Clarifying the Role of Attention on Own Gender Bias in Face Recognition

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Author's Declaration

This thesis is the result of the author's original research. It has been composed by the author and has not been previously submitted for examination which has led to the award of a degree.

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Abstract

Extensive research in face recognition has demonstrated that we are better at remembering individuals belonging to our own social groups than those who do not. There is a tendency to remember better faces which belong to our own race (Own Race Bias, Meissner and Brigham, 2001), our own age (Own Age Bias, Anastasi & Rhodes, 2012) and even our own gender (Own Gender Bias, Herlitz & Loven, 2013). The present thesis aimed to examine possible underlying mechanisms concerning Own Gender Bias. While research on this topic is fairly limited, in general female observers compared to male observers demonstrate an advantage in face recognition. Further, this advantage is more prominent for female faces than for male faces. This tendency to better recognise same gender faces is only consistent for female observers (Herlitz & Loven, 2013). Recent studies on Own Gender Bias emphasise the role of attention; however two studies (Loven, Herlitz, & Rehnman, 2011; Palmer, Brewer, & Horry, 2013) which have directly investigated its role provide inconsistent results. The role of attention has been further highlighted by Hugenberg and colleagues (Hugenberg, Wilson, See, & Young, 2013), in their recent extension of Categorisation-Individuation Model (CIM), where they aim to apply the model to all Own Group Biases. Hugenberg and colleagues also emphasised the role of motivation, especially for Own Gender Bias, since the perceptual models might be less applicable to Own Gender Bias considering that at their core lays the amount of experience that one has with a category of faces.

By drawing on the plethora of research on Own Race Bias and the recent findings from Own Gender Bias literature, the main aim of this thesis was to examine specific attentional and motivational processes which may underlie Own Gender Bias in face recognition. Studies 1a and 1b investigated the ability of same gender faces in capturing attention when they were task irrelevant. The results did not reveal any gender differences however an initial preferential allocation of attention to the male face was demonstrated (in manual reaction times as well as eye movement analysis), a finding which was interpreted in terms of male faces being perceived as more threatening. It was argued that participant gender might be more important in later stages of attention rather than in the pre-attentional stages of attention. Hence,

in study 2a and 2b sustained attention was examined in a go/no-go task, where the face was also task irrelevant. Based on previous findings (Bindemann, Burton, Hooge, Jenkins, & De Haan, 2005), it was assumed that faces would sustain attention compared to other objects, however this finding as well as any indication of gender differences or a possibility of same gender faces holding attention were not found. Therefore, Study 3 used eye tracking technology to examine the role of attention during encoding and recognition stages while participants performed a simple yes/no recognition task. Study 3 aimed to control for perceptual expertise by utilising androgynous faces (gender ambiguous faces) in a between groups design, where for each group, the gender social category of the androgynous faces was activated. Results suggested that female observers outperformed male performers, with no indication of Own Gender Bias being present. The eye movement analysis seemed to suggest that male and female observers differed from each other in the amount of attention that they paid to the eyebrow and the nose regions of the face. It was only the amount of attention paid to the eyebrow region which was found to result in low accuracy scores; no other pattern for the other internal features was found. Considering the absence of the Own Gender Bias, and findings that participants' sexual orientation seems to modulate the male Own Gender Bias (Steffens et al., 2013), Study 4 used a simple yes/no recognition task without manipulating the face stimuli to examine the basic effect of Own Gender Bias. Furthermore, Study 4 took a social cognitive perspective with an evolutionary viewpoint, where partner guarding and mating purposes variables were hypothesized to act as motivation. It was argued that if Own Gender Bias is subsumed by motivation (as suggested by CIM) then females who routinely inspect other females for mate guarding purposes would display a stronger female Own Gender Bias. However an opposite sex Gender Bias was expected for those who were sexually unrestricted and were always searching for new short-term partners. The results revealed no Own Gender Bias, even on groups who scored high on mate guarding and searching. It was speculated that since females' behaviour especially in relation to mate guarding and mate preferences changes throughout the menstrual cycle, it might be a variable that might need to be taken into consideration in future studies on Own Gender Bias. It was concluded that further studies are needed to establish the consistency of Own Gender Bias, furthermore the results were discussed in terms of the different theories of own group bias.

Chapter 1 – Review of the literature

1.1 Importance of Faces. Are we Face experts?

The role of the human face in social interactions is fundamental. Its importance is evident in the case of those with autism, where communication and social interaction is impaired (Hefter, Manoach, & Barton, 2005). Furthermore, face memory is crucial in eye-witness identification, as well as identifying friends and enemies. Only a quick glance is needed to establish the gender, age, race as well as their facial expression, despite the visual similarity of these stimuli (Ito & Urland, 2005). It is held that this tendency to automatically encode categorical information might be the underlying mechanism in social perception (Macrae & Bodenhausen, 2000). Furthermore, it has been suggested that faces are a special type of perceptual stimulus and humans are equipped with the appropriate mechanisms that facilitate effortless and accurate recognition, such that a face specialized area of the brain, Fusiform Face Area (FFA) (Kanwisher, McDermott, & Chun, 1997), responds both strongly (Sergent, Ohta, Macdonald, & Zuck, 1994) and selectively (McCarthy, Puce, Gore, & Allison, 1997) to faces. In addition, the Occipital Face Area (OFA) has also shown face specific activation (Kanwisher & Yovel, 2006).

Case studies of individuals with acquired damage to specific areas of the brain suggest that it might be possible to distinguish between the processing of faces and objects at the neural level. Some patients have been found to have relatively intact facial recognition skills, but impaired recognition of objects (Farah, 1991; McMullen, Fisk, Phillips, & Maloney, 2000). Other patients have shown a specific face processing impairment (Farah, 1991; Riddoch, Johnston, Bracewell, Boutsen, & Humphreys, 2008). This has been termed prosopagnosia (face-blindness) and is associated with damage to a specific area in the bilateral occipito-temporal region, the fusiform gyrus (Delvenne, Braithwaite, Riddoch, & Humphreys, 2002; Rossion et al., 2003). This double dissociation has been interpreted as evidence that faces are processed differently from other objects, utilizing specific areas of the brain (Haxby, Hoffman, & Gobbini, 2000). However, prosopagnosia may not be specific to face stimuli, as the process itself of distinguishing between objects which are visually highly similar might be responsible for the activity in the fusiform face area (Farah, 1991, 1996). Farah (1991) highlighted that in order to process faces successfully, one needs to encode them holistically/configurally[1], and it is this process that is impaired in prosopagnosia.

The same areas of the brain which are damaged in prosopagnosia have been shown in functional imaging studies to display increased activation to facial stimuli in comparison to non-face objects. These areas include the lateral fusiform gyrus, Fusiform Face Area (FFA) (Henson et al., 2003), and the Occipital Face Area (OFA) (Kanwisher & Yovel, 2006). Even though these observations suggest that these areas are clearly related to face processing, it has been argued that the increased activation in these areas might be due to expertise in discriminating between objects which are highly similar. Generally, expertise with faces is greater than expertise with any other objects. However, according to the expertise hypothesis (Carey, De Schonen, & Ellis, 1992; Diamond & Carey, 1986; Gauthier, Skudlarski, Gore, & Anderson, 2000; Gauthier & Tarr, 1997; Tarr & Gauthier, 2000) this expertise could also be developed with other stimuli too, as long as one’s experience with that class of stimuli is extensive. This has been demonstrated in several studies by Gauthier and colleagues, who trained participants to become experts in discriminating new objects with face-like properties (Greebles). Greeble experts displayed increased activation to the FFA compared to novices (Gauthier et al., 2000; Tarr & Gauthier, 2000). Similar results have also been shown with bird and car experts (Gauthier, Skudlarski, Gore & Anderson, 2000). In contrast, recent evidence from Rezlescu, Barton, Pitcher, and Duchaine (2014) suggests that acquiring expertise with Greebles is independent of face recognition abilities, as demonstrated by the two prosopagnosics, who displayed normal Greeble learning despite their impairment in face recognition.

[1] Holistic processing has been defined as the “gluing” together of the facial features, where the face is perceived as a whole and information about individual features is less accessible. During configural processing the spatial relations between the individual facial are encoded in contrast to the more featural processes which rely heavily on information about the isolated facial features (Mondloch, Le Grand & Maurer, 2002).

In general, behavioural evidence maintains that faces are processed differently from objects. Evidence for this originates from Yin's (1969) influential studies on the effects of inversion on the ability to process stimuli. The inversion had a disproportionally detrimental effect in the recognition of faces compared to other visual stimuli; a finding replicated numerous times (Carey, Diamond, & Woods, 1980; Collishaw & Hole, 2000; Leder & Bruce, 2000; Tanaka & Farah, 1993). Even though this finding might seem robust, it has been suggested that the inversion effect might merely be a reflection of the high level of expertise that one has with face stimuli compared to other stimuli (Diamond & Carey, 1986). A similar effect to the inversion effect was found when participants had extensive experience with dogs. Dog experts showed a detrimental recognition for dogs, when their pictures were inverted, in comparison with novices. Similarly, Greeble experts showed impairment after training on the inversion task, although no impairment was demonstrated on accuracy, only on reaction times (Rossion et al., 2003). In fact, a few studies have not been able to replicate the inversion effect with car experts (Xu, Liu, & Kanwisher, 2005), bird (Gauthier et al., 2000) or Labrador experts (Robbins & McKone, 2007), however one key drawback with this line of research is that the level of expertise might not been as high as the level of expertise that one has with face stimuli. Furthermore, it has been argued by Robbins & McKone (2007) that even though the effect of inversion might be present in experts with other objects, it is considerably smaller compared with the detrimental effect that inversion has on face stimuli. The debate is still on-going, and the research is too vast to be further reviewed here. The present thesis is only concerned with face stimuli. In particular, it is the main goal of this thesis to examine the mechanisms underlying the preference for recognizing own gender faces.

