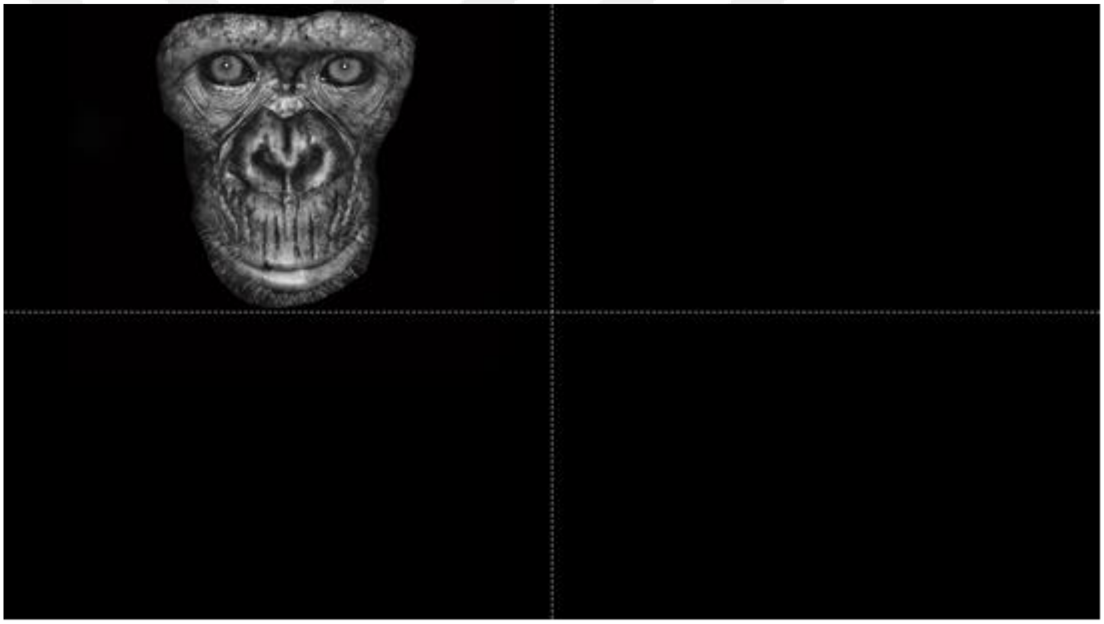

Figure 15. Example of stimulus presentation during Experiment 2 (Line dashes represent four equal quadrants)

a typical distance for human interaction (Baxter, 1970). Eye tracking device was just beneath the monitor. In order to stabilize participants' head, a chin rest was used (Figure 16). Calibration process was applied with a black background and 8 red-point fixation procedure which is implemented in SMI Experiment Center. Calibration process was repeated three times and smallest diversion from the x- and y-axis was selected to go on. Calibration was accepted only if the diversion from x- and y-axis are smaller than 0.80. Calibration validated with 4-point fixation procedure by SMI Experiment Center.

SMI Experiment Center AOI Editor was used in order to specify interested parts on the stimuli. Considering previous research on sex categorization from face (Sæther et al., 2009; Bindemann et al., 2009; Peterson & Eckstein, 2012) eyes, nose, mouth, cheeks, and jaw were determined as AOI in the analysis (Figure 17, 18, 19). Eyes were drawn with eyebrows and only top of nose was defined as nose because upper part of the nose (below the eyes) is shown to be a crucial point in holistic processing before (Peterson & Eckstein, 2012; Hsiao & Cotrell, 2008) and it is not a sexually dimorphic area (Sæther et al., 2009).

3.1.4. Procedure

Participants were first informed about the study shortly and signed an inform consent form in a similar way with the first experiment (Appendix D). They also filled out the participant information form that asked their age, sex, whether they have a neurological, psychiatric disorder, whether they have any problem with their vision and whether they are using glasses or contact lenses (Appendix E). After that, they filled out the Edinburg Handedness Inventory (Oldfield, 1971) (Appendix C). Before starting the experiment, participants instructed that they were expected to categorize the faces that will appear on the screen as female or male by using the keyboard (M and N keys) with their right index finger. Participants were also instructed to categorize in 5 seconds, otherwise, next stimuli appeared on the screen. In order to practice with keys, they completed a short version of the experiment with 10 faces. After this practice, participants' head was arranged with the eye-tracking device and stabilized with a chin rest. Participants were instructed that they should not move their heads until the end of the experiment. After calibration and validation processes were successfully completed, actual experiment was started. Before each face, there was a fixation cross at the center of the screen. A

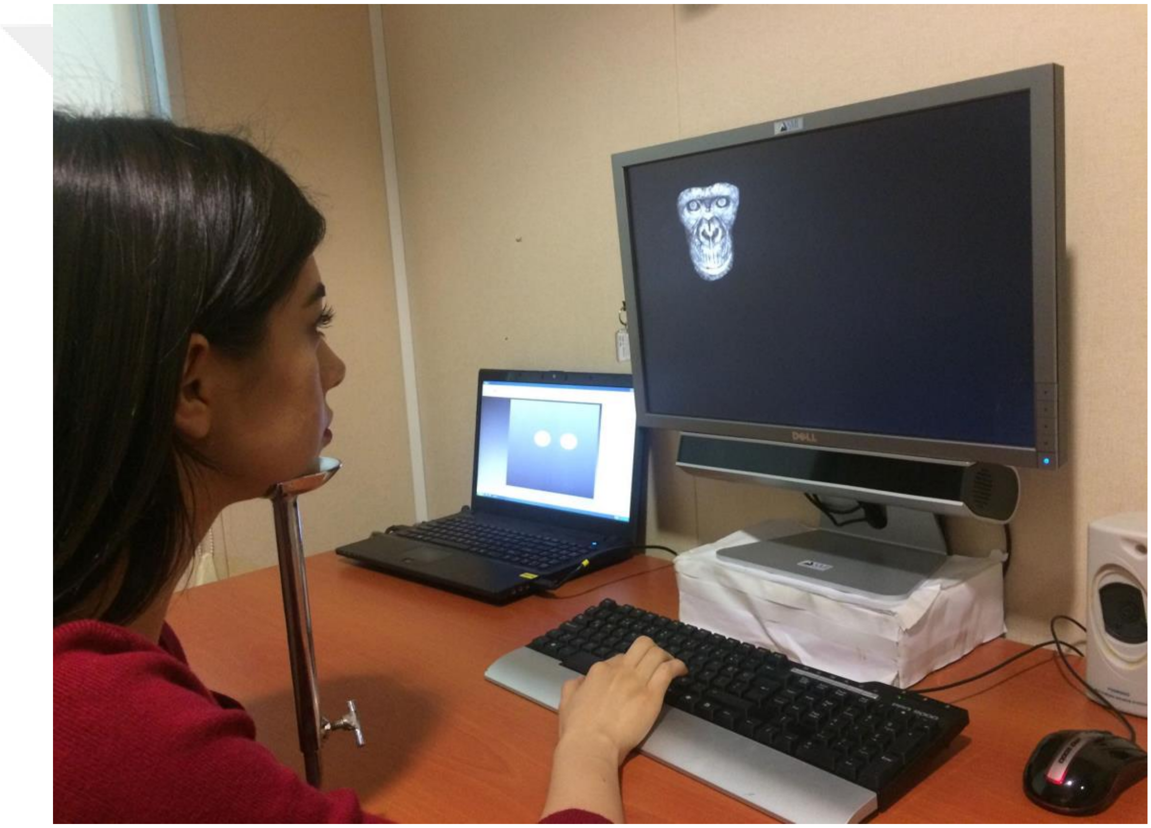

Figure 16. Experimental setup in Experiment 2

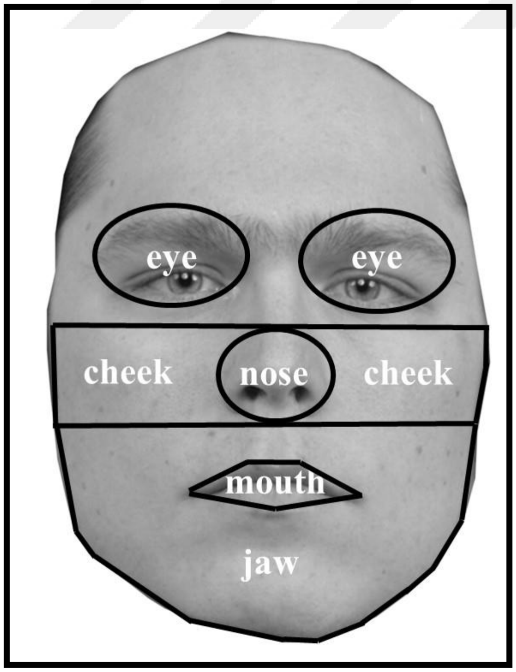

Figure 17. Example of defined AOI’s in a Caucasian face.

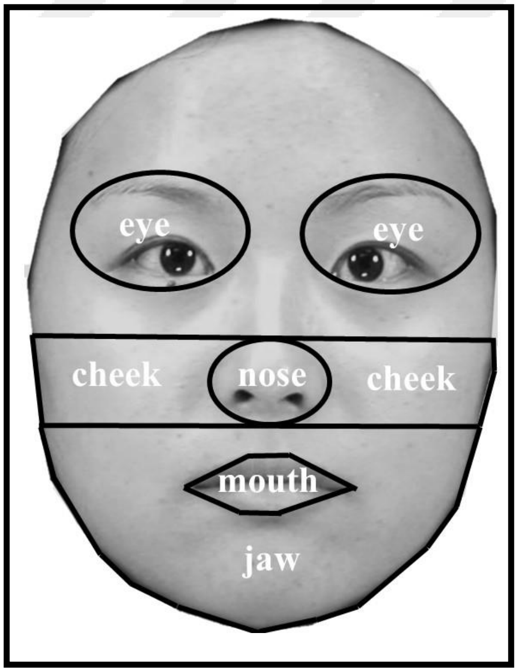

Figure 18. Example of defined AOI's in an Asian face.

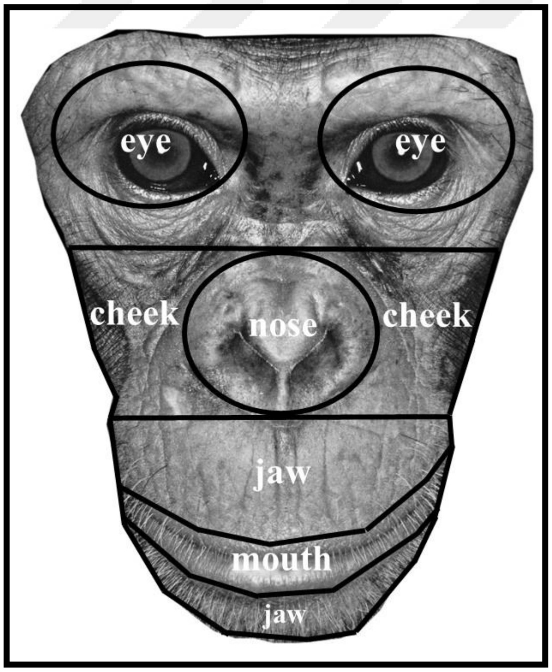

Figure 19. Example of defined AOI's in a chimpanzee face.

500ms fixation trigger was arranged for each fixation cross, so the next stimuli did not appear until the participant fixated on the cross for 500ms. Between each block, there was a resting period of 30 seconds. During this time, participants could rest by closing their eyes or looking outside the screen without moving their head (Figure 20). At the end of the experiment, participants received a debriefing about the study.

3.2. Results

3.2.1. Behavioral Analysis

In a similar way with the first experiment Caucasian ($M = 95.17$, $SE = 4.27$), Asian ($M = 89.96$, $SE = 5.25$) and chimpanzee faces ($M = 64.84$, $SE = 64.84$) were categorized by their sex significantly higher than chance level (50%); $t(15) = 42.35$, $p < .001$, $r = .99$, $t(15) = 30.43$, $p < .001$, $r = .98$; $t(15) = 4.07$, $p < .01$, $r = .72$, respectively.

A 3 (face category; Caucasian, Asian, and chimpanzee) *X* 2 (sex of the face; female, male) repeated measures ANOVA was conducted to see whether face category and sex of the face had any effect on the percentage of accuracy. Initially, in order check sphericity assumption Mauchly’s test was performed. Results revealed that assumption of sphericity had been violated for face category and face category *X* sex of the face interaction, $\chi^2(2) = 13.48$, $p < .01$, $e = .62$; $\chi^2(2) = 17.42$, $p < .001$, $e = .58$, respectively. Therefore, Greenhouse-Geisser corrected results will be reported for these effects.

ANOVA results showed that there was a main effect of face category on percentage of accurate sex categorization, $F(1.24, 18.54) = 50.79$, $p < .001$, $\eta_p^2 = .77$. Repeated contrasts showed that Caucasian faces categorized by their sex more accurately than Asian faces, ($F(1, 15) = 12.36$, $p < .01$, $r = .67$) and Asian faces more accurately than chimpanzee faces, $F(1, 15) = 40.39$, $p < .001$, $r = .85$. Furthermore, male faces categorized by observers more accurately than female faces, $F(1, 15) = 6.37$, $p < .05$, $\eta_p^2 = .30$. However, sex of the face *X* face category interaction did not reach significance level, $F(1.17, 17.53) = 1.92$, $p > .05$.

Another 3 (face category; Caucasian, Asian, chimpanzee) *X* 2 (sex of the face; female, male) repeated measures ANOVA was conducted to see whether face category and sex of the face had any effect on the reaction time of correct categorizations. Mauchly's test indicated that sphericity assumption was violated for the face category *X* sex of the face interaction effect, $\chi^2(2) = 9.08$, $p < .05$, $e = .68$.