1.2 Biases in Face Recognition

As discussed in the previous section, it is clear that there is something special about faces, whether it is the level of high expertise that we have with them or whether specific areas of the brain are face specific: either way faces seem to be favoured when compared to objects; this has been found to be the case with faces capturing (Langton, Law, Burton, & Schweinberger, 2008) and holding attention (Bindemann, Burton, Hooge, Jenkins, & de Haan, 2005) as well as being better remembered than objects (attentional capturing and holding will be discussed in more depth in Chapters 2 and 3). Even though faces might show an advantage compared to other stimuli, the ability to memorize faces is influenced by a host of factors, including attractiveness (Mueller, Heesacker, & Ross, 1984), likeability (Becker, Kenrick, Guerin, & Maner, 2005), and uniqueness (Going & Read, 1974).

Extensive research in face recognition has demonstrated that we are better at remembering individuals belonging to our own social groups than those who do not. There is a tendency to remember better faces which belong to our own race (Own Race Bias, (Meissner & Brigham, 2001), own age (Fulton & Bartlett, 1991; Rhodes & Anastasi, 2012) and even our own gender (Own Gender Bias, (Wright & Sladden, 2003; Herlitz & Lovén, 2013). Furthermore, numerous recent studies (Bernstein, Young, & Hugenberg, 2007; Hehman, Mania, & Gaertner, 2010; Hugenberg & Corneille, 2009; MacLin & Malpass, 2001) have suggested an in-group recognition bias for faces which appear perceptually ambiguous. A wide range of studies has been tackling these biases for a long period of time; however the underlying mechanisms are still unclear. By drawing on the plethora of research on Own Race Bias and the limited literature on Own Gender Bias, the present thesis aims to examine the underlying mechanism concerning Own Gender Bias.

1.3 What can decades of research in Own Race Bias tell us?

In order to try and establish the possible reasons underlying Own Gender Bias, it might be fruitful to consider other Own Group Biases that appear in the face recognition literature, such as the extensively studied and well-established Own Race Bias (or Cross Race Effect; for reviews see Brigham, Bennett, Meissner, & Mitchell, 2007; Meissner & Brigham, 2001; Sporer, 2001). Own Race Bias is a central research area within the bias literature; thus it would be appropriate to review this literature as it may also be applicable to Own Gender Bias. Gender, like race is a social category, which is frequently utilized for guiding the processing of the target or for evaluative purposes regarding the target (Macrae & Bodenhausen, 2000). In fact, Hugenberg, Wilson, See, and Young (2013) extended their previous model of Own Race Bias into an inclusive model where all face recognition biases are grouped together. They argue that it serves as a starting point in considering all the Own Group Biases as one. Hence, it might be expected that the mechanisms underlying one of these biases should underlie all mnemonic biases irrespective of content. It should be noted at this point that the authors suggest that Own Gender Bias might be less reliant on perceptual expertise considering the extensive experience acquired with male and female faces on a daily basis. It should also be noted that this is just a suggestion which is not based on any particular evidence (this is a point which will be discussed in more depth on Chapter 4 – which controls for perceptual expertise in order to examine whether gender social categorisation alters the perceptual information that is used at encoding).

As mentioned previously, Own Race Bias is the observers' tendency to be more accurate in perceiving and recognizing differences amongst faces from their own race than those from another race. Usually, the Own Race bias is demonstrated using face recognition tasks, such as the old/new (yes/no) recognition memory task. Observers are shown a set of faces of both own race and other race, later on (normally after taking part in a distraction/unrelated task) they are presented with a second set of faces, which comprises of the old faces, intermixed with new ones. The usual finding is that observers are better at distinguishing the old faces from the new ones if these faces belong to their own race group (e.g. Furl, Phillips, & O'Toole, 2002; Valentine & Endo, 1992).

A number of theoretical hypothesis attempting to account for this effect have been postulated. Research thus far has failed to provide consistent evidence for one account over another. Nevertheless, these accounts can be broadly categorised into two main strands: one strand concentrates on the perceptual and different levels of expertise which observers have with own race versus other race faces; and the other strand emphasises the role of attention and motivational factors, which contribute to Own Race Bias. More specifically this strand suggests that more attention is paid to members of our own group, while the members of the other groups seem to be disregarded and are processed categorically.

1.4 Perceptual Models

Three different types of accounts (the expertise hypothesis, the contact hypothesis, and the multidimensional face space model), emphasising different aspects of processing can be included under the perceptual model umbrella. At the core of the perceptual models lays the amount of experience that one has with faces, same race or other race. The lack of experience with other race faces results in observers processing these faces in a different way to the faces of their own race. This difference in processing and encoding of the faces translates into an impairment in recognizing other race faces (e.g. Rhodes, Tan, Brake, & Taylor, 1989; Sangrigoli & De Schonen, 2004; Tanaka, Kiefer, & Bukach, 2004; Valentine, 2001).

The Expertise Hypothesis

The expertise hypothesis is concerned with the amount of visual expertise one has with face stimuli. As described previously in Section 1.1 the average adult is an expert at processing faces, in comparison with objects, and this superior level of expertise occurs due to the vast experience that s/he has with face stimuli. Based on this logic, the expertise hypothesis argues that continuous exposure to own race faces leads to increased levels of expertise with these faces, hence making one expert at encoding own race faces. Essentially the expertise hypothesis has two main components: (a) that experience with faces of a particular group leads us to become more expert (proficient) at processing that group of faces; (b) experience with a particular group of faces leads us to process those faces in a qualitatively different way from other faces with which we have little experience, i.e. more “configurally”. Configural processing has been argued to be an efficient mechanism as it allows the observer to first perceive the common configuration of faces (first order relations), and secondly, it allows the observer to process the spatial dimensions between the individual features in the faces, as well as processing the face as a whole without dividing the face into individual features (Maurer, Grand, & Mondloch, 2002). Hence, research on adult samples measures participants' performance on tasks which can interfere with our ability to process faces configurally. Three main lines of research have demonstrated that own race faces are processed in a qualitatively different way from other race faces. Using the inversion task, Rhodes et al. (1989) demonstrated a larger inversion effect for own race faces. This is arguably as own race faces are processed more configurally than other race faces, and inverting the faces leads to an impairment in configural processing. This effect was also replicated by Hancock and Rhodes (2008), who found that the face inversion effect and recognition was modulated by inter-racial contact, i.e. increased contact reduced the other race effect, and increased the inversion effect for other race faces. While, these findings are interesting, a few studies have not been able to replicate the effect (Buckhout & Regan, 1988).

The Composite Effect paradigm (Young, Hellawell, & Hay, 1987) is another task that has been used to examine configural processing of own race and other race faces. In this task participants are asked to judge whether the top halves of two faces are identical or different, while the bottom half of the faces can also be either identical or different. Usually the top halves of the faces are perceived as different (i.e. participants are slower to recognise them), when the bottom halves of the faces are two different faces. This is due to the participants perceiving the top half and the bottom half of the face as a whole, which in turn interfered with the participants' ability to detect that the top halves of the face portrayed the same identity. In other words, the novel face overrides the ability to perceive the top half of the face as separate from the bottom half. Michel, Rossion, Han, Chung, and Caldara (2006) employed this paradigm; participants were asked to make same/different judgements to own race and other race faces. The target faces were either aligned or misaligned composites. It was found that recognition of own race faces was impaired to a greater extent when the faces were aligned compared to when they were misaligned; hence showing a greater composite effect for own race than for other race faces. This was interpreted by the authors as evidence supporting the claim that own race faces are perceived more configurally than other race faces.

Another paradigm demonstrating that own race faces are perceived more configurally is the Whole/Part paradigm. The whole/part paradigm was designed to measure the interdependence of the featural and configural information in the faces. In this task participants are asked to learn a series of faces or houses (presented either upright, inverted or scrambled). Afterwards, they are asked to recognize the target parts belonging to the previously presented faces (e.g. a nose) or a house (e.g. a door); this was presented either in isolation or in the context of a face or a house. Parts from upright faces are usually better recognized when presented in a whole face than when presented in isolation. This advantage was not found for houses, scrambed and inverted faces (Tanaka & Farah, 1993; Tanaka & Sengco, 1997). Modifying the whole/part task to minimize memory demands, Tanaka et al. (2004) found better recognition when parts were presented within a face, rather than in isolation. This was found to be the case only for Caucasian participants with own race faces, while, Asian participants demonstrated a whole/part advantage independently of face race. Tanaka and colleagues indicated that this was due to inter-racial experience, as their Asian participant had more contact with Caucasian faces than vice versa.