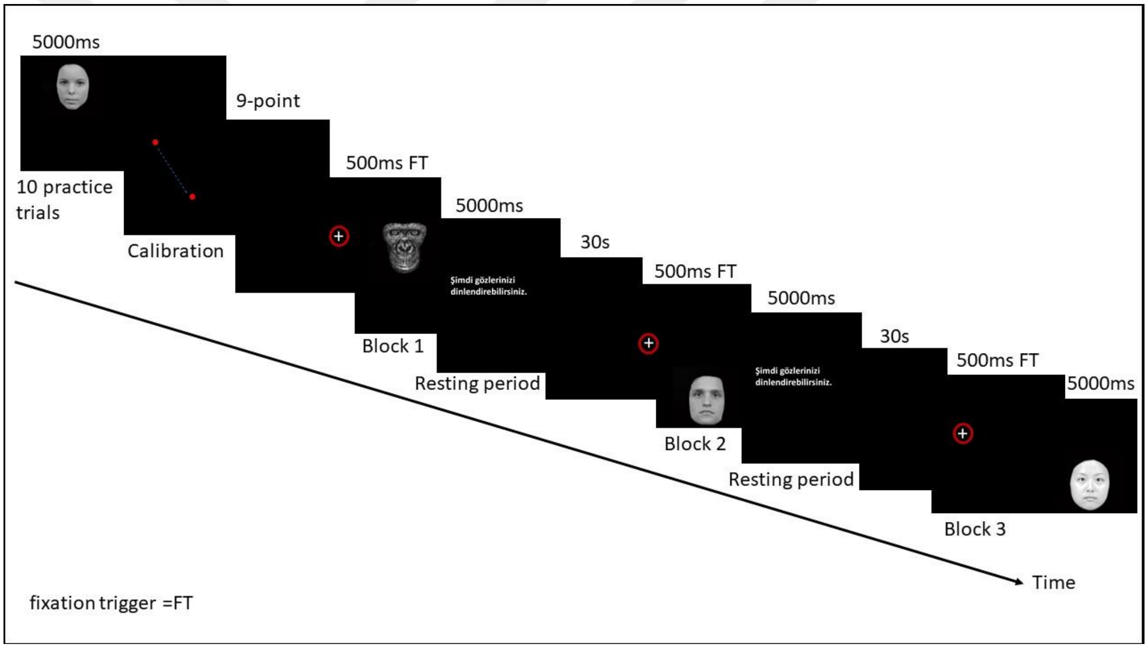

Figure 20. Flow diagram of stimulus presentation of Experiment 2

ANOVA results revealed that main effect of face category was statistically significant, $F(2, 30) = 21.53$, $p < .001$, $\eta_p^2 = .59$. Repeated contrasts showed that there was no significant difference between Caucasian and Asian faces on their reaction time of correct categorization, $F(1, 15) = 2.59$, $p > .05$. However, Asian faces were categorized faster than chimpanzee faces, $F(1, 15) = 22.40$, $p < .001$, $r = .77$. Furthermore, sex of the face main effect and face category *X* sex of the face interaction had no effect on reaction time of correct categorization of observers, $F(1, 15) = 0.80$, $p > .05$; $F(1, 35) = 1.46$, $p > .05$, respectively. Sex of the face *X* face category interaction also did not reach significance level, $F(1.35, 20.31) = 1.46$, $p > .05$.

Behavioral results of Experiment 2 are not completely consistent with the first study. In reaction time measurement, *the other-race effect* was not observed in Experiment 2, contrary to Experiment 1. Furthermore, male face advantage was not found in Experiment 2. The only difference of Experiment 2 was that faces appeared in one of four quadrants of the screen randomly instead of at the center of the screen. Therefore, it was thought that hemispheric asymmetry might confound the results and presentation of faces in the right and the left visual field might affect the reaction time of observers since the faces appeared not in a counterbalanced order but randomly in one of four quadrants of the screen.

In order to reveal whether the position of the face had any effect on the reaction time of observers, the horizontal position of the face (right, left) was added to the model. Therefore, a 3 (face category; Caucasian, Asian, chimpanzee) *X* 2 (sex of the face; female, male) *X* 2 (horizontal position; right, left) factorial repeated measures ANOVA was conducted on the reaction time of correct categorizations. Results revealed that there was no main effect of the horizontal position of the face on reaction time measurements, $F(1,15) = 1.27$, $p > .05$. However, the horizontal position of the face interacted with the face category. Simple effects analysis revealed that in Caucasian ($MD = 3.40$, $SE = 58.11$) and Asian faces' ($MD = 124.08$, $SE = 62.57$) horizontal position was not effective on reaction time of observers, both p's $> .05$. On the other hand, chimpanzee faces that appeared on the left side of the screen ($MD = 283.12$, $SE = 87.80$) were categorized faster than the ones on the right side, $p < .05$ (Figure 21). Furthermore, horizontal position of the face *X* sex of the face interaction was statistically significant, $F(1,15) = 6.85$, $p < .05$,

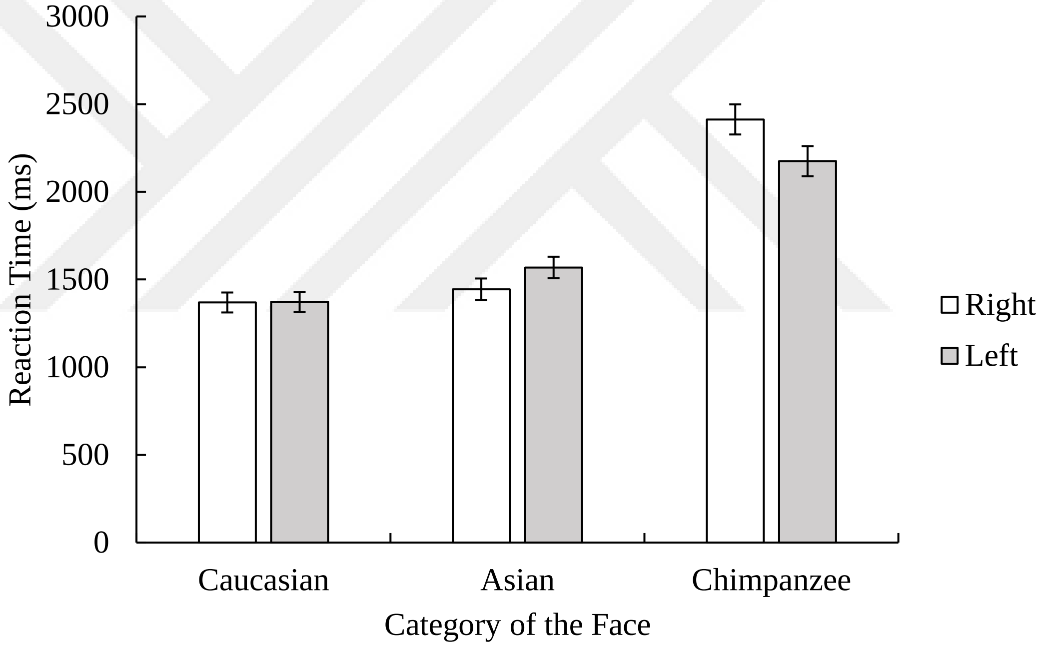

Figure 21. Mean reaction time (with 95% within-subjects CI) of observers in the right and left visual field of the screen

η_p^2 = .31. Simple effect analysis revealed a significant advantage of male faces on the right visual field. Observers' correct sex categorization was faster in male faces than female faces (*MD* = 295.68, *SE* = 83.97) when the face appeared on the right side of the screen, $p < .01$. On the other hand, there was no significant difference between female and male faces on response time measurements in the left visual field, p > .05. Finally, three-way interaction of horizontal position *X* category of the face *X* sex of the face did not reach significance level, $p > .05$ (Figure 22).

3.2.2. Eye tracking analyses

In all analyses, only correct trials were analyzed and fixations other than face were excluded. Fixation defined as maintaining the gaze for at least 100ms. (Reichle, Rayner & Pollatsek, 2003; Brielman, Bülthof,& Armann, 2014). A preliminary analysis showed that gender of the observer and sex of the face did not affect any of the measurements. Therefore, these two independent variables collapsed in all analyses.

First whole face analyses were conducted for fixation number, fixation duration and first fixation measurements. In order to understand whether face category (Caucasian, Asian, and chimpanzee) had any effect on fixation number of observers, one-way repeated measures ANOVA was conducted. Mauchly's test indicated that the sphericity assumption was violated for face category, $\chi^2(2) = 14.50$, $p < .01$, $e = .61$. Therefore, Greenhouse-Geisser corrected results will be reported. ANOVA results revealed that face category had a significant effect on fixation number of observers, $F(1.22, 18.24) = 8.09$, $p < .01$, *partial* η_p^2 = .35. Helmert contrasts showed that participants made more fixations to chimpanzee faces than human (Caucasian and Asian) faces, $F(1, 15) = 8.83$, $p < .05$, r = .61. However, there was no significant difference between Caucasian and Asian faces on their fixation number, $F(1, 15) = 1.80$, $p > .05$ (Figure 23).

There is no information gathered during saccades (Leigh & Zee, 2015). Therefore, fixation duration is calculated as summing the duration of fixations. A one-way repeated measures ANOVA was conducted to see the effect of face category on fixation duration of observers. Mauchly's test indicated that the sphericity assumption is violated, $\chi^2(2)$ = 13.39, $p < .01$, $e = .62$. Therefore, Greenhouse-Geisser corrected results will be reported. ANOVA results showed that there was no effect of face category on fixation duration of observers, $F(1.24, 18.57) = 3.48$, $p > .05$ (Figure 24).

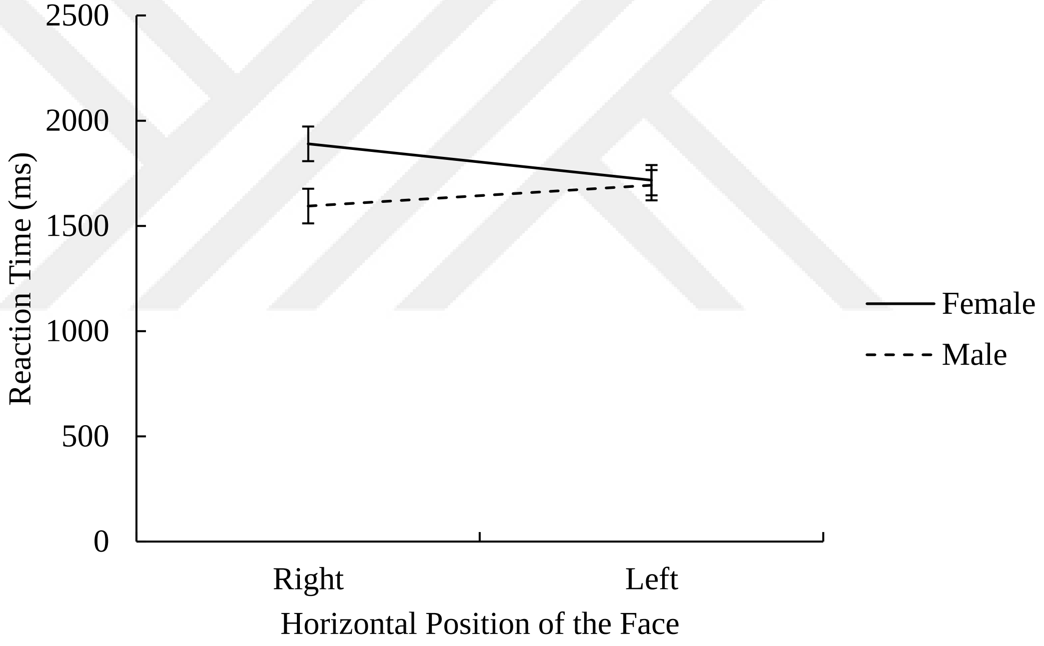

Figure 22. Mean reaction time (with 95% within-subjects CI) of observers for the male and female faces.

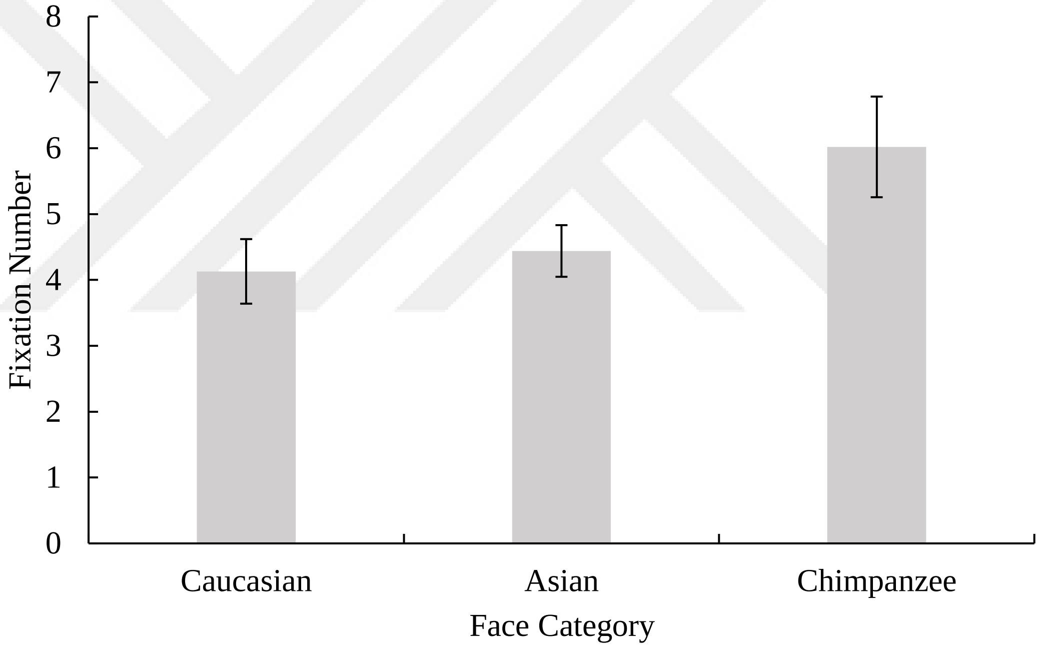

Figure 23. Mean (with 95% within-subject CI) number of fixations in Caucasian, Asian and chimpanzee faces

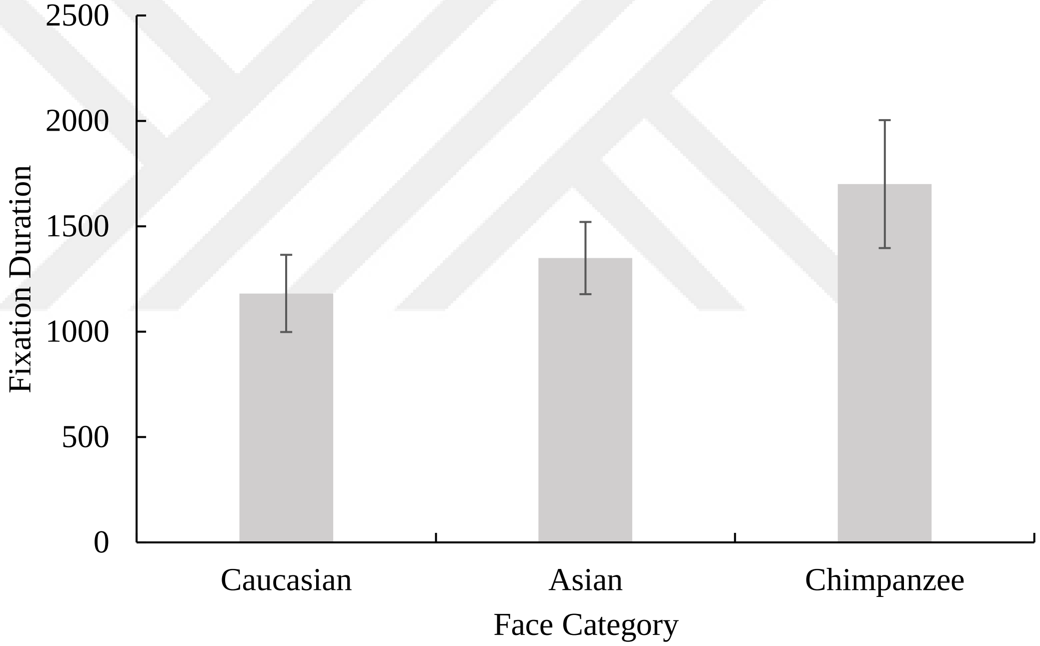

Figure 24. Mean (with 95% within subjects CI) fixation duration in Caucasian, Asian, and chimpanzee faces

In addition to the whole face analysis an AOI analyses were conducted for fixation number, fixation duration and first fixation measurements. Before the analysis, AOI's and non-interested parts in the face were compared according to their fixation number. 70.36 % of the fixations of observers were on AOI's and 29.64 % of them were on other areas on the face that was no interest for sex categorization. Paired samples *t*-test revealed that fixation number of observers were significantly higher for AOI's than non-interested areas, $t(15) = 7.27$, $p < .001$, $r = .88$. A 3 (face category; Caucasian, Asian, chimpanzee) *X* 5 (face part; eyes, nose, mouth, cheeks, jaw) repeated measures ANOVA was conducted to see whether face category had any effect on fixation number of observers in different face areas. The proportion of fixations in each AOI for each face category used as dependent variable in the analysis. First, in order to check sphericity assumption Mauchly's test was conducted. Results indicated that assumption of sphericity had been violated for face part and face category *X* face part interaction, $\chi^2(9) = 60.25$, $p < .001$, $e = .34$; $\chi^2(35) = 101.21$, $p < .001$, $e = .47$, respectively. Therefore, Greenhouse-Geisser corrected results will be reported for these effects.

ANOVA results revealed that main effect of face part was statistically significant, $F(1.36, 20.34) = 31.20$, $p < .001$, $\eta_p^2 = .68$. Bonferroni corrected pairwise comparisons revealed that eyes were more frequently fixated than the nose ($p < .01$). Moreover, nose, cheeks, and jaw were not statistically different ($p > .05$) and more frequently fixated than mouth ($p < .01$). (Figure 25).

Furthermore, face category *X* face part interaction significantly affected fixation number of observers, $F(3.78, 56.67) = 10.79$, $p <. 001$ $\eta_p^2 = .42$. In order to break down the interaction effect, planned contrasts were performed. Results revealed that eyes were more frequently fixated than the nose in human faces compared to chimpanzee faces, $F(1, 15) = 36.65$, $p < .001$, $r = .84$ (Figure 26). Nose was more frequently fixated in chimpanzees compared to human faces yet mouth did not differ between two groups (Figure 26). In both human and chimpanzee faces cheeks were more frequently fixated than the mouth, $F(1, 15) = 0.01$, $p > .05$ (Figure 27). In a similar way, cheeks and jaw did not differ on their fixation number in human and chimpanzee faces, $F(1, 15) = 3.33$, $p > .05$ (Figure 28). Only, the nose was more frequently fixated than the mouth in Asian faces compared to Caucasian faces, $F(1, 15) = 8.85$, $p < .01$, $r = .61$ (Figure 29). None of the

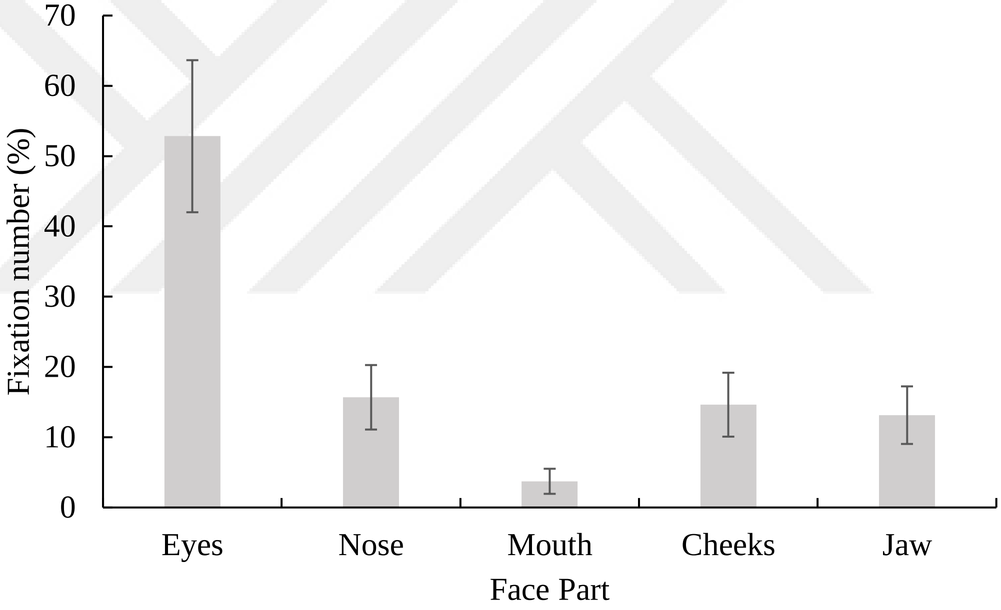

Figure 25. Mean (with 95% within-subject CI) percentage of fixation numbers in different face parts

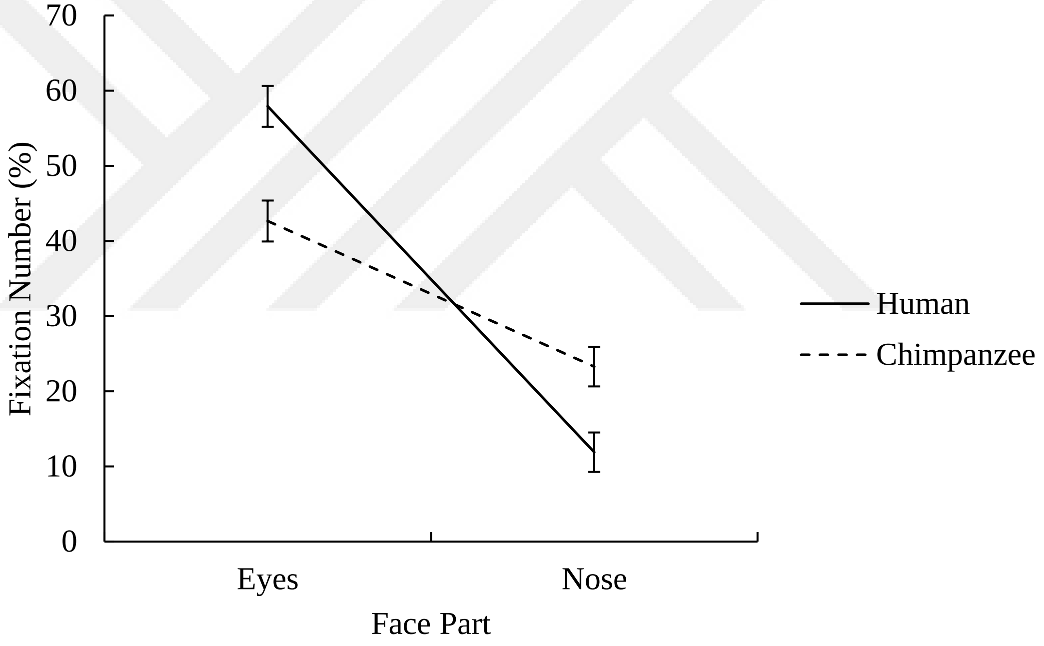

Figure 26. Mean (with 95% within-subject CI) percentage of fixation numbers of eyes comparing nose in human and chimpanzee faces

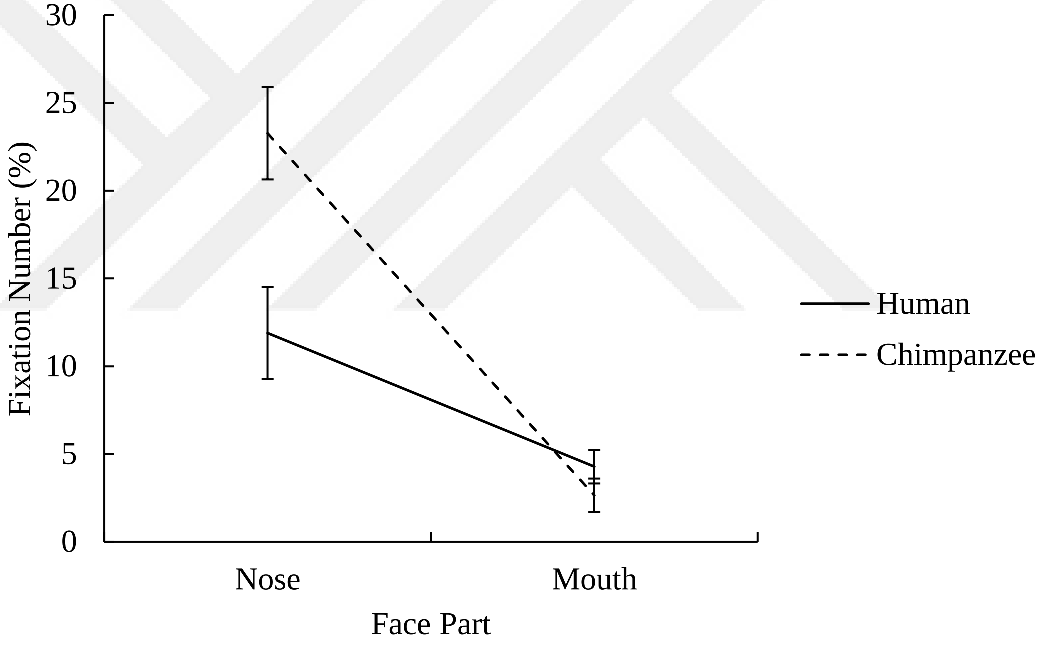

Figure 27. Mean (with 95% within-subject CI) percentage of fixation numbers of nose comparing mouth in human and chimpanzee faces

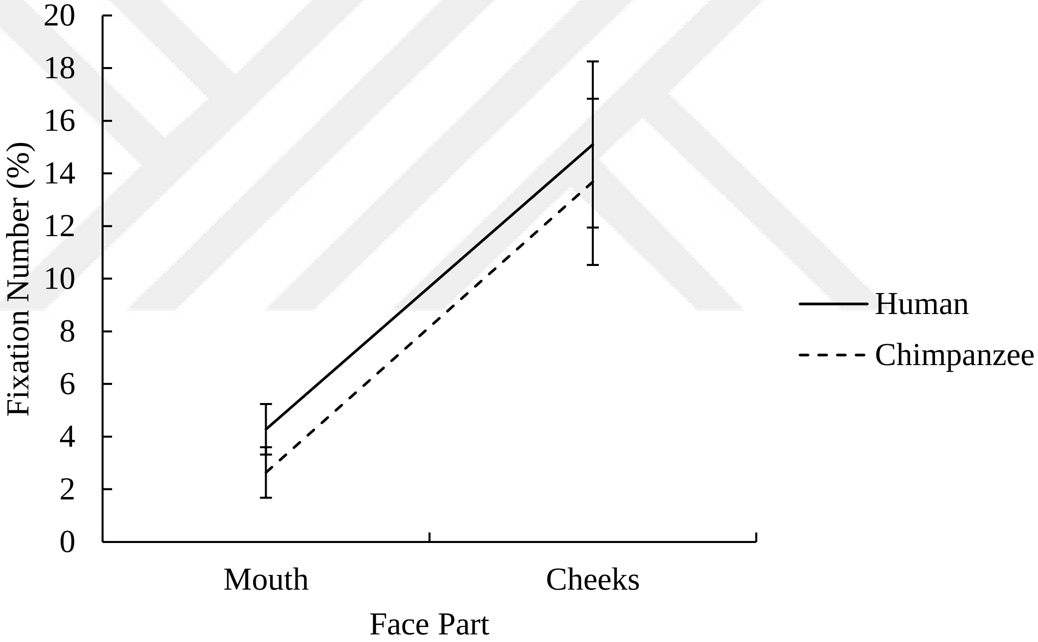

Figure 28. Mean (with 95% within-subject CI) percentage of fixation numbers of mouth comparing cheeks in human and chimpanzee faces