Evidence addressing the above claims also comes from, developmental studies which has suggested that observers as young as three months display a preference to gaze at own race faces, while no such preference is shown by new-borns (Kelly, Liu, et al., 2007; Kelly et al., 2005; Sangrigoli & De Schonen, 2004). Further, it has been argued that 6 month infants are only able to discriminate between new and old faces when these faces are from their own race (Kelly, Quinn, et al., 2007). Kelly, Quinn, et al. (2007) interpret their findings in terms of perceptual narrowing (Nelson, 2001), implying that these early experiences shape the observer's visual system to become finely "tuned" to only those stimuli with which the observer has more experience. In fact, De Heering, De Liedekerke, Deboni, and Rossion (2010) reported that young observers (6 to 14 years) show a clear Own Race Bias. Furthermore, it has been found that the magnitude of the Own Race Bias increases with age (Chance, Turner, & Goldstein, 1982; Walker & Hewstone, 2006a).

The Contact Hypothesis

The contact hypothesis is closely linked with the expertise hypothesis due to its proposal that people become more expert with faces from their own race due to the extensive contact that they have on a day to day basis, while a lack of experience with other race faces results in lower levels of expertise, giving rise to poorer recognition. This explanation has been supported by a number of studies, which have found a positive relationship between face recognition and the respective amount of experience one has with the other race. Studies have measured contact in several ways; some studies have examined actual contact (self-report as well as training offered as part of the study) while others have recruited participants from parts of the world which are racially homogeneous. Meissner and Brigham (2001) meta-analysis of 29 studies, which used self-report of inter-racial contact, indicated that even though there might be a positive relationship between contact and own-race bias, this finding explained only 2% of the variability in the data, questioning the robustness of self-reported inter-racial contact as a measure, as well as an explanation for Own Race Bias. More powerful association between contact and Own Race Bias has been found with items which assess current friendships (Michel, Caldara, & Rossion, 2006; Slone, Brigham, & Meissner, 2000) and other meaningful individuating contact (Walker & Hewstone, 2006b; Walker, Silvert, Hewstone, & Nobre, 2007). However, many studies have not found a significant relationship between contact and accuracy (Corenblum & Meissner, 2006; Walker & Hewstone, 2006a). Self-report contact measures may be problematic as we are susceptible to biases (either overestimating or underestimating the amount of contact). The quality rather than the quantity of the contact with other race faces, such as how much attention is paid to them, and the motivating factors behind the contact might be a more important factor. In fact, Walker and Hewstone (2006a) emphasised that mere contact with other race faces is unlikely to improve expertise, but rather effortful encoding of other race faces might be required. To avoid the potential problems with self-report measures, some studies have grouped participants into groups of high and low contact. For example, in line with the contact hypothesis Li, Dunning, and Malpass (1998) found that white participants who frequently watched NBA basketball (majority of players are black) were less likely to show the Own Race Bias than those who were novices. Even though it might not seem obvious, these results are also in line with the above claims regarding quality of contact, even though these fans have frequent contact (exposure), in order to follow one must be able to discriminate between the different players, hence close attention must be paid.

Chiroro and Valentine (1995) examined the contact hypothesis as an explanation for Own Race Bias by recruiting participants with varying inter-racial contact (high and low contact black and white participants in Zimbabwe). Those in the high contact group had daily contact with other race faces (multi-racial college), as well as greater opportunities to interact. In contrast, those in the low contact group, had no contact with other races (participants were from small villages from Zimbabwe and England, where contact with races in the community is rare, even though in England it is likely that there might have been exposure to other race faces via media). Results showed that both low contact groups displayed a clear Own Race Bias. However, so did the white participants in the high contact group. This did not appear to be the case for the black participants in the high contact group. While, the results of low contact groups and the results of black high contact group support the contact hypothesis, the quality of the contact is emphasised by the white high contact group. Even though the white high contact group had daily contact with other race faces, this mere daily contact did not improve their recognition of other race faces. Considering the country's history, where racial segregation was practiced under white minority ruling, it might be possible that the motivations for interacting with the other race might be different. It is possible that the white high groups are not attending to the other race faces to the level that allows one to be experienced enough to apply configural processing.

Similar results providing further evidence for importance of the quality of the relationship with other race faces comes from Wright, Boyd, and Tredoux (2003), who also examined groups of varying levels of inter-racial contact. Strong support is further provided by Tanaka and Pierce (2009) , who trained participants to either identify or categorise other race faces by race. Participants who were trained in the identification task performed better than those in the categorization task, despite being exposed to the faces the same amount of time. Some of these findings seem to provide strong evidence supporting the importance of quality of the relationship with other race faces, furthermore findings from these studies suggest that training individuals to discriminate between other race faces reduces the Own Race Bias effect (i.e. Meissner & Brigham, 2001).

Support for the contact hypothesis does not seem to be consistent, and mainly results from self-report measures. Results from studies comparing high contact and low contact groups provide more supportive evidence and seem to be more consistent. Even though they seem to provide evidence emphasising the importance of the quality of the relationship with other race faces, they do not explicitly refer to any of the processes that might underlie Own Race Bias.

Multidimensional Face Space Model

The underlying principle of the Multidimensional Face Space Model (Valentine, 1991; Valentine & Endo, 1992) is perceptual expertise. In contrast with the expertise hypothesis this model does not advocate differential processing; it proposes that all faces are encoded in the same way; however experience modulates the effectiveness with which this is carried out. Hence, all faces are represented as unique points within the multidimensional face space, where the dimensions consist of different facial characterises such as nose length, mouth length etc. These are usually the facial characteristics that differentiate one face from another face. The centre of the face space is usually where most of the faces lie, due to the fact that most faces are typical, whereas atypical or distinctive faces are located sparsely around the edges, surrounded by a few neighbour faces. The model suggests that the faces which are clustered together are generally harder to distinguish, due to similarity of facial characteristics. While, distinctive faces are easier to distinguish as they stand out from the crowd, and they are indeed far away in face space from the typical faces, and they have fewer neighbours around them, hence making them easily distinguishable. These properties of distinctive faces promote recognition speed and accuracy. Other race faces in face space are considered to be highly distinctive, hence as some research has suggested they are categorised quicker than own race faces (Valentine, 1991; Valentine & Endo, 1992). The multidimensional face space model also suggests that through experience one becomes more proficient in utilising the correct dimensions which differentiate one face from another, and these are usually the own race faces. However, if these same dimensions are used with other race faces, they will not be effective. Hence, the lack of experience with other race faces, results in the wrong dimensions being used, resulting in ineffective encoding.

Originally, two versions of multidimensional face space model were proposed: the norm-based model and the exemplar-based model. In the norm-based model, there is an average, norm face, which is the product of all the faces that one has encountered in their life time. Every new face that an observer sees is denoted in the face space model in terms of how much it deviates from this average a face (which is the origin of the face space model). The distance and direction from the average/norm face is encoded as a "vector". In contrast, in the exemplar-based model there is no average face, in fact each face is represented in the face space as a single point. The distribution of the faces in both models is similar, dense in the middle and sparse at the edges of the face space; however this arises for different reasons. In the norm-based model, the faces are more clustered around the middle due to their similarity to the average face, not many faces deviate from the norm face. Those that do are located around the edges, as their distance from the norm face is greater. Similarly, in the exemplar-based model, the faces are encoded around the middle (central tendency) due to their perceptual similarity with other faces (Valentine, 1991). This central tendency does not play a role in encoding, however it indicates the maximum density of faces present (Valentine, 1991). For both models, the location of the faces in the face space gives an indication of the easiness of recognition. Two similar vectors (in the norm-based model) and two points close together (exemplar-based model) will result in recognition errors. Valentine and Endo (1992) argued that the exemplar-based model would offer a more useful explanation regarding Own Race Bias.

As mentioned earlier, in line with the multidimensional face space model, a few studies have suggested that different facial features are used for distinguishing between faces of different races. Shepherd and Deregowski (1981) study found that the lower facial features seem to be more important in distinguishing between black faces, while white participants use the eye region in relation to nose and mouth when encoding own race faces (Schyns, Bonnar, & Gosselin, 2002). Further extending these findings, Hills and Lewis (2006) confirmed that training white participants to attend to the lower features when presented with black faces, actually reduced the Own Race Bias. This was due to the fact that the lower facial features are most useful in differentiating the other race faces (in this case black faces). The lower part of black faces is more diagnostic in distinguishing one black face from the other, as a result directing white participants' attention to the lower part of the black faces has enabled them to differentiate between the black faces.

Substantial support has been provided for the multidimensional face space model, however the model is not able to account for all findings regarding Own Race Bias e.g., studies which have employed race ambiguous faces. This line of studies are problematic for the Multidimensional Face Space model as they provide evidence that the social categorisation of faces seems to have an influence in the way that faces are encoded. A similar Own Race Bias has been found depending on whether the faces had own race or other race cues (MacLin & Malpass, 2001). The race ambiguous faces were given either typical Hispanic or African hairstyles, while the rest of the face was identical. The main aim was to examine whether this simple visual cue could result in producing an effect similar to Own Race Bias, even though the face itself was exactly the same. The authors found a better memory for the faces that were presented with hairstyles that were characteristic of their own racial group (MacLin & Malpass, 2001). The Multidimensional Face Space Model is not able to explain this finding, according to this model the faces should be encoded in a similar fashion and no differences should be found. However, the cues provided have an influence on how the faces are encoded. A similar Own Group Bias has been found even when the perceptual expertise with faces of the in/out-group is the same (only same race faces were employed). The allocation of these faces to randomly created groups was sufficient to produce an Own Group Bias (Corneille, Goldstone, Queller, & Potter, 2006).

The model might be an elegant way of representing faces in memory, however it does not take into account the social aspect of faces. While expertise is certainly an important factor in Own Race Bias, other factors such as social, attentional and motivational factors might also play an important role. The next few sections will thus be devoted to the social cognitive accounts of Own Race Bias.

1.5 Social Cognitive Accounts

The notion of an out-group homogeneity effect (the tendency of perceiving out-group member as more homogenous than in-group members) has been well documented in the literature (Park & Judd, 1990). Social psychology has long indicated that out-group members are usually processed according to social categories (e.g. race, sex and age) instead of their individuating information (Bodenhausen, Macrae, & Hugenberg, 2003). As suggested by Allport (1954), the categorisation of people and objects is necessary as they provide us with a vast array of information, which is overwhelming; hence categorisation is necessary to make this information more manageable. Using this line of work as well as integrating the Subjective Expected Utility Theory[2] (Savage, 1954), it was suggested that remembering faces of other individuals acts as a tool in predicting which social interactions are going to be useful or dangerous. Predicting whether the social interactions within one's in-group are useful or hurtful might be quite difficult, as there are no obvious visual cues, thus recognizing in-group members will be worthwhile. Malpass (1990) claimed that social interaction with an out-group member might not be as valuable as the ones with the in-group members, consequently it would be appropriate to categorise them simply as out-group members. Learning to individuate out-group members would exhaust one's cognitive resources, and the human aim is to maximise rewards, for this reason they are not processed any further. Thus, when presented with same race faces, perceivers pay more attention to facial features that distinguish one face from another; while when

[2] One of the decision making theories, which is partially normative considering humans as rational beings when dealing with our cognitive constraints. The theory argues that cognitive resources are used to maximise rewards and minimise losses.

presented with other race faces, category-specifying features such as skin tone or brow shape might be paid more attention to. In fact, it has been argued that social categorisation can lead to cognitive disregard (Rodin, 1987), with less attention being paid to the out-group faces, resulting in a recognition deficiency for other-race faces. Moreover, studies have shown that individuals are limited in their cognitive resources, and act like "attentional misers" processing others individuals at the necessary level (Fiske & Taylor, 2013), as a result cognitive resources are directed to a selective set of targets and person attributes, by means of using categorical cues (Macrae & Bodenhausen, 2000). In other words, when observers are presented with a cue that the face that they are viewing is 'out-group', the out-group status is activated and any further information regarding the stimulus is disregarded. This leads to important information, which distinguishes one face from another, being ignored, with the end result being poor recognition of other race faces.

Two main theories, Levin's Feature Selection Theory (Levin, 1996, 2000) and Sporer (2001) Ingroup/Outgroup model (IOM) form the base of the social cognitive accounts (even though the IOM model integrates both perceptual and social factors). More recently Hugenberg and colleagues (Hugenberg, Young, Bernstein, & Sacco, 2010) proposed the Categorisation-Individuation Model (CIM), integrating categorization, motivation to individuate and perceptual expertise to account for Own Race Bias. In a further extension of the CIM model (Hugenberg et al., 2013), they argue that this model can be used to explain all biases in face recognition, making predictions on possible interventions for own group biases.

Feature Selection Model

Levin (2000) argues that our tendency to think categorically about out-group members triggers a search for category specific information. It is this information, in this case race, which is extracted before any identity specific information. Hence, this whole process interferes with extracting useful information for identification. For own race faces, this feature (race) is not present, thus there is no such interference, resulting directly into straightforward coding of relevant information. Levin (2000) suggests that poor recognition of other race faces arises due to coding of information that is ideal for categorisation and not for individuation. In other words, attention is paid to areas of the face that do not individuate one face from another; too much emphasis is placed on this visual information specifying race. This theory originated from Levin's findings (Levin, 1996) where participants were asked to classify faces as belonging to own race or another race. Even though these participants displayed the usual Own Race Bias, they were faster at identifying the race of other race faces. Recent findings from neuroscience confirm that racial category is processed automatically (Caldara, Rossion, Bovet, & Hauert, 2004; Ito & Urland, 2003). Ge et al. (2009) and Susa, Meissner, and de Heer (2010) also provide further support for the feature selection theory, indicating that there might be a competition between categorisation and individuation during face encoding. However, a few findings seem to challenge the model, Rhodes, Lie, Ewing, Evangelista, and Tanaka (2010) utilising racially ambiguous faces, suggests that categorisation of the out-group does not always lead to poor recognition performance. Moreover, Zhao and Bentin (2008) found that race does not necessarily precede other categorical information such as age or gender, and therefore it would be useful to examine these early attentional processes regarding gender, where it would be possible to compare across Own Race and Own Gender Biases.

In-group/Out-group Model (IOM)

Sporer (2001) In-group/Out-group Model was an attempt to account for the evidence that was present at the time; he took into account some of the criticism for the previous theories (perceptual models and feature selection model), as well as integrating parts of these theories. This model is at an advantage to the other mentioned models as it is said to account for other biases such as Own Age and Own Gender Bias (Sporer, 2001). Furthermore, it also takes into consideration social factors such as, in eyewitness context "motivation of the witness to make a positive identification" (Sporer, 2000, p. 86). This model postulates that whenever a face is encountered the observer determines whether the face belongs to their in-group or out-group. In-group faces are processed automatically in a configural fashion, as per the expertise account. For a face to be perceived as an out-group some feature/characteristic or cue must trigger the categorisation, this can be skin tone or even skinhead's shaved head. This feature is usually typical of all the out-group members. The detection of this feature is said to be automatic and without conscious awareness (Sporer, 2000). This categorisation elicits a different processing mechanism, which is less effective than configural processing. In accordance with Rodin (1987) cognitive disregard suggestions Sporer argued that the cues that serve for categorisation might lead to cognitive disregard, such that attention might be directed elsewhere, hence the face is not further processed. Sporer also claimed that the cues that indicate a face is an out-group member might also encourage shallow (featural) encoding (Craik & Lockhart, 1972) since the out-group members have a low social utility (Malpass, 1990), hence there is no real benefit in further interaction. Moreover, the model asserts that more attention is paid to the cues that differentiate the out-group from the in-group member, and this is carried out at the expense of differentiating out-group members from each other. Hence, all the out-group members are perceived as homogenous.

The support for the IOM model is vast, given the hybrid nature of the model. The main prediction of the IOM is that in-group and out-group faces are perceived qualitatively differently. As outlined under the expertise hypothesis, the literature does indeed suggest (to some extent) that own race faces elicit greater configural processing than other race faces. The IOM also claims that this different processing should also be noticed in other categories. This argument has been supported by several studies (MacLin & Malpass, 2001) which have utilised racially ambiguous faces, aiming to examine whether social categorisation was driven from physical facial properties or from social mechanisms. The race ambiguous stimuli were given either typical Hispanic or African hairstyles, while the rest of the face was identical. Hence, the main aim was to investigate whether this simple visual cue could result in producing an effect similar to the Own Race Bias, even though the face itself was exactly the same. The authors found that participants showed a better memory for the faces that were presented with hairstyles that were characteristic of their own racial group. It was concluded that the expertise hypothesis could not account for this effect, as the faces were exactly the same in both conditions. The categorisation itself led the in-group faces to be processed configurally, hence resulting in better recognition. Even though the faces were exactly the same in all the conditions, it could be argued that hairstyle is one of the dimensions in multidimensional face space model (Valentine, 1991). This might as well be the case, however the ambiguous race recognition effects have been found when categorical racial labels (Pauker & Ambady, 2009) and race congruent names (Hilliar & Kemp, 2008) have been used. Furthermore, categorisation also affects holistic processing, racially ambiguous faces are processed more holistically when they are categorised as in-group members (Michel, Corneille, & Rossion, 2007). Providing further support for the IOM, simply dividing same race faces into in/out-group (Bernstein et al., 2007) creates an effect similar to Own Race Bias, even when the perceptual expertise with the stimuli is controlled for; moreover these in-group faces seem to be perceived more configurally than the out-group faces (Hugenberg & Corneille, 2009). Additionally, providing instructions to individuate before encoding the other race faces eliminates the Own Race Bias (Hugenberg, Miller, & Claypool, 2007). The evidence, supporting the IOM seems to have expanded over the years and it is indeed quite vast.

The Categorisation-Individuation Model

Similarly, to all of the other accounts for Own Race Bias, the Categorization-Individuation Model (CIM, e.g., Hugenberg & Sacco, 2008; Hugenberg et al., 2010) focuses on the encoding stage due to evidence suggesting that encoding is crucial to Own Race Bias (see Hugenberg et al., 2010). The main aim of the model was to integrate and address weaknesses in the literature of Own Race Bias resulting from the two main standpoints, that of perceptual expertise and the social cognitive accounts. The model argues that “social categorisation, perceiver motivation and perceiver experience….work together to drive selective attention during encoding, thereby affecting face recognition” (Hugenberg, et al., 2010, p. 1170). At the core of the model are the two qualitatively different ways of processing faces during encoding: categorisation and individuation. It is claimed that individuation requires the perceiver to discriminate among faces, it requires them to extract information from the face that is identity diagnostic (Hugenberg & Sacco, 2008). While individuation is effortful, categorisation on the other hand is extremely fast, and as mentioned previously, the perceiver is attending to cues that are specific to a particular group membership. Similarly, to Levin's (1996, 2000) feature selection model and Sporer's (2001) IOM, CIM argues that attending to the one particular cue that distinguishes the in-group from the out-group (i.e. skin tone) at the expense of individuating the other race faces results in poorer recognition for the other race faces. Thus, different processing mechanisms are applied to in-group and out-group faces. Identity diagnostic information is extracted from in-group faces, while attention is paid to category specific features for the out-group faces. The CIM argues that similar own race effects can also be induced via situational factors (i.e. creating in/out-groups in lab situations (Hugenberg et al., 2010)).