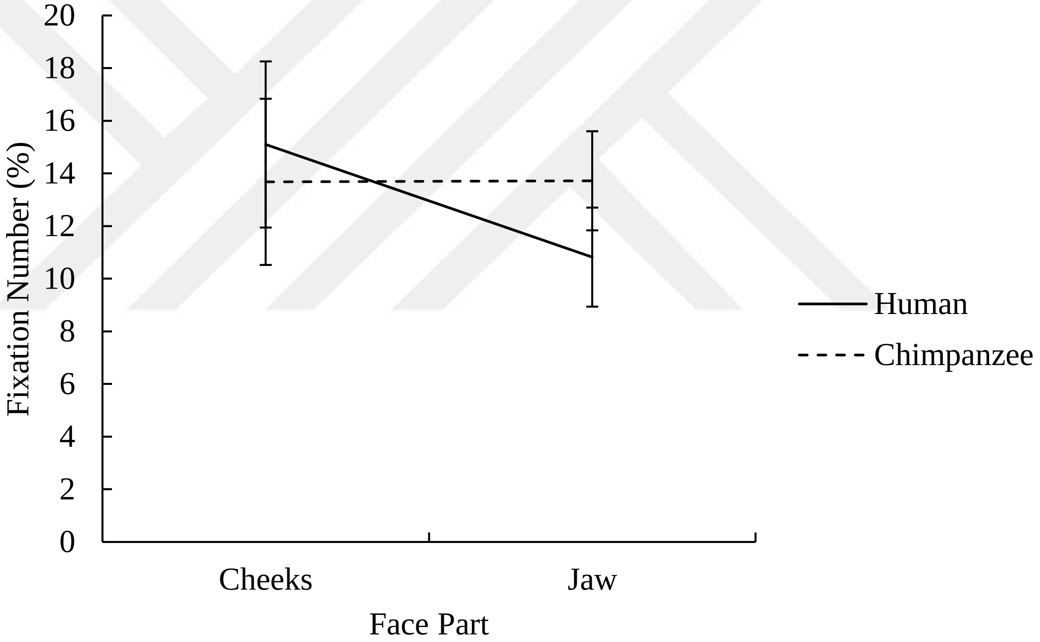

Figure 29. Mean (with 95% within-subject CI) percentage of fixation numbers of cheeks comparing jaw in human and chimpanzee faces

other comparisons between Asian and Caucasian faces reached the significant level, all *F*'s < 2.26, all *p*'s > .05 (Figure 30).

An additional simple effect analysis was performed in order to understand the distribution of fixation number of each face part in different face categories. According to that, in Caucasian faces eyes were more frequently fixated than other parts ($p < .001$). Nose, cheeks, and jaw were not significantly different ($p > .05$) and more frequently fixated than mouth ($p < .05$). In Asian faces, the pattern was the same. Most frequently eyes ($p < .001$) followed by nose, cheeks, and jaw ($p > .05$) and least frequently ($p < .01$) mouth was fixated. Similarly, in chimpanzee faces, eyes more frequently fixated than other parts ($p < .05$). Nose, cheeks, and jaw were not significantly different ($p > .05$) and more fixated than mouth ($p < .01$) (Figure 31).

In a similar way with fixation number analysis, AOI's and non-interested parts were compared according to their fixation duration. 65.71 % of the fixation duration was on AOI's on faces and 34.29 % of it was on non-interested areas on the face. Paired samples t-test revealed that observers fixated on AOI's longer than non-interested areas of the face, $t(15) = 4.22$, $p < .01$, $r = .74$.

A 3 (face category; Caucasian, Asian, chimpanzee) *X* 5 (face part; eyes, nose, mouth, cheeks, jaw) repeated measures ANOVA was conducted to see whether face category had any effect on fixation duration of observers in different face parts. The proportion of fixation duration in each AOI for each face category used as dependent variable in the analysis. First, in order to check sphericity assumption Mauchly's test was conducted. Results indicated that the assumption of sphericity was violated for face part and face category *X* face part interaction effects, $\chi^2(9) = 69.09$, $p < .001$, $e = .35$; $\chi^2(35)= 97.80$, $p < .001$, $e = .48$, respectively. Therefore, Greenhouse-Geisser corrected results will be reported for these effects.

ANOVA results showed that main effect of face part was statistically significant, $F(1.39, 20.84) = 33.45$, $p < .001$, $\eta_p^2 = .69$. Bonferroni corrected pairwise comparisons revealed that fixation duration was longer for eyes comparing nose ($p < .01$). Moreover, nose, cheeks, and jaw did not significantly differ from each other ($p> .05$) and longer fixated than mouth ($p < .05$) (Figure 32). Furthermore, interaction effect of face category

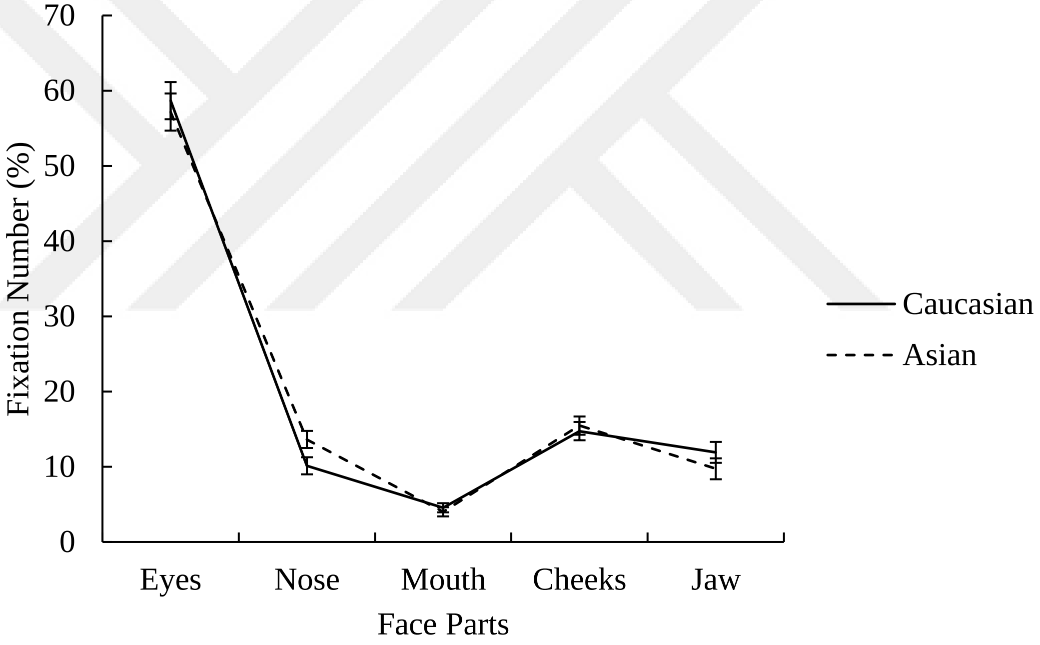

Figure 30. Mean (with 95% within-subject CI) percentage of fixations of each face part in Caucasian and Asian faces

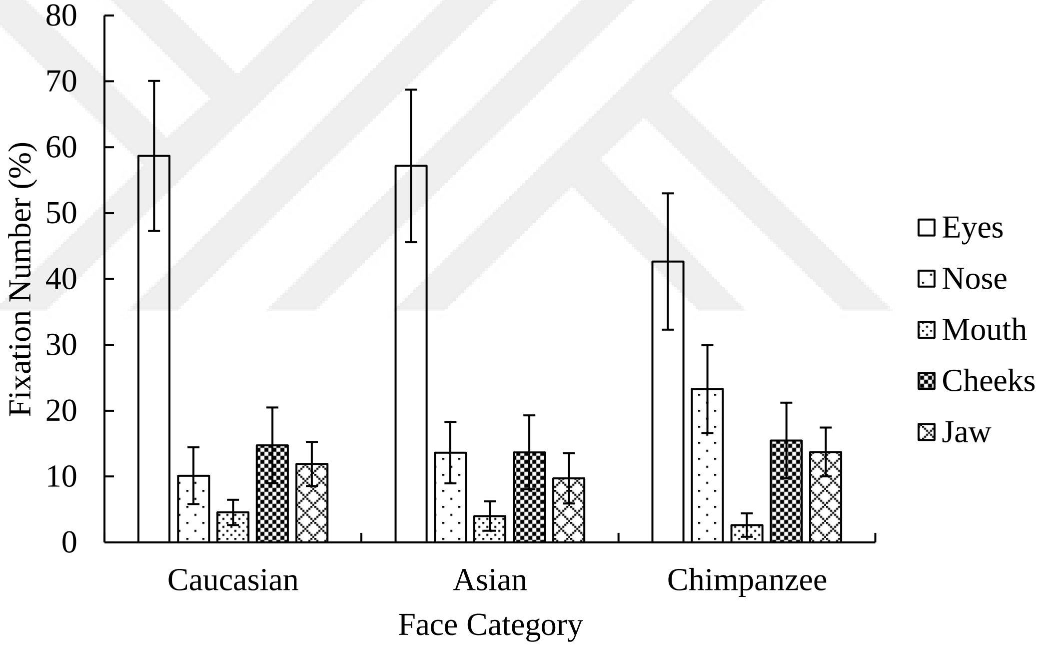

Figure 31. Mean (with 95% within-subject CI) percentage of fixation number distribution in Caucasian, Asian, and chimpanzee faces.

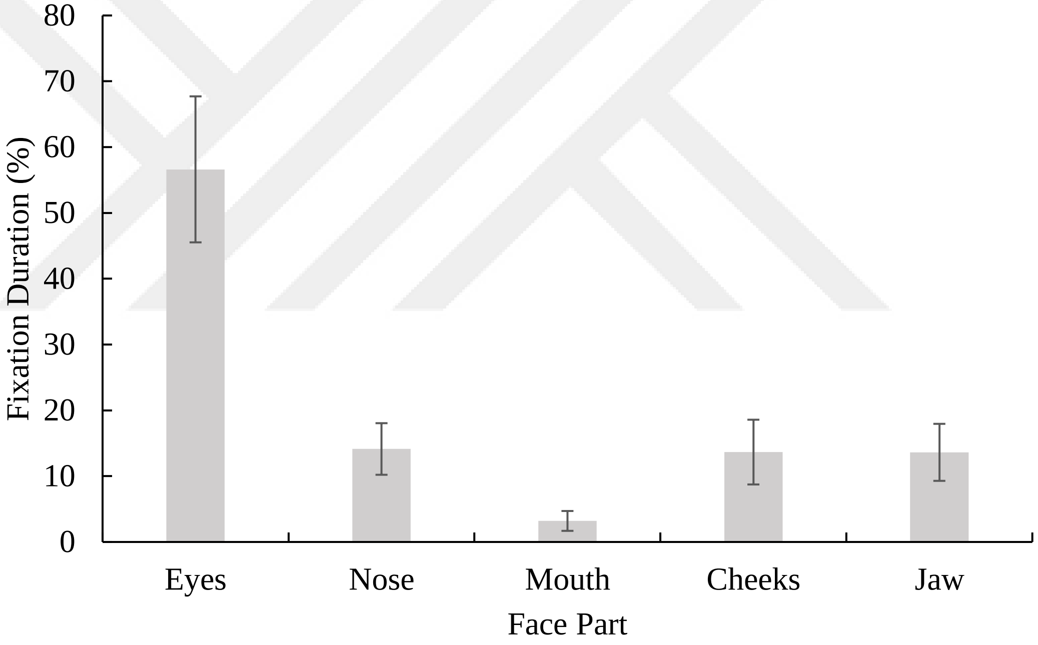

Figure 32. Mean (with 95% within-subject CI) percentage of fixation duration in different face parts

X face part was statistically significant, *F*(3.80, 57.05) = 9.79, $p < .001$, $\eta_p^2 = .40$. In order to break down the interaction effect planned contrasts were performed. Results revealed that eyes were fixated longer than nose in human faces compared to chimpanzee faces, *F*(1, 15) = 30.25, $p < .001$, $r = .82$ (Figure 33). On the other hand, the nose was fixated longer than in chimpanzee faces compared to human faces yet the mouth did not significantly differ between two groups, *F*(1, 15) = 17.23, $p < .01$, $r = .73$ (Figure 34). Mouth and cheeks difference showed the same pattern in human and chimpanzee faces, *F*(1, 15) = 0.19, $p > .05$ (Figure 35). In a similar way, cheeks and jaw were not significantly different on their fixation duration in human and chimpanzee faces, *F*(1, 15) = 2.23, $p > .05$ (Figure 36). Any of the contrasts between Caucasian and Asian faces on fixation duration reached the significance level, all *F*'s < 2.36, all *p*'s > .05 (Figure 37). Additionally, a simple effect analysis was conducted to see the fixation duration distribution of face parts in each face category. Results revealed that in Caucasian faces the most attended area was eye ($p <.001$). Nose, cheeks, and jaw were not statistically significant ($p > .05$) and more attended than mouth ($p < .05$). The same pattern was observed in Asian and Chimpanzee faces as well. Eyes were longer fixated than other parts (for Asian faces, $p < .01$; for chimpanzee face $p < .05$). Nose, cheeks, and jaw were not significantly different (p > .05) and longer fixated than mouth ($p < .01$) (Figure 38).

59.96 % of the first fixations were on AOI's and 40.04 % of them were on non-interested areas on the face. Paired samples t-test revealed that first fixations were more frequent in AOI's than non-interested areas, $t(15) = 2.56$, $p < .05$, $r = .55$.

A 3 (face category; Caucasian, Asian, chimpanzee) x 5 (face part; eyes, nose, mouth, cheeks, jaw) repeated measures ANOVA was conducted to see the effect of face category on first fixation frequency of observers in different face parts. In order to check sphericity assumption Mauchly's test was performed. Results indicated that the assumption of sphericity was violated for face part and face category *X* face part interaction effects, $\chi^2(9) = 113.19$, $p < .001$, $e = .31$; $\chi^2(35) = 138.20$, $p < .001$, $e = .39$, respectively. Therefore, Greenhouse-Geisser corrected results will be reported for these effects.

ANOVA results revealed that main effect of face part was statistically significant, *F*(1.22, 18.31) = 17.99, $p < .001$, $\eta_p^2 = .55$. Bonferroni corrected pairwise comparisons

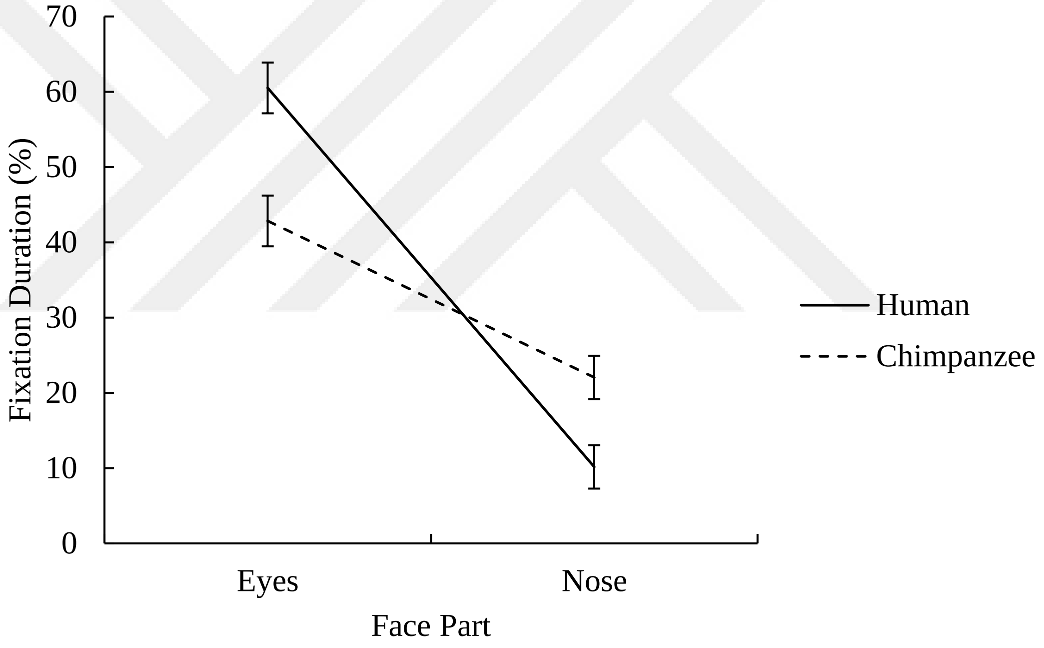

Figure 33. Mean (with 95% within-subject CI) percentage of fixation duration of eyes comparing nose in human and chimpanzee faces

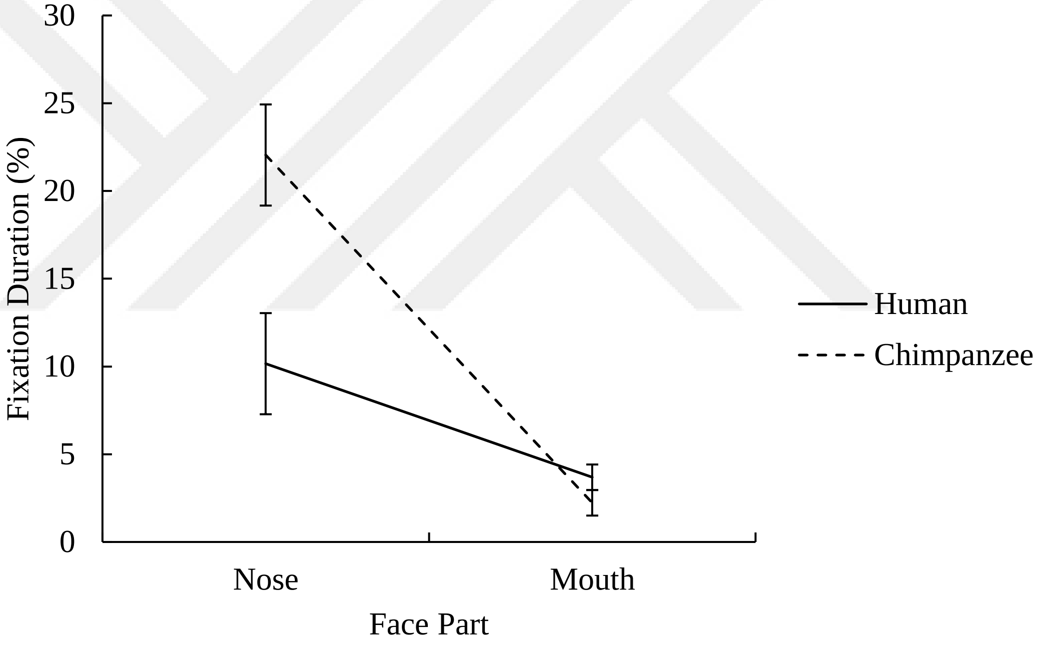

Figure 34. Mean (with 95% within-subject CI) percentage of fixation durations of nose comparing mouth in human and chimpanzee faces

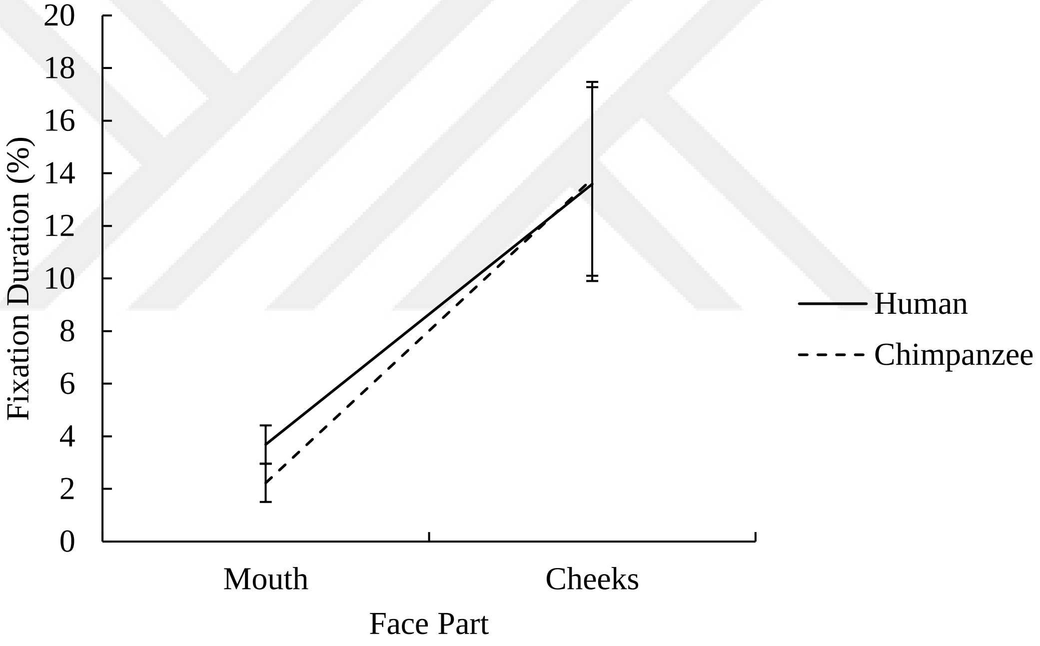

Figure 35. Mean (with 95% within-subject CI) percentage of fixation duration of mouth comparing cheeks and jaw in human and chimpanzee faces

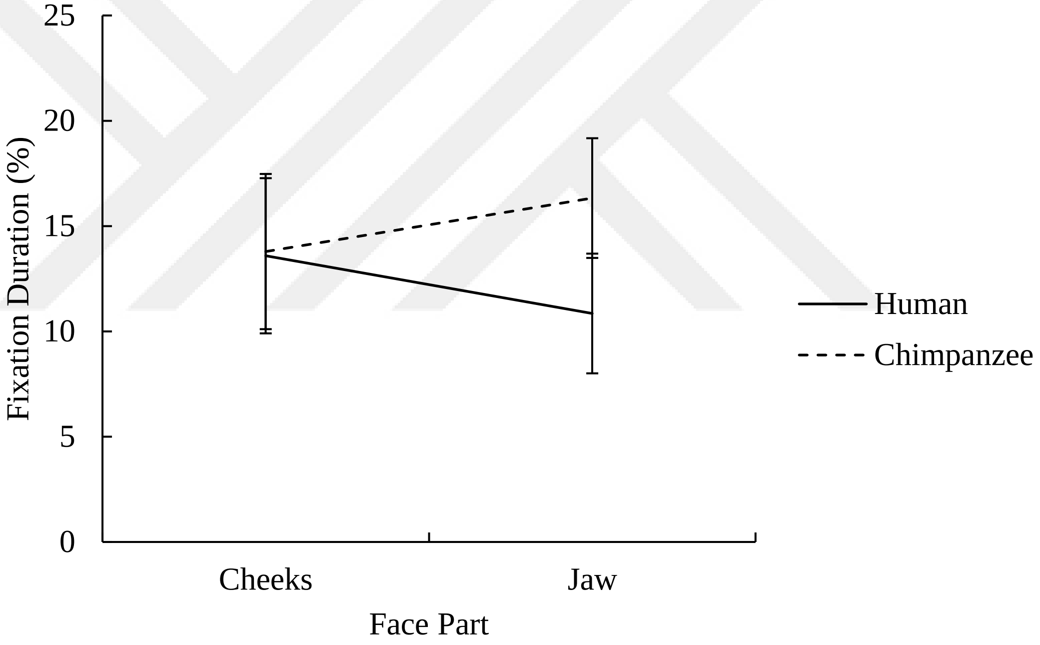

Figure 36. Mean (with 95% within-subject CI) percentage of fixation durations of cheeks comparing jaw in human and chimpanzee faces

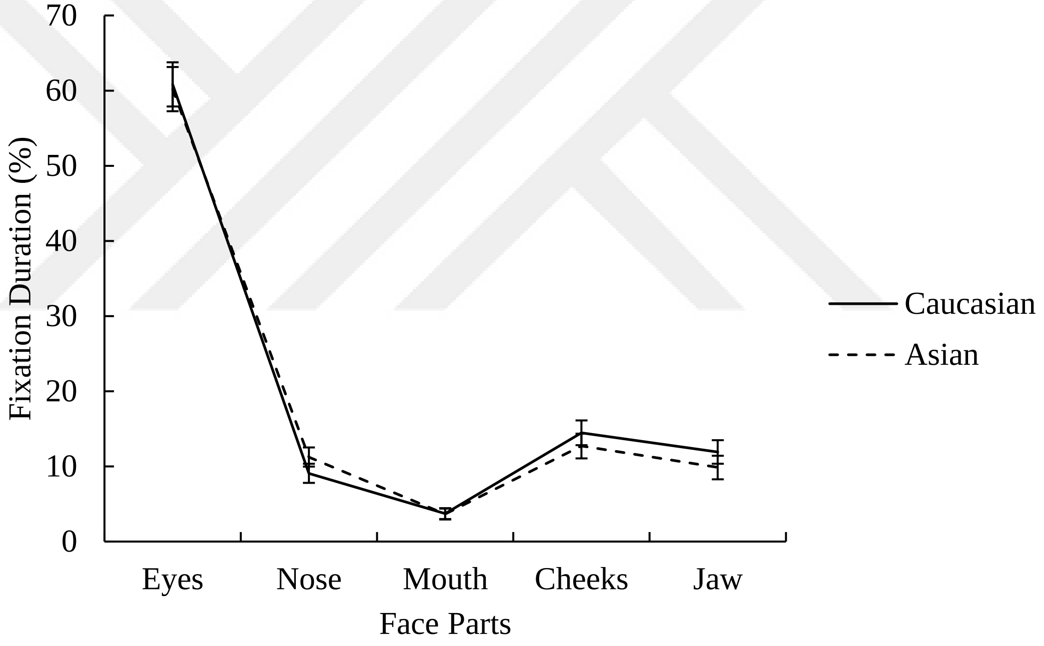

Figure 37. Mean (with 95% within-subject CI) percentage of fixation duration of each face part in Caucasian and Asian faces

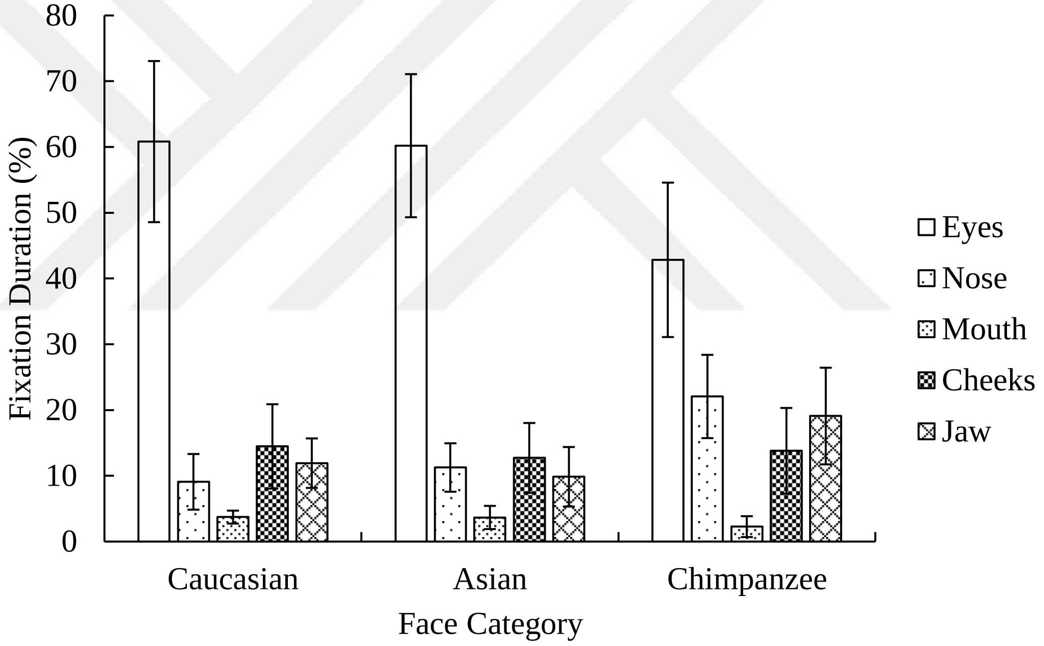

Figure 38. Mean (with 95% within-subject CI) percentage of fixation duration distribution in Caucasian, Asian, and chimpanzee faces

revealed that eyes were significantly the most frequently first fixated area ($p < .01$). Nose and cheeks were not significantly different ($p > .05$) and were more frequently first fixated than jaw ($p < .01$). Finally, jaw was more frequently first fixated than mouth ($p < .05$) (Figure 39).