Similarly to the IOM, the model emphasises motivation, however motivation in CIM is central to the model. It is emphasised that perceivers are able to shift their attention from categorical specific features to identity diagnostic information only when they are sufficiently motivated. As mentioned previously, extracting identity diagnostic information is more effortful hence some degree of motivation is required (Hugenberg et al., 2010). The model's emphasis on motivation is crucial to the point that perceptual expertise skills with the face stimuli only benefit the individual who is motivated to utilise their expertise. In those cases when motivation decreases, such as when same race faces are assigned to an out-group, individuation will also decrease despite experience (Bernstein et al., 2007). In line with the perceptual accounts, CIM claims that individuals do have more experience at individuating same race faces than other race faces. Furthermore, this greater experience leads them to be better attuned to the identity diagnostic information that differentiates one face from another face (these would be the same race faces). However, the attunement provided by individuating experience is most effective in situations when the perceiver is motivated. The importance of prior individuating experience is highlighted in Shriver, Young, Hugenberg, Bernstein, and Lanter (2008). They replicated the in/out-group effect findings from Bernstein et al. (2007), however they did not find evidence that categorising other race faces as in-group enhanced memory for them. In other words, the recognition for other race faces was not enhanced, even though they were in-group faces. This finding emphasises the importance of the individuating experience with other race faces, and it also suggests that motivation itself might not be enough. Evidence suggests that participants might not have the individuating experience, which is needed to pay attention to the identity diagnostic features required to discriminate between the other race faces. It is claimed that in order to distinguish other race faces one must be able to extract the correct identity diagnostic information from the face. Hence extracting the same info from other race faces which is used for discriminating among same race faces, is not always useful (e.g. Hills & Lewis, 2006). However, recent evidence suggests that participants can demonstrate a better memory for in-group members than out-group members independent of the race of the faces (Hehman et al., 2010; Van Bavel & Cunningham, 2012); hence suggesting that motivation to process in-group faces seems to be enough to even process other race faces without the prior discriminatory knowledge suggested by Hills & Lewis (2006).

Similarly to the IOM, the evidence supporting CIM is extensive due to its integrative nature. Very recently the CIM has been extended with the aim of applying the model to all group biases in face recognition including race, age, gender and other in-group biases (Hugenberg et al., 2013). The extended model argues that in some categories such as race, age, and gender, there are obvious facial cues that trigger categorisation, however in Bernstein et al (2007) and Young & Claypool (2010) studies there were no obvious facial cues to indicate their group membership (other than the cues that the experimenters provided). The extended model argues that in such cases, when there are no obvious facial cues that can elicit categorisation, the Own Group Bias is driven by motivation to individuate in-group faces, and pay less attention to the individuating characteristics of the out-group members. Even though the perceivers have extensive experience with out-group faces (e.g., same-race faces), the model maintains that extensive experience does not convert to greater recognition. As mentioned previously, even though the perceiver might be an expert with the face stimuli (same race faces) it is the motivation to utilise this expertise that will determine their performance. These claims are supported by a range of studies suggesting that power status and a need to belong both increase perceivers motivation, and influence Own Group Biases. For example

Ratcliff, Hugenberg, Shriver, and Bernstein (2011) found that faces believed to be in high power were remembered better than those belonging to the low power group, even though all the faces were own race faces. Van Bavel, Swencionis, O'Connor, and Cunningham (2012) demonstrated a strong Own Group Bias in those cases when participants had increased belongingness needs (i.e. feeling left out). Furthermore, a greater identification with the in-group (lab created) leads to a stronger Own Group Bias (Van Bavel & Cunningham, 2012).

The extended model further argues that different Own Group Biases have different causes, and as such they can be organised as points along the dimensions of perceiver experience and perceiver motivation. Own Race Bias is claimed to be the product of both high experience and high motivation, while Own Gender Bias is suggested to be mainly due to motivation, as most perceivers "do not live in strongly sex-segregated environments" (Hugenberg et al., 2013, p. 10). Moreover, the model maintains that "magnitude and stability of the own group biases will depend on their causes". Own Race Bias is such a robust effect as it is "rooted in part in differential experience" (Hugenberg et al., 2013. P 11). Hugenberg et al (2013, p. 13) suggest that the inconsistency of the Own Gender Bias might be due to a "weak difference in experience" and its high dependence on motivational factors. As discussed below (section 1.6) Own Gender Bias is not as inconsistent as Hugenberg and colleagues suggest, in fact the female Own Gender Bias has been demonstrated to be a fairly consistent effect (see Herlitz & Lovén, 2013 for a meta-analysis), while the male Own Gender Bias is only found in rare occasions.

In summary, recent effort has attempted to integrate the vast literature on Own Race Bias (Sporer, 2000; Hugenberg & Sacco, 2008; Hugenberg et al., 2010). The recent CIM model and the IOM model are very similar in most of their predictions. The main difference between the two models lays on the motivational component. Hugenberg and colleagues have made this component very central to CIM to the point that one is able to shift their attention from categorical specific features to identity diagnostic information with sufficient motivation. In addition, if one lacks motivation, but still has the perceptual expertise skills with the face stimuli, this still leads to a poor performance as demonstrated by the in/out-group studies with same race faces. The CIM is the product of this integration, making this theory difficult to refute. The model argues that social categorisation, perceiver motivation and perceiver experience are closely interlinked in predicting an Own Group Bias.

1.6 Own Gender Bias in Face Recognition

Relatively little research has been carried out in this area, however the most consistent finding is that female observers are certainly at an advantage in face recognition (See Table 1 for a summary). Own Gender Bias is most prominent amongst female observers, with a very few studies reporting a Male Own Gender Bias (see Witryol & Kaess, 1957; Wolff, Kemter, Schweinberger, & Wiese, 2014; Wright & Sladden, 2003). There seems to be a difference in the way Own Gender Bias is defined. Considering that the Male Own Gender bias is rarely found, the hypothetical biases described in here are based on situations in which females show a bias (Female Own Gender Bias) but males do not. In order for Own Gender Bias to be present a significant interaction between the Observer Gender and Face Gender must occur. A full crossover effect[3] has only been demonstrated in a few studies (Lovén et al., 2012; Lovén, Svärd, Ebner, Herlitz, & Fischer, 2013; Slone et al., 2000). Some authors interpret a recognition advantage for own gender faces over other gender faces as an Own Gender Bias being present. An example for the Female Own Gender Bias would be female observers showing better memory for female faces than for male faces (see Figure 1, based on fictional data). Furthermore, in some cases the mere advantage of one group of observers over the other group of observers when presented with faces belonging to their own gender group is also interpreted as presence of Own Gender Bias (Figure 2, fictional data) (Lewin & Herlitz, 2002; Rehnman & Herlitz, 2006, 2007). This case could simply suggest a gender difference in the recognition of female faces, due to the fact that female observers perform significantly better in recognizing female faces than male

[3] A full crossover effect would result from a significant interaction between face gender and observer gender, where female observers would show a better memory for female faces than for male faces. In addition when compared with male observers, female observers should demonstrate a better recognition for female faces.

observers. These two interpretations might appear similar; however they represent two different effects. A full crossover effect for the Female Own Gender bias would result in both of the definitions above being fulfilled, such that female observers would perform significantly better with female faces than with male faces, as well as significantly outperforming male observers on their recognition of female faces, as can be seen in Figure 3 (based on fictional data). Female observers outperforming male observers only in the recognition of female faces, while recognizing the female faces at an equivalent level to that of the male faces, or even slightly better than the male faces, might just indicate that there are only gender differences in the recognition of female faces (Figure 2). Hence, this thesis will use the term Own Gender Bias as referring to the advantage for own gender faces over other gender faces (as depicted in Figure 1).

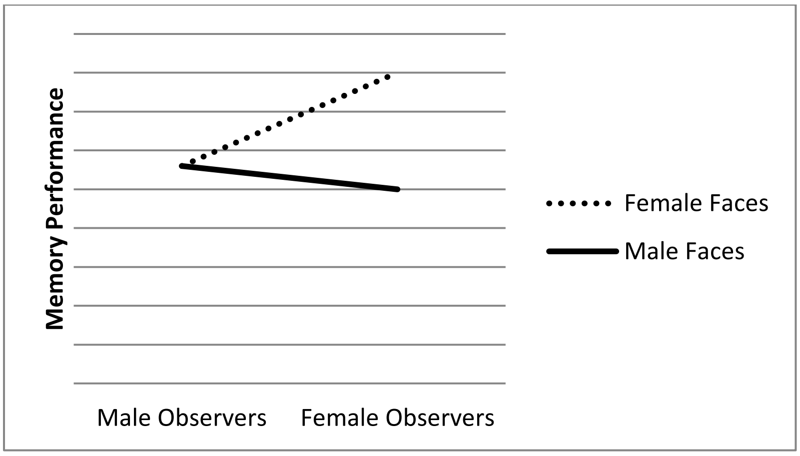


Figure 1. Female Own Gender Bias – female observers showing better memory for female faces than for male faces