Face category *X* face part interaction effect was also statistically significant, $F(3.08, 46.21) = 4.56$, $p < .01$, $\eta_p^2 = .23$. In order to break down the interaction effect, planned contrasts were performed. Results showed that only eyes were more frequently first fixated than the nose in human faces compared to chimpanzee faces, $F(1, 15) = 9.18$, $p < .01$, $r = .62$.None of the other comparisons reached significance level, all F's < 4.15, all $p > .05$. (Figure 40). Furthermore, none of the comparisons between Caucasian and Asian faces on first fixations reached significance level all F's < 3.03, all p's $> .05$ (Figure 41).

An additional simple effect analysis revealed that in Caucasian faces eyes received most of the first fixations ($p < .01$). Nose and cheeks were not significantly different ($p > .05$) and received more first fixations than mouth and jaw ($p < .05$). Mouth and jaw did not significantly differ on their first fixation frequency ($p > .05$). In Asian faces, the pattern was the same. Eyes were the first ($p < .01$), nose and cheeks were not significantly different from each other ($p > .05$) and second ($p < .05$) area that received most of the first fixations. Mouth and jaw were not significantly different ($p > .05$) and the least first fixated areas ($p < .05$). In chimpanzee faces, eyes, nose, and cheeks were not significantly different ($p > .05$) and the most frequently first fixated areas ($p < .05$), followed by jaw ($p < .05$). Finally, the mouth was never first fixated in chimpanzee faces (Figure 42).

3.3. Discussion

Behavioral analysis revealed that percentage of accuracy results of the Experiment 1 was confirmed. Participants categorized other-race and other-species faces accurately at a significantly higher than chance level. Other-race and other-species effect was also consistently found in Experiment 2. Participants were more accurate in Caucasian faces than in Asian faces, similarly more accurate in Asian faces than in chimpanzee faces. In reaction time measurements, *other-species effect* was successfully replicated. Participants categorized the human faces faster than chimpanzee faces. On the other hand, the *other-race effect* could not found in reaction time measurements. Participants' reaction time

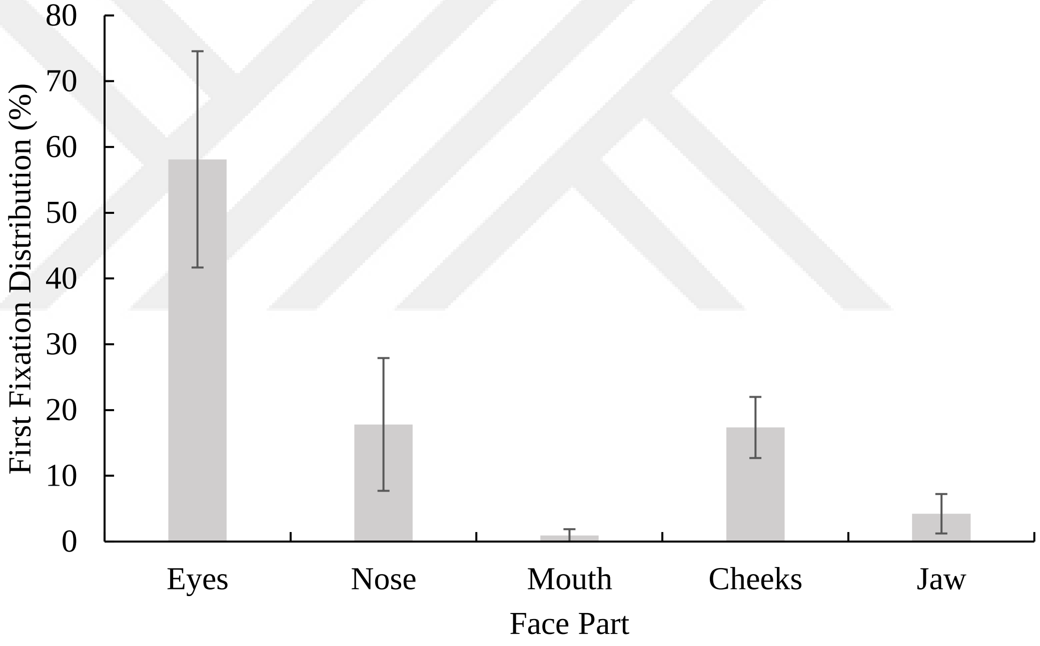

Figure 39. Mean (with 95% within-subject CI) percentage of the first fixations in different face pars

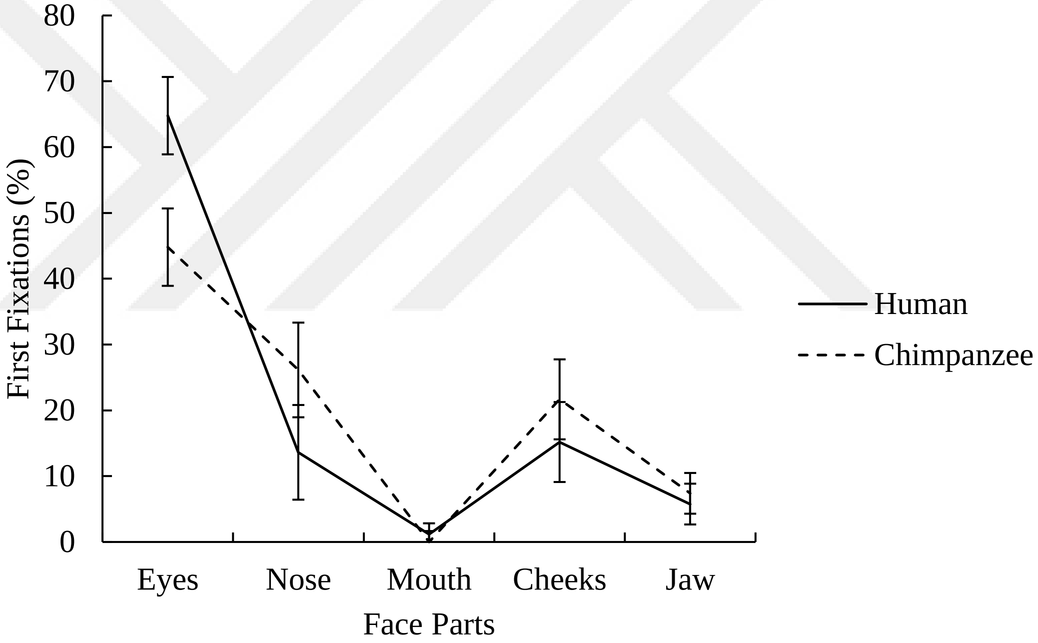

Figure 40. Mean (with 95% within-subject CI) percentage of first fixations of each face part in human and chimpanzee faces.

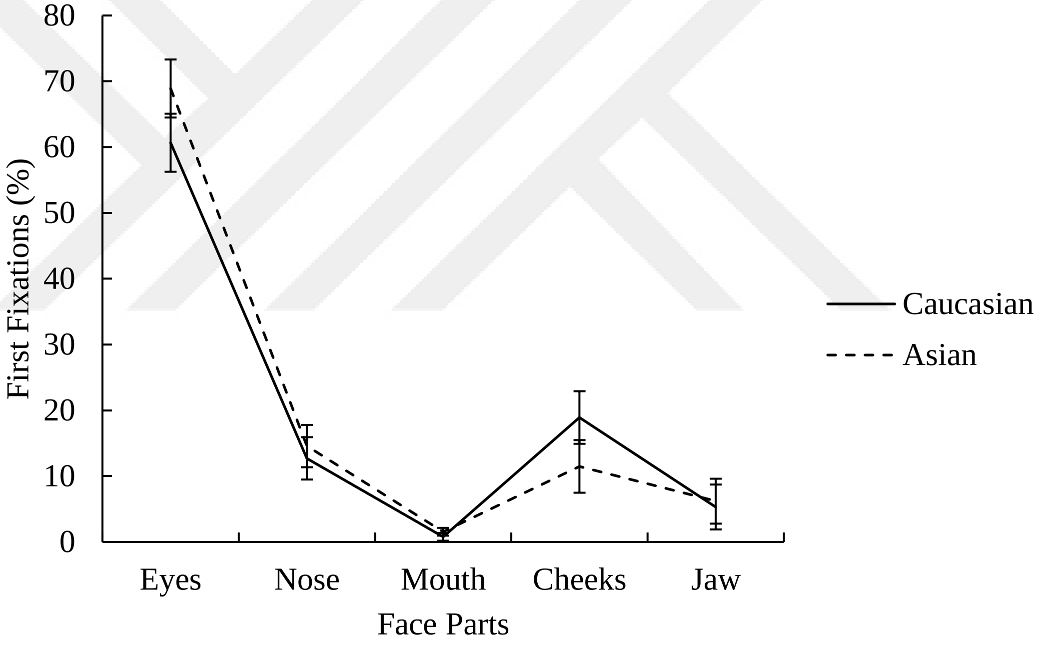

Figure 41. Mean (with 95% within-subject CI) percentage of first fixations of each face part in Caucasian and Asian faces

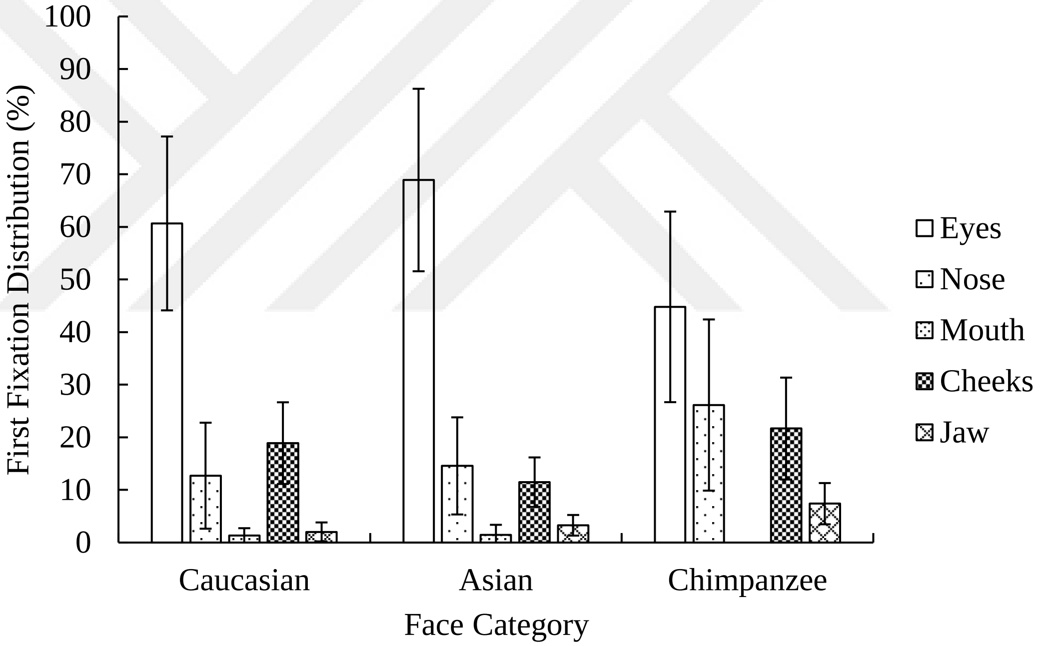

Figure 42. Mean (with 95% within-subject CI) percentage of first fixations distribution in Caucasian, Asian, and chimpanzee faces

Figure 43. Focus map of three observers' fixation on a Caucasian, Asian and a chimpanzee face. Overtly attended areas (fixation duration > 3000ms) are highlighted in the map.