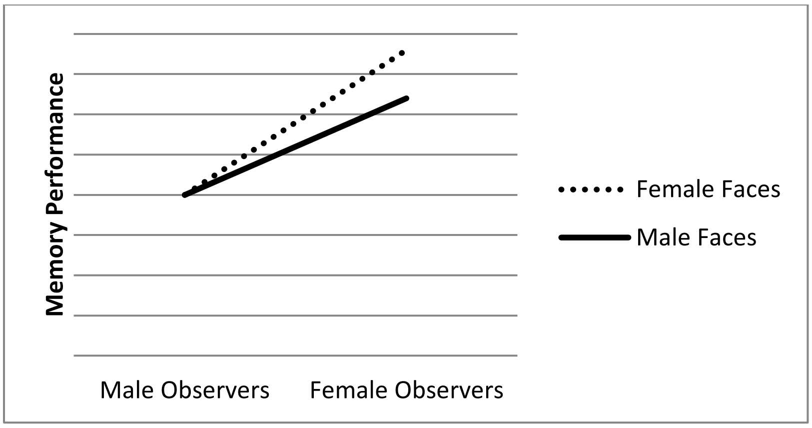


Figure 2. Gender differences on the recognition of Female Faces – female observers perform better than male observers on the recognition of Female faces (as well as male faces)

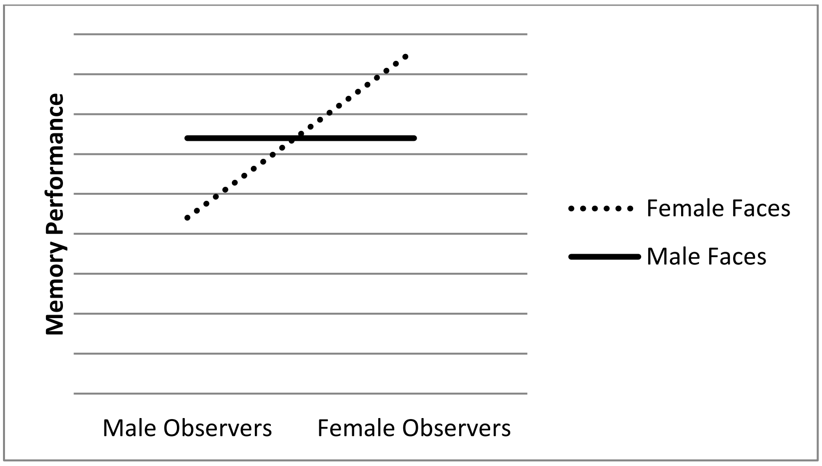


Figure 3. Full Cross over effect for the Female Own Gender Bias – Female observers show better memory for female faces than for male faces. Furthermore, female observers demonstrate better memory than males in the recognition of female faces.

Table 1 *Summary of Studies Examining Own Gender Bias in Face Recognition*

Study	Year	N	Type of Effect
Lewin & Herlitz	2002	192	Gender differences on Female Faces
Rehnman & Herlitz	2006	197	Gender differences on Female Faces
Rehnman & Herlitz	2007	219	Gender differences on Female Faces
Loven, Rehnman et al.	2012	52	Full Cross Over Effect for Female Own Gender Bias
Loven, Svard et al.	2013	29	Full Cross Over Effect for Female Own Gender Bias
Slone et al.	2000	129	Full Cross Over Effect for Female Own Gender Bias
Weirich et al.	2011	36	No effect
Sommer et al.	2013	151	No effect
Wright & Sladden	2003	40	Full Cross Over effect for Male and Female Own Gender Bias
Wolff et al.	2013	28	Full Cross Over effect for Male and Female Own Gender Bias

Early research on gender differences on face recognition suggests that female observers outperform male observers generally on face recognition (Goldstein & Chance, 1971; Howells, 1938; Shepherd & Ellis, 1973; Witryol & Kaess, 1957). The female advantage is usually found on recognition of female faces; however Witryol & Kaess (1957) has demonstrated that both male and female observers perform better with faces from their own gender. Yet, Cross, Cross, and Daly (1971) found no such differences for male observers, only female observers performed better with female face than male faces. Employing only female faces, Goldstein and Chance (1971) demonstrated an advantage for female observers over male observers. Similarly, Shepherd and Ellis (1973) showed that girls outperformed boys on the recognition of female faces.

More recent research as well as the recent meta-analysis (Herlitz & Lovén, 2013) on gender differences and Own Gender Bias on face recognition is in line with these early findings. What becomes apparent from the findings of these studies is that both male observers and female observers show a better memory for female faces i.e., the female face seems to be more memorable (only the following studies do not seem to show this effect (Lovén et al., 2013; Sommer, Hildebrandt, Kunina-Habenicht, Schacht, & Wilhelm, 2013; Weirich, Hoffmann, Meißner, Heinz, & Bengner, 2011; Wright & Sladden, 2003).

Another consistent finding is the lack of a Male Own Gender Bias (Herlitz & Lovén, 2013). Only a couple of studies have found a Male Own Gender Bias[4] (Wolff et al., 2014; Wright & Sladden, 2003). In an attempt to investigate the contribution of hair in Own Gender Bias due to its importance in recognition of unfamiliar faces, Wright and Sladden (2003) had participants complete a yes/no recognition task. Both male and female observers performed better with faces of their own gender. As expected, the presence of hair enhanced face recognition memory. In addition, it was found that hair was more important when recognizing faces of one's own gender, i.e. hence the absence of the hair for faces of one's gender was more detrimental than for faces of the opposite gender. Even though this might seem as an interesting finding, it might be argued that if Own Gender Bias is a real effect then it should be observed across a variety of stimuli.

Utilising different stimuli, Wolff et al. (2014) found similar results. An Own Gender Bias was found for both males and females, both male and female observers showed superior performance for own gender faces compared with other gender faces. The authors suggest that it would be hard to explain Own Gender Bias in terms of contact- or expertise-based accounts since it is inevitable to avoid contact with the opposite gender. Hence, event related potentials (ERP) were used to directly compare the cognitive and neural processes underlying Own Gender Bias, considering that previous similar research has been carried out with Own Race Bias, and have found some evidence of perceptual expertise (Vizioli, Rousselet, & Caldara, 2010). Wolff et al. (2014) analysis of the ERP components related to perceptual face processing

[4] In addition, these studies also found a Female Own Gender Bias

did not reveal strong evidence for different processing of own gender versus other gender faces. Quantity and quality of contact with same and opposite gender of participants indicated that even though female observers showed a greater quality of contact with other females than with males, this did not correlate with the memory bias scores. The authors concluded that their findings point to more social-cognitive explanations for Own Gender Bias.

Neither Wolff et al. (2014) nor Wright & Sladden (2003) acknowledge that Male Own Gender bias is very rare, and no reasons or suggestions are given for their findings. While, Male Own Gender Bias might appear occasionally, Female Own Gender Bias has often been reported even as a full cross over effect (see Figure 3). In a surprise face recognition memory test, (Lovén et al., 2012) presented participants with faces, showing same sex pairs of an own race and other race face. The main aim was to examine attentional bias for other race male faces or for own race male faces, and whether similar biases were present for female faces, while recording eye movements. Viewing time and subsequent memory findings indicate that the probability of a face to be remembered was higher if the face was from own race and if the face was a female. In more detail, the own race face and the female faces are remembered better. In addition a full cross over effect was found , female observers remembered more female faces than male faces, and furthermore they remembered more female faces than did male observers. For male pair faces, initial gaze was most likely to be directed to the other race male faces, while for female pairs this was not the case. Participant gender did not predict initial gaze or interact with face gender. Longer viewing times were found for own race faces, on both male and female faces.

The same researchers (Lovén et al., 2013) utilising a similar surprise recognition task in conjunction with functional magnetic resonance imaging (fMRI) also found a full cross over effect for the Female Own Gender Bias. The analysis revealed that female observers showed more activation in Fusiform Gyrus for female faces than for male faces. No such effect was found for male observers. Furthermore, female observers showed an increased BOLD response in Inferior Occipital Gyrus (IOG) for female faces compared to male faces. This was interpreted as evidence that the visual analysis of facial features occurs quite early on for female faces. The difference in memory between the female and male faces was associated with the female-male difference in left FFG Bold Response. A greater BOLD response in the left FFG to one gender was associated with a better memory for that gender, and this was the case only for female participants only. The authors conclude that face gender has an effect on only female observers' BOLD responses in Fusiform Gyrus and IOG, and this resulted in them having higher face processing skills for female than for male faces.

The full cross over effect for the Female Own Gender Bias was also found in Slone et al. (2000) employing a simple yes/no recognition task. Their main aim was to examine the factors associated with Own Race Bias in face recognition, in order to have a clear idea of the characteristic of those individuals who would be more susceptible to the Own Race Bias. They also examined the effects of face gender and observer gender. Interestingly, female observers were more likely to display the Own Race Bias. Moreover, female observers outperformed male observers on female faces; however no gender differences were found for male faces. It seems that participants' gender plays an important role even on the well replicated Own Race Bias, hence it might need to be considered in future studies examining Own Race Bias.

Similar results were also found by Rehnman and Herlitz (2006) examining the role of familiarity on the magnitude of Own Gender Bias on a child sample (M = 9 years, SD = 0.32). As expected girls performed better than boys. Furthermore, own race faces were remembered better than the other race faces. In addition, female faces were remembered better than the male faces. Girls performed better than boys in the recognition of female faces (independent of race), no gender differences were found in the recognition of male own race faces. Gender differences were found in the recognition of male other race faces, with girls outperforming boys. Rehnman and Herlitz (2006) found that female observers' ability to outperform male observers on the recognition of female faces "is independent of age and ethnicity of the face to be remembered" (Rehnman & Herlitz, 2006, p. 295).

Rehnman and Herlitz (2006) is one of three early studies (Lewin & Herlitz, 2002; Rehnman & Herlitz, 2007) on Own Gender Bias, that seem to interpret simple gender difference on female faces as Own Gender Bias, without the female observers showing any significant difference on their performance between male and female faces (whether these differences are indeed non-significant or just not reported is un-known). Lewin and Herlitz (2002) and Rehnman and Herlitz (2006) examined gender differences in an adult sample. Lewin and Herlitz (2002) examined the role of verbal abilities on face recognition, assuming that the utilization of verbal labels with the faces during encoding might be an important strategy for females. Results showed that verbal abilities had no impact on face recognition. The female faces were recognized better than the male faces. The significant interaction between Observer Gender and Face Gender indicated that male and female observers performed on a similar level for male faces, however female observers outperformed male observers on the recognition of female faces. As mentioned previously, there is no indication as to whether female observers remember more female faces than male faces. No such differences were also reported in Rehnman and Herlitz (2007), who examined the influence of gender schemas [5] utilising the Bem Sex-Role Inventory (Bem, 1981), which is used to measure gender role perceptions). Even though gender differences were found in the recognition of female faces, this was not influenced by the observer's gender schemas. Surprisingly, Herlitz and Lovén (2013) has included these studies under their investigation for the Female Own Gender bias, even though no Own Gender data are reported.

Interestingly, two recent studies (Sommer et al., 2013; Weirich et al., 2011) have provided no evidence of an Own Gender Bias, even for female observers. The only finding which is consistent in the literature seems to be the female observer advantage in face recognition.

Weirich et. al (2011) argued that the female advantage might result from a greater "interest or experience in faces", hence longer periods of presentation time would "make it easier for someone with a strong interest or experience in looking at faces to focus attention on unique perceptual features of a face" (Weirich et.al., 2011, p. 806). Varying their presentation times they found a general advantage for female

[5] Gender schemas are a "set of ideas that define as appropriate for men and women particular skills, preferences, personalities and self-concepts, and that act as filters shaping our perceptions and interpretations of events" (Goodnow, 1985, p.19).

observers than male observers. This female advantage was found to be present with the longer presentation times (10secs) and mainly after a 24 hour delay. The authors conclude that female observers might benefit more than male observers from longer presentation duration during encoding.

Reanalysing the results of 3 previous studies (N=800) Sommer et al. (2013) found a general female advantage; however the usual Female Own Gender Bias was absent. The female advantage was found in face recognition (memory) as well as in face perception (accuracy of perceiving the face without memory demands, i.e. indicating whether 2 faces are the same identity), with two different types of stimuli as well as controlling for cognitive abilities. Furthermore, social involvement accounted partially for the female superiority. It was also found that gender differences in face memory increased with age, and this was mainly due to an age related decline in males. This was not the case with face perception though; the magnitude of gender differences in face perception was independent of age.

1.7 Factors underlying Own Gender Bias

As can be seen from the studies reviewed above an attempt has been made to examine the factors underlying Own Gender Bias. Lewin and Herlitz (2002) demonstrated that verbal abilities have no effect on face recognition. Wright and Sladden (2003) showed that hair has been found to be important in the recognition of faces of one's own gender. However Own Gender Bias has been found even on those occasions when only face features have been present and the hair has been removed (i.e. Loven et al., 2012). Rehnman and Herlitz (2007) have further demonstrated that gender schema does not have an effect on face recognition memory. Loven et al. (2012) results suggested that more attention might be paid to the female faces, since there was a greater chance for female faces to be better remembered. Loven's (2013) results indicated that the gender of the face stimuli has only an effect on female observers' BOLD responses in Fusiform Gyrus and IOG. These areas are responsible for the perception of facial identity and early perception of facial structural properties as a result it has been argued by the authors that the greater activity in these areas results in higher face processing skills for female faces in female observers. However, these results do not suggest that Own Gender Bias is due to perceptual expertise or merely due to a greater attention/motivation towards the preferred face stimuli. On the contrary the authors explicitly state that this should be “determined in future research” (Loven et al., 2013, p. 4). Wolff et al. (2013), in an attempt to examine the neural correlates for Own Gender Bias did not find any consistent evidence in favour of a perceptual expertise account, hence they suggested that the social cognitive accounts might prove more fruitful for Own Gender Bias. Furthermore, they found that quantity and quality of contact with own and other genders did not correlate with gender differences nor with Own Gender Bias. Sommer et al. (2013), finding only an advantage for female observers in both face perception and face recognition, argued that social involvement (i.e. activities which involved people) partially accounts for the female superiority in face perception and face recognition. Furthermore, they also found that gender differences increased with age in face memory, and this was mainly due to an age related decline in males.

Rehnman, Lindholm & Herlitz (2007) attempted to examine empirically the cognitive process underlying Own-Gender bias. Inspired by findings, which suggest that the presence of a key feature such as hair (acting as a racial marker) leads the same race-ambiguous faces to be categorized as one race or another (McLin & Malpass, 2001), they presented androgynous (non-gender specific – a morphed face consisting of 50% male and 50% female) faces, each of which could be given a male or a female label (hence, it was necessary to have a between groups design). Thus, in the female condition, both male and female participants were told to remember female faces and, in the male condition they were told to remember male faces despite the face stimuli being the same androgynous faces in both conditions. A general advantage for female observers was found, especially with the androgynous faces labelled female than those labelled male or faces. No such differences were found for male observers. Similar results were also found for the filler faces[6]. Rehman and colleagues interpreted this as evidence against a perceptual expertise explanation, since face memory was influenced by the male and female category labels. However they make the assumption that differential categorisation of faces

[6] The filler faces were genuine male and female face

does not influence the perceptual characteristics that are utilised in encoding and retrieval processes. Indeed recent evidence indicates that different parts of the face are used depending on the gender of the face being processed. Cellerino, Borghetti, and Sartucci (2004) using a spatial filtering method[7] (to increase the difficulty in gender classification task) found that less information is required to recognize male faces than is required to recognize female faces. Furthermore, females were more efficient in recognizing female faces. These findings suggest that different information is required to process male and female faces, indicating that maybe they are processed differently. In spite of this, Rehnman and colleagues based their argument on findings from social cognition models such as cognitive disregard (Rhodin, 1987) and Levin's feature selection model (Levin, 1996, 2000) from Own Race Bias, to conclude that attention plays a crucial role in Own-Gender Bias, such that females direct more attention to female than to male faces, resulting in more accurate face recognition for female faces.

The role of attention in Own Gender Bias has been a topic of interest recently. Both, Lovén, Herlitz, and Rehnman (2011) and Palmer, Brewer, and Horry (2013) using divided attention tasks at encoding have found contrary results. Loven, Herlitz, and Rehnman (2011) basing their hypothesis on Sporer (2001) ingroup/outgroup model argue that Own Gender Bias could be the result of differences in attentional resources allocated to male and female faces, hence female faces would be processed more elaborately and as a result they would be better remembered. They reasoned that if female observers are processing the female faces more effortfully than male faces, then performing an additional auditory task (digit monitoring task) while encoding the faces would have a detrimental effect on the processing of female faces. Therefore, a reduction of Own Gender Bias would be expected. Results indicated that female faces were remembered better than male faces. Furthermore, performance was better on the full attention condition than on the divided condition. Moreover, a full crossover effect was found for the Female Own Gender Bias. The female observers remembered more female faces than male faces on both the full and the divided attention. The authors argued that female observers might have greater perceptual expertise for female faces, which would lead

[7] A technique used in image processing where the image is blurred or sharpened

to a better performance in those situations where face processing might be shallower (i.e. in the divided attention condition).

Similarly to Loven, Herlitz, and Rehnman (2011), Palmer et al. (2013) examined the role that attention plays at encoding, utilising a divided attention task. In contrast with Loven et al. (2011) findings they found that for female observers the divided attention had a greater effect on the female faces than on the male faces. Male observers performed better under full attention than on the divided attention task. The divided attention for male observers had similar effects for both male and female faces. This was interpreted as attention at encoding being a crucial contributing factor for the Female Own Gender Bias. The authors suggest that the reason that Loven et al. (2011) did not find such an effect is due to the fact that their divided attention task might have been too demanding. Palmer and colleagues argue that with this less demanding task Loven's results suggest that there is a trend for the dividing attention task to reduce the Female Own Gender Bias. In their 2nd study a similar pattern of results was found for female participants in an identification task, the female participant's performance on the female faces compared with the male faces deteriorated in the divided attention task.