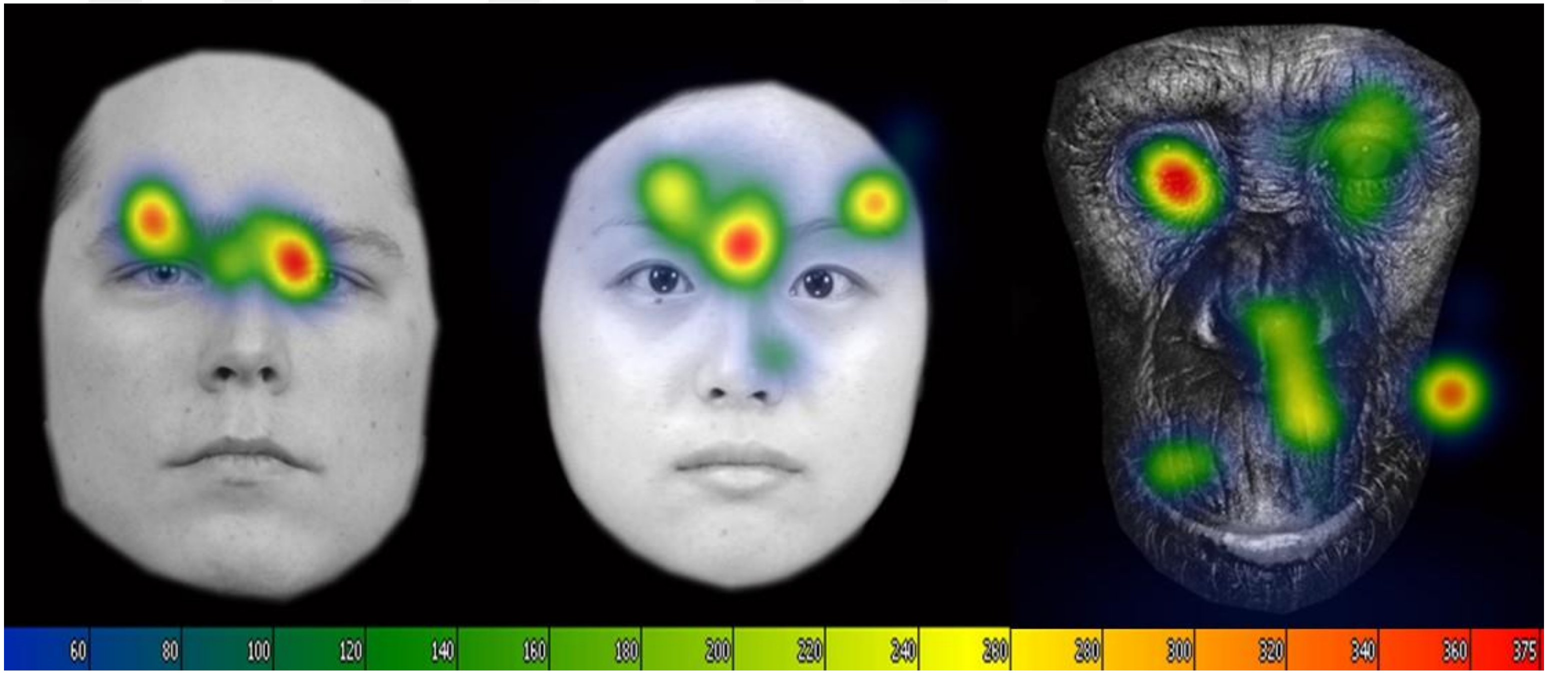

Figure 44. Heat map of three observers’ fixation on a Caucasian, Asian and a chimpanzee face. Colorful scale represents the fixation time average

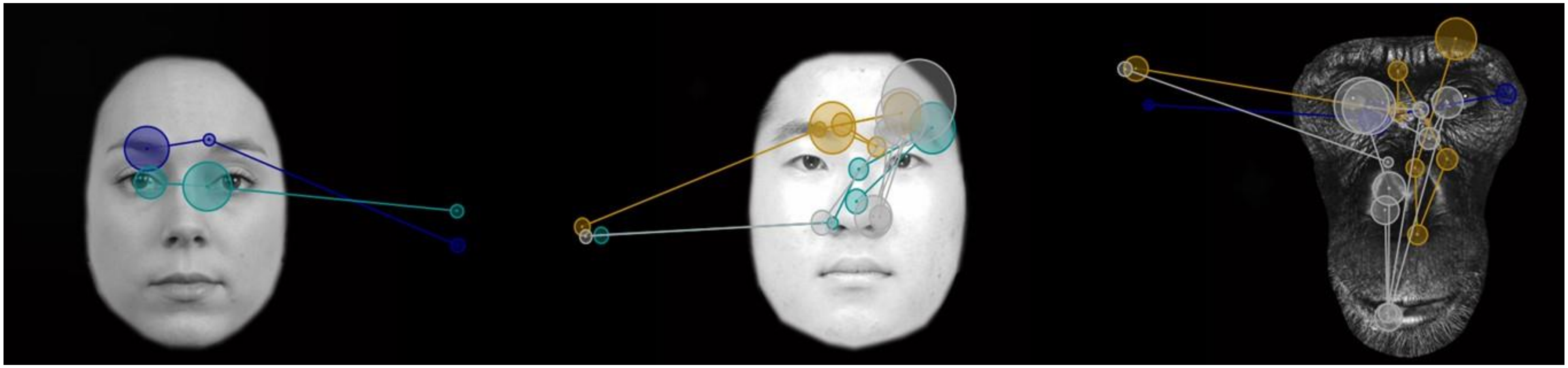

Figure 45. Scan path examples of eight observers (showed in different color lines) on a Caucasian, Asian and a chimpanzee face. Fixations starts from the outer of the face because of the fixation cross in the previous screen. Center of the circles represent the fixated point and circle size relates to the fixation duration. Lines represent the saccadic eye movement.

measurements were not significantly different in Caucasian and Asian faces. Furthermore, sex of the face did not differ on reaction time measurements. These results were inconsistent with the first study. The underlying reason for the inconsistent result was thought as the difference between stimuli presentation between two experiments. Observers were presented the faces in one of four quadrants of the screen randomly in Experiment 2 unlike the Experiment 1 in which faces appeared at the center of the screen. It was thought that the possible reason for the inconsistent results would be that the location of the face during the experiment. Therefore, the repeated measures ANOVA model was extended by adding the horizontal (right, left) position of the face as independent variable. Results revealed a significant right visual field advantage for male faces. Participants' correct sex categorization was faster in male faces compared to female faces in the right visual field. On the other hand, there was no difference in reaction time of male and female faces in the left visual field. Prete et al. (2016) have found a similar hemispheric asymmetry in their study. They found a male face advantage in the right visual field and female face advantage in the left visual field. In the current experiment, we could not found any difference between female and male faces in the left visual field. This could be due to the other-race and other-species faces that were used in the current study. Independent from the task, other-race faces might be lateralized differently than own-race faces. For example, Golby et al. (2001) showed that left hemisphere is more active during presentation of other-race faces. Therefore, left hemisphere is thought to mediate feature-based (processing each face feature separately) visual processing. Own-race faces on the other-hand activate more of the right hemisphere because of the configural (processing the relation of features) processing of these faces (Scott, & Nelson, 2006).

The current study further found that for the Caucasian and Asian faces there was no reaction time difference in the right and the left visual field. On the other hand, chimpanzee faces were categorized by their sex in the left visual field faster, showing a right hemispheric lateralization. This finding is not consistent with above-mentioned study of Golby et al. (2001) which showed that other-race faces activates more of the left hemisphere. However, categorizing the sex of chimpanzee faces requires more detailed visual scanning than other-race faces and might not be an easy categorization task as Asian faces. This detailed scanning of chimpanzee faces might activate more of the right hemisphere which includes a larger portion of the fusiform gyrus (Haxby et al., 2000).

Gaze behavior of human adults in own-race faces during a sex categorization task is well documented before (Bindemann et al., 2009; Sæther et.al.,2009). Experiment 2 in the current study aimed to show the gaze pattern of participants during a sex categorization task with other-race and other-species faces and how it differs from the own-race faces. Eye tracking device was used to record eye movement of participants.

The whole face analysis revealed that fixation number of the chimpanzee was higher compared to human faces. Fixation duration, on the other hand, did not differ between face categories. This result indicate that observers made more frequent fixations to chimpanzee faces but in fact, they did not look them longer than human faces.

For a more detailed analysis, we specified some area of interest (AOI) (eyes, nose, mouth, cheeks, and jaw) and analyzed the gaze data of observers according to these areas in three face categories. For Caucasian face category, the most attended area was the eye (eye defined with eyebrow) in terms of both fixation number and fixation duration. Therefore, the hypothesis 4 and 6 were accepted. The second most attended areas were nose, cheeks and, jaw and they were not significantly different. It was hypothesized that when the infraorbital margin is excluded and the faces were presented not in the center but rather in one of four quadrants of the screen, the nose would no longer be the first attended area and regress to the second order. In the current study, the nose was no longer the most attended area but did not also differ from cheeks and jaw in terms of both fixation number and duration. Therefore, hypothesis 5 and 7 were rejected. Mouth finally was found as the least attended area in the current study. Sæther et al., (2009) found in their study with Caucasian faces and Caucasian observers that eyes, nose, and cheeks were not significantly different and the most frequently fixated area during a sex categorization task. The same study found that nose was the most attended area in terms of dwell time. In this study, nose area was defined with infraorbital margin, which is an important area in face processing. It was shown by both Sæther et al. (2009) (in sex categorization task) and Peterson and Eckstein (2012) (determining identity, sex and emotional state) that infraorbital margin (just below the eyes) are the most attended area in many face perception tasks and is thought to play an important role in holistic face perception. The current study aimed to show the most informative areas in the face during sex categorization, and because the infraorbital margin is not sexually dimorphic (Sæther et al., 2010), this area was not defined in the nose region. As a result, we found that the most attended area by observers was the eye region. Pearson et al. (2003) found similarly that observers attended mostly eye area during a sex categorization task. Schyns et al. (2002) also showed that showing only the eye region is enough for observers to indicate the sex of the face.

The fixation pattern in Caucasian faces were similar in Asian and chimpanzee faces as well. In all categories the most attended areas were the eye, followed by nose, cheeks and jaw and these were not different and least attended was the mouth. This indicates that observers use similar gaze strategy in order to categorize the sex of the face regardless of face's race or species. Kelly et.al. (2010) found that observers did not change their fixation pattern when recognizing the sheep faces. Researchers suggest that when we encounter a new stimulus, we tend to maintain our usual gaze strategy to process the stimuli. The current study, on the other hand, revealed some differences along with similarities. The eye was the most attended area in all categories. However, eye region was more attended in human (Caucasian and Asian) compared to chimpanzee faces. On the other hand, nose was more attended in chimpanzee compared to human faces. These results were consistent with both fixation number and fixation duration measurements. Human faces might receive more fixations in the eye region due to its importance in human interaction (Senju & Johnson, 2009).

Caucasian and Asian faces showed a difference only in fixation number in the nose area, and other contrasts were not significant. According to that, Asian nose received more frequent fixations even though the fixation duration did not differ. Brielmann et al. (2014) found similar results with a race categorization task in Caucasian observers. In their study, they also showed that observers make more frequent fixations to nose in Asian face compared to Caucasian face (Blais et al., 2008; Fu et al., 2012). They also showed that the eye is the most fixated area regardless of the face's race. The only difference in their finding was that in their study Caucasian eye region was more fixated than Asian eye region. Goldinger et al. (2009) also found that observers attend more at the eye of own-race faces, while they attend more at the nose of the other-race faces in face recognition task. This interaction effect for eyes and nose in other-race faces was not observed in the current study and might be depending on the task. In sex categorization task, observers might focus on the determining the sex of the face and search information in the eye region of Asian faces as well as Caucasian faces.

First fixation analysis revealed that the most first fixated area in Caucasian faces was the eye. Hsiao and Cottrell (2009) found that the initial fixation was the nose region during a face identification task. They interpreted this results, as the nose was an important area because it is at the center of the face and an advantageous area to gather a large amount of information from the face. Sæther et.al.(2009) have also found that the nose was the first and eye was the second most fixated area in sex categorization task. However, as mentioned before, nose gathered the first fixations because the nose includes infraorbital margin in their study. When we excluded the infraorbital margin, eye ended up being the most frequently first fixated area. Brielman et.al. (2014) found similarly the eye region as the first fixation area in both Caucasian and Asian faces. In this study, while Caucasians received more first fixations in the eye region than Asian faces, the current study has not found such an effect. This difference might be due to that in their study participants categorize the race of the faces. In chimpanzees; eye, nose, and cheeks were not significantly different and the most frequently fixated areas, indicating that because chimpanzee is unusual stimuli for observers, they did not have any first fixation strategy.

Overall, regarding the research question 4 and 5, observers exhibit a similar strategy across all categories. The eye was dominantly most fixated in Caucasian, Asian and chimpanzee faces. Moreover, nose, cheeks, and jaw were not significantly different and were second most attended areas. The mouth also found to be the less attended area in all categories. Even though the general fixation pattern was similar, observers tend to attend more at the nose region of other-race and other-species faces compared to own-race faces. On the other hand, they tend to attend more at the eye region of own-race compared to other-species faces.

CHAPTER 4

GENERAL DISCUSSION AND SUMMARY

Scientific evidence strongly suggests that face perception is observed (for a detailed review see Leopold & Rhodes, 2010) and works similarly in most of animals. For example, most of the animals use their face perception ability to detect threat, mate selection, or use it in a social context. Even in its simplest forms (e.g. face perception works as attending a pair of eyes or moving circles in snake) (Herzog, 1994), it serves the same purposes which are survival and mate selection. Therefore, it is suggested as a common mechanism in vertebrates and even in some invertebrates and takes its final form in modern humans during the evolutionary history.

In the current study, it was investigated whether or not human adults can categorize the sex of other-race and other-species faces. We particularly interested in sex categorization task because face identification is rather a complex system (Young & Burton, 2018). There is a strong evidence that humans are not successful even in own-race faces in certain conditions (i.e. when the presented face is unfamiliar to them) (Bruce et al., 1999; Jenkins et al., 2011; Burton et al., 2010). The sex categorization, on the other hand, is an extremely fast and easy task that humans even perform with unfamiliar faces. Moreover, it is a crucial aspect of face processing for survival and mate selection.

In order to understand whether or not human adults can categorize own-race (Caucasian), other-race (Asian) and other-species (chimpanzee) faces, we developed a sex categorization task. Observers could successfully categorize the faces in all categories in the first experiment, indicating the sex categorization is an ability that humans might expand to other-race and other-species faces as well. This is the first study that reveals that humans can expand their sex categorization ability to chimpanzee faces. With a previous study with macaque faces (Franklin et al., 2013), it suggests that sex categorization might be an ability of humans that can be expanded to other-species unlike face recognition. In humans, categorizing the sex of other-race and other-species faces might be a result of extreme sensitivity to the sexual dimorphism. Sexual dimorphism and symmetry of the face were found to be related in both humans (European and Hadza) and macaque faces before (Little et al. 2007), indicating that sexually dimorphic features might signal symmetry and implicitly the gene quality in primates. Detecting the gene quality is crucial for humans in terms of reproduction. This advantage might lead humans to show extreme sensitivity to sexual dimorphism and elicit high performance in other-race and other-species faces in sex categorization task.

Franklin et al. (2013) have found similarly that humans can successfully categorize the sex of macaque faces. Even though observers' accuracy rate is higher than chance level, it was still not as high as own-species faces. The same was valid for other-race faces. Their accuracy rate was lower than own-race faces. The reaction time of observers was also consistent with accuracy measurement, indicating a strong *other-race* and *other-species effect* in Turkish sample in sex categorization task. The other-race effect was also observed in sex categorization with Caucasian and East Asian participants by O'Toole et al. (1996). However, Zhao and Bentin' (2008) could not replicate the other-race effect in their study with Chinese and Israeli participants. Task difficulty might be the reason for the emergence of other-race effect, especially in reaction time measurement. Because in both O'Toole et al. (1995)'s and in the current study, a time restriction was applied for observers when presenting the stimuli, the other-race effect might be more evident compared to Zhao and Bentin's study (2008) in which observers had no time restriction to respond. Furthermore, the sexual dimorphic pattern of different race's face might also be effective on performance. Because in the same study both Chinese and Israeli participants were more accurate in categorizing the sex of Caucasian faces.

In order to understand how does the sexually dimorphic pattern on faces relates to the participants' response, a facial metric analysis was performed after the first experiment. Some facial metrics that were successfully used in sexual dimorphism studies were measured and analyzed to reveal whether or not some specific measurement on faces related to the observers' response. Results of this analysis showed that eye height, eye width, brow to eye distance in human faces and eye height in chimpanzee faces had the strongest correlation with participants' response. Furthermore, eye (eye height, eye width, brow to eye distance) and nose measurements were the common distances that correlated the participants' response in all face categories. Eye and nose are the sexually dimorphic areas in the Caucasian face. However, neither Asian face nor chimpanzee face was showed to be sexually dimorphic on these measurements. This indicates that observers use the same cues of own-race face sexual dimorphism with other-race and other-species faces regardless of these faces' sexual dimorphic pattern in order to indicate the face's sex.

By using an eye-tracking system, we aimed to show the gaze pattern of human adults in own- and other-race and other-species faces during sex categorization. Gaze behavior in Caucasian as an own-race face had been studied several times before. Most of the studies found that eye and nose were dominantly attended during sex categorization. Sæther et.al. (2009) found that infraorbital margin – a part of the nose adjacent to the eye attended mostly by observers. Peterson and Eckstein (2012) also found this region to be attended by observers in several face perception tasks including sex categorization. This region was arguably thought to be an area that allows participants to easily process the whole face (Sæther et.al., 2009). In the current study, it was excluded from the analysis because it is not a sexually dimorphic area. We furthermore, intentionally presented the faces in one of four quadrants of the screen rather than at the center in order to prevent the first fixation occurred in the center of the face which corresponds to the nose area. Consequently, eye region was the most attended area in all measurements, the nose became the second most attended area and did not differ from the cheeks and jaw. With the current study findings, it was showed that in own-race faces the eye is the most attended area by observers to gather information about face's sex. This finding is consistent with several studies in the literature (Pearson et al., 2003; Schyns et al., 2002) and also with the facial metric findings of the first experiment.

Most of the fixations gathered in the eye region in Caucasian faces. In Asian and chimpanzee faces, eyes were similarly attended more than other regions, but less dominantly compared to Caucasian faces. It can be seen clearly from heat map (Figure 43) and focus map (Figure 42) that fixations are gathered in the eye region dominantly for Caucasian faces. For the Asian faces, the pattern is a lot similar to a little spread to the nose area. In chimpanzee faces finally, it can be observed that the fixation pattern is distributed to the entire face. Eyes are sexually dimorphic and give enough information to indicate the faces' sex in Caucasian faces (Schyns et al., 2002) Therefore, observers probably did not need to switch their fixation to other areas in the face. On the other hand, the information from the eyes was not enough for Asian faces and lead observers to change their gaze to the nose area. Attending the nose area in other-race faces have documented before (Brielmann et al., 2014; Goldinger et al.,2009). In chimpanzee faces, on the other hand, observers look for a cue to categorize the sex as male or female and because they had probably no experience on this task before, they distributed their gaze on the entire face. Wheeler et al. (2011) showed that from 6-10 month infants showed the similar pattern with adults when presented with own-race and other-race faces. They revealed that infants tend to look more at the nose region of other-race faces. They further found that this effect was increased with age. With the findings of this study, the current study indicates that humans process all faces in a similar way when they were born and with experience with own-race faces, these faces are processed at the individual level, while other-race faces processing stayed in a category-based level. This processing difference gets even larger with other-species faces regarding the fact that observers almost no experience with these faces.

4.1. Limitations

In the current study, there were only 8 photographs of chimpanzee faces available. This is a small number to evaluate the sex categorization performance of observers efficiently. This was because there were no specific chimpanzee face database available to us. Moreover, the Experiment 1 and 2 were conducted in different experimental setups due to the nature of experiments. In the second experiment, the researcher had to stabilize the participants head with a chin rest. Consequently, participants performed the task is probably a more uncomfortable position in the eye-tracking study compared to the first study. This might affect their performance especially in reaction time measurements and might be a partial explanation for the inconsistent results for the first study and behavioral part of the eye-tracking study on reaction time measurements.

Last but not least, other-race and other-species effect should be studied cross-culturally to gather more comprehensive evidence. Previous cross-cultural studies, for example, revealed that Asians are better at categorizing the sex of macaque faces than Caucasian participants (Franklin et al., 2013). Gaze behavior, on the other hand, had shown to be different among East Asian and Caucasian participants (Miyamoto et.al., 2006; Masuda & Nisbett, 2001; Norenzayan et al., 2002). Therefore, both behavioral and eye-tracking experiments of the current study can be more efficient with cross-cultural replications.

4.2. Conclusions

This study showed that Caucasian adults can categorize the sex of Asian and chimpanzee faces at higher than chance level with a strong *other-race* and *other-species* effect. Categorizing the sex of other-race and other-species faces might be a result of the extreme sensitivity of humans to sexual dimorphism and symmetry (Little et al., 2008) and might explain the high performance of human adults on this task. Therefore, sex categorization can give a lot of information about the face perception and its progress during the evolutionary history. Studying this task with own-race and other-race faces in future studies would give some insights into what extents humans are sensitive to sexual dimorphism and have some implication to understand the importance of faces in mate selection.

Furthermore, the eye was found as consistently the most informative area in both facial metric and eye-tracking analysis in all face categories. Even though the general fixation pattern was similar between face categories, the eye was more dominantly attended in humans compared to chimpanzees and in Caucasian compared to Asians, suggesting own-race and own-species faces tend to attract the gaze of observers more at the eye region, whereas other-race and other-species at the nose. Consistent with previous literature, in the context of perceptual narrowing, we suggest that more experienced faces (own-race, own-species) were processed at a more individual level by attending the eyes whereas less experienced faces (other-race and other-species) were processed in a category-based level by attending the nose.

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APPENDIX A

Katılımcı Bilgilendirme ve Onam Formu

Bu araştırmanın amacı kişilerin insan ve hayvan yüzlerine yönelik cinsiyet algılarını incelemektir. Çalışma boyunca bir bilgisayar ekranına gelen insan ve hayvan yüzlerinin cinsiyetlerini belirlemeniz ve bir klavye aracılığı ile tepki vermeniz gerekmektedir. Deney yaklaşık olarak 15 dakika sürecektir. Lütfen çalışma boyunca araştırmacının verdiği yönergeleri dikkatle takip edin ve anlamadığınız kısımları sorun.

Katılacağınız çalışma Türk Psikologlar Derneği Etik Yönergesine uygun biçimde kurgulanmıştır. Çalışma kapsamında elde edilen veriler, isim kullanılmaksızın analizlere dahil edilecektir.

Çalışmaya katılımınız tamamen kendi istediğinize bağlıdır. Katılımı reddetme ya da çalışma sürecinde herhangi bir zaman diliminde çalışmayı bir neden belirtmeksizin terk etme hakkına sahipsiniz.

Araştırmacının iletişim bilgileri:

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Çalışmanın amacını ve içeriğini ………………………….. katılımcı numarasına sahip katılımcıya açıklamış bulunmaktayım. Çalışma kapsamında yapılacak işlemler hakkında katılımcının herhangi bir sorusu olup olmadığını sordum ve katılımcı tarafından yöneltilen tüm soruları yanıtladım.

Tarih: Araştırmacının İmzası:

…. / …. / ……. ………………………….

Çalışmanın amacı ve içeriği hakkında açıklamaların yer aldığı “ Katılımcı Bilgilendirme Formu” nu okudum. Araştırmacı çalışma kapsamındaki haklarımı ve sorumluluklarımı açıkladı ve kendisine yönelttiğim bütün soruları açık bir şekilde yanıtladı. Sonuç olarak, uygulama esnasında şahsımdan toplanan verinin bilimsel amaçlarla kullanılmasına izin verdiğimi ve çalışmaya gönüllü olarak katıldığımı beyan ederim.

Tarih: Katılımcının İmzası

…. / …. / ……. ………………………………

APPENDIX B

KATILIMCI BİLGİ FORMU

Ad-Soyad:…………………………………….

Cinsiyet:……………………………………….

Yaş:…………………………………………….

İletişim Bilgileri:

e-mail:………………………………………….

Telefon:……………………………………………

1. Herhangi bir ciddi görme bozukluğunuz var mı ?
    - Evet
    - Hayır
2. Daha önce psikiyatrik bir rahatsızlık tanısı aldınız mı ?
    - Evet
    - Hayır

Eğer yanıtınız evet ise lütfen konulan tanıyı belirtiniz……………………………..

3. Herhangi bir ilaç kullanıyor musunuz ?
    - Evet
    - Hayır
    - Evet
    - Hayır

Eğer yanıtınız evet ise lütfen konulan tanıyı belirtiniz……………………………..

APPENDIX C

Edinburg El Tercihi Envanteri					
	Her zaman sol	Genelde sol	Tercihim yok	Genelde sağ	Her zaman sağ
Yazma					
Fırlatma					
Makas					
Diş fırçası					
Bıçak					
Kaşık					
Kibrit					
Mouse					

APPENDIX D

Katılımcı Bilgilendirme ve Onam Formu

Bu araştırmanın amacı kişilerin insan ve hayvan yüzlerine yönelik cinsiyet algılarını bir göz-takip cihazı ile incelemektir. Çalışma sırasında başınız bir çene sabitleyicisi yardımıyla sabitlenecektir. Bu sabitleme sırasında kafanızı kesinlikle hareket ettirmemeniz gerekmektedir. Öncelikle gözleriniz cihaza göre ayarlanacak, ayarlama süreci bittikten sonra ise bir bilgisayar ekranına gelen insan ve hayvan yüzlerinin cinsiyetlerini belirlemeniz ve bir klavye aracılığı ile tepki vermeniz gerecektir. Bu sırada göz hareketleriniz kaydedileceği için gözünüzü ekrandan ayırmamanız gerekmektedir. Deney yaklaşık olarak 20 dakika sürecektir. Lütfen çalışma boyunca araştırmacının verdiği yönergeleri dikkatle takip edin ve anlamadığınız kısımları sorun.

Katılacağınız çalışma Türk Psikologlar Derneği Etik Yönergesine uygun biçimde kurgulanmıştır. Çalışma kapsamında elde edilen veriler, isim kullanılmaksızın analizlere dahil edilecektir. Çalışmaya katılımınız tamamen kendi istediğinize bağlıdır. Katılımı reddetme ya da çalışma sürecinde herhangi bir zaman diliminde çalışmayı bir neden belirtmeksizin terk etme hakkına sahipsiniz.

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Çalışmanın amacını ve içeriğini ………………………….. katılımcı numarasına sahip katılımcıya açıklamış bulunmaktayım. Çalışma kapsamında yapılacak işlemler hakkında katılımcının herhangi bir sorusu olup olmadığını sordum ve katılımcı tarafından yöneltilen tüm soruları yanıtladım.

Tarih:	Araştırmacının İmzası:
…. / …. / …….	………………………….

Çalışmanın amacı ve içeriği hakkında açıklamaların yer aldığı " Katılımcı Bilgilendirme Formu" nu okudum. Araştırmacı çalışma kapsamındaki haklarımı ve sorumluluklarımı açıkladı ve kendisine yönelttiğim bütün soruları açık bir şekilde yanıtladı. Sonuç olarak, uygulama esnasında şahsımdan toplanan verinin bilimsel amaçlarla kullanılmasına izin verdiğimi ve çalışmaya gönüllü olarak katıldığımı beyan ederim.

Tarih:	Katılımcının İmzası
…. / …. / …….	………………………………

APPENDIX E

KATILIMCI BİLGİ FORMU

Ad-Soyad:…………………… Cinsiyet:…………………

Yaş:…

İletişim Bilgileri:

e-mail:…………………………………………….

Telefon:……………………………………………

1. Herhangi bir ciddi görme bozukluğunuz var mı ?

   ○ Evet
   ○ Hayır

2. Dereceli gözlük ya da dereceli kontakt lens kullanıyor musunuz ?

   ○ Evet
   ○ Hayır

3. Daha önce psikiyatrik bir rahatsızlık tanısı aldınız mı ?

   ○ Evet
   ○ Hayır

Eğer yanıtınız evet ise lütfen konulan tanıyı belirtiniz……………………………..

4. Daha önce nörolojik bir rahatsızlık tanısı aldınız mı ?

   ○ Evet
   ○ Hayır

Eğer yanıtınız evet ise lütfen konulan tanıyı belirtiniz ..……………………

5. Herhangi bir ilaç kullanıyor musunuz ?

   ○ Evet
   ○ Hayır

Eğer yanıtınız evet ise lütfen ilacın adını belirtiniz ..………………………….