Even though a few studies have attempted to examine the underlying factors in Own Gender Bias, there is by no means a consensus. Collectively, the studies point to Own Gender Bias being more difficult to explain in terms of a perceptual account, and social cognitive accounts might be more appropriate. It has been argued that amount of attention and processing that an observer pays to a given stimuli directly influences their performance of recall and recognition of the stimuli (Craik and Lockhart, 1972; Jenkins, 1979). From an early age, gender differences have been observed in attention directed to faces. In a sample of neonates (1 day old), Connellan and colleagues (Connellan, Baron-Cohen, Wheelwright, Batki, Ahluwalia, 2000), demonstrated that infant girls usually attend more to a face than infant boys, while infant boys showed more interest in a physical-mechanical mobile. More recent evidence indicates early tendencies for female observers to prefer faces. Using eye tracking Alexander et al (2009) found that infants (M = 5.5 months) show gender differences in toy preferences, with girls showing a visual preference for a doll over a toy truck and boys showing a greater number of fixations on the trucks than girls (Alexander, Wilcox & Woods, 2009). This difference in interest among males and females is also apparent in adulthood. Mckelvie, Standing, St. Jean and Law (1993) devised 2 studies to examine gender differences in face recognition and in car memory. In Study 1, gender differences in memory for line drawings of faces and cars was examined. The line drawings of faces were remembered better than the line drawings of cars. It was found that female observers performed better with faces from their own gender, however there were no gender differences on the recognition of female faces. On the other hand male observers outperformed female observers on the recognition of male faces. In their second study real photographs of faces and cars were used. Furthermore, instead of adult faces, children's faces were used. Similarly to Study 1, performance was better on faces than on cars, however the significant interaction showed that female observers outperformed male observers on the recognition of children's faces. Male observers on the other hand recognized more cars than female observers. These findings were in line with a similar previous study (Davies and Robertson, 1993), as well as McKelvie's (1981) proposition that gender differences in face recognition might be mediated by differential interests. McKelvie et al (1993) suggest that "the effects of interest (motivation) and knowledge (expertise)" could be investigated in future experiments (p.448). Interestingly, Tafili (2008, 2009) found evidence for a social cognitive position as male observers showed a better recognition for male faces than for female faces when the context in which the faces were presented was male-oriented (football and politics) rather than more female oriented (astrology). This is a rare example of Male Own Gender Bias and cannot be explained by a perceptual expertise hypothesis. This could indicate that more than one mechanism has a role to play in Own Gender Bias in face recognition.

Collectively, the social cognitive theories, the findings from Rehnman and colleagues, the inconsistencies between Loven and Palmer studies, as well as findings from McKelvie and colleagues and Tafili (2008, 2009) point to the direction that the role of attention on Own Gender Bias is worthy of further investigation. A few studies (Chiroro & Valentine, 1995; Goodman et al., 2007) from Own Race Bias suggest that the quantity of contact with other race faces is not important; however the quality of contact is crucial. The presence of other race faces in daily life is not significant, unless one is paying attention to them too (Hole & Bourne, 2010). This important finding could certainly be involved in Own Gender bias, especially since we are surrounded by both male and female faces. Furthermore, attention is closely linked with memory; hence it is surprising that only two studies to date have examined its role on Own Gender Bias. Loven et al. (2013) explicitly state that future studies should determine whether attention or perceptual expertise is responsible for this bias. Hence, the primary aim of the present thesis was to examine the role of attention on Own gender Bias, with two initial experiments examining the ability of male/female faces capturing and holding males/female observers attention. The 3rd study was a replication and extension of Rehman and colleagues (2007) androgynous study, and the 4th study, while controlling for sexual orientation examines the role of mating and mate guarding as potential motivators for Own Gender Bias.

Chapter 2

2.1 Brief introduction to attention

As mentioned earlier one of the aims of this thesis is to examine the role of attention on Own Gender Bias. A brief section on research into attention is therefore included because of its relevance to the ensuing experimental investigations.

Every day one is bombarded constantly with information which needs to be filtered, resulting in only a small fraction selected to be further processed (e.g., (Broadbent, 1952; Sperling, 1960). This process is crucial and absolutely necessary in order for one to make sense of any situation, the mechanism which serves to filter this continuous flow of information is called attention. Two factors are taken into account when information is filtered: 1) the relevance of the information to current task goals 2) the ability of the information to capture attention independent of the task at hand. The second factor has been described as a "circuit breaker" of voluntary attention, and it has great importance as it makes sure that any stimulus with potential significance is processed (Corbetta & Shulman, 2002). One would certainly be at disadvantage if they failed to notice a potential threat/benefit in their environment if they continuously paid attention to the current task.

As stated previously stimuli are selected for further processing, the stage of this selection process has elicited long standing debate within the attention domain. The most influential theory being Treisman's Feature Integration Theory (Treisman & Gelade, 1980), which proposes that processing is inevitable, even for irrelevant stimuli which are not recognised by the perceptual system. They advocate that individual information on features such as colours, size or orientation is automatically extracted separately without any effort in a "pre-attentive stage", but this information is integrated together by attention to make sense of the object. In this sense attention has more binding than selective qualities.

Earlier, it was mentioned that sometimes certain stimuli might capture one's attention in a bottom up fashion. Therefore, the stimulus receives priority even when it contradicts the observers' goals. To study this stimulus-driven attentional capture, visual search tasks are commonly utilised, usually a search for a target amongst distractors. The degree of interference with the task is usually measured as a slowdown in search time. For example, search time for a distinctive shaped item is usually slowed if one of the irrelevant items (distractor) is in a different colour, or vice versa, the search for a coloured item is disturbed by a differently shaped distractor (Theeuwes, 1991, 1994). Similar stimulus-driven attentional capture effect has been found with more meaningful stimuli, such as participant's own name (Mack & Rock, 1998; Shapiro, Caldwell, & Sorensen, 1997; Wolford & Morrison, 1980), as well as participant's own face stimuli (Brédart, Delchambre, & Laureys, 2006; Tong & Nakayama, 1999). While these studies might be criticised on the bases that own-name/face are simply more recognisable rather than capturing attention (Bundesen, Kyllingsbaek, Houmann, & Jensen, 1997; Kawahara & Yamada, 2004), other studies which have used negatively charged emotional words have demonstrated an attentional capture especially for anxiety-prone participants (MacLeod, 1996). Similar biases have also been noted for substance-related cues (Waters, Shiffman, Bradley, & Mogg, 2003). From this brief overview of the literature it seems that meaningful stimuli capture attention in a bottom up fashion, such that they signify the stimulus' power to capture one's attention independent of the task, potentially developed in the pre-attentive stages of attention. In general, faces are said to be one of the most important stimuli that one encounters, and as such their relationship with attention is quite 'special'.

2.2 The importance of attention in holistic face processing

Initial review of the literature on face specificity seemed to suggest that faces are not processed like other objects, in a piecemeal fashion (feature by feature); but rather are perceived holistically. Taking an approach similar to Treisman's Feature Integration Theory, Reinitz and colleagues (Reinitz, Morrissey, & Demb, 1994) examined whether facial features and their spatial relations are processed independently, and for which of these processes attention is required. Participants studied line-drawn faces under full attention or in a divided attention (counting rapid sequences of dots alternating between the top half and the bottom half of the face), with no mention of a subsequent memory task. The divided attention condition had a detrimental effect on the classification of old (faces seen during dot counting task) faces, such that original old faces were classified as equally old as conjunction faces (constructed from combining different features from two previously studied faces. i.e. eye-nose set from one previously studied face with mouth-hair from another studied face). Furthermore, the faces in both these conditions were classified as old more frequently than new faces and conjunction faces (composed from an old and a new face). It was argued by the authors that during the divided attention the participants were encoding only the features of the faces, rather than their relations, hence it was concluded that for holistic processing of faces full attention is required[8].

Similar results were also found in Palermo and Rhodes (2002) where holistic processing was measured with the part-whole task under full attention or divided attention. Participants were presented for a brief time with a central target face and two peripheral flanker faces, followed by a test for holistic encoding[9] of the target face. Under full attention, participants were advised to ignore the flanker faces, while under divided attention participants were required to match the identity of the peripheral flanker faces. As predicted, results demonstrated holistic processing under full attention condition, while under divided attention the participants were not able to holistically process the target face, suggesting that attention is required. Based on the findings from their subsequent study Palermo and Rhodes (2002), where the matching of inverted flanker faces did not disrupt holistic processing of the target face, whereas the matching of upright flanker faces did; the authors argued that there might be an attentional mechanism which is dedicated to holistic face processing. Matching the inverted faces might not have exhausted the holistic resources; hence the target face was able to be perceived holistically. In fact capacity limits have been suggested when faces are presented simultaneously (Jenkins, Lavie, & Driver, 2003; Raymond, Shapiro, & Arnell, 1992). Whereas attention might be necessary to

[8] It should be noted that important differences have been found between line-drawn faces and real faces, such that real faces are processed more holistically than line-drawn faces (Leder & Carbon, 2004), casting the validity of this study into doubt.

[9] Using a whole/part paradigm explained on page 19

process the identity of unfamiliar faces, attention might not be required when processing very familiar or famous faces (Jackson & Raymond, 2008).

There seems to be converging evidence that attention is necessary at least in the processing of identity. The human face is the predominant mechanism for identifying individuals and as such they can be seen as highly emotional stimuli, even when displaying neutral expressions (Jackson & Raymond, 2008). It has been proposed that highly emotional significant stimuli receive enhanced processing (Compton, 2000), thus increasing the likelihood of being remembered. It has also been found that face processing is not automatic but it depends on allocation of spatial attention (Crist, Wu, Karp, & Woldorff, 2007). This indicates that in order for a face to be remembered, attention must be paid to it. Faces also seem to be prioritised by the attentional system in comparison with other objects. Newborns prefer to visually track a schematic face than a scrambled face (Johnson, Dziurawiec, Ellis, & Morton, 1991), as well as preferring to gaze at upright rather than inverted faces (Mondloch et al., 1999). Faces have been found to draw attention to their location (Hershler & Hochstein, 2005) as well as capturing attention when they are not relevant to the task at hand (Jenkins et al., 2003). Furthermore, they also have an advantage in retaining attention over other stimuli (Bindemann, Burton, Hooge, Jenkins, & de Haan, 2005). In addition, faces are better remembered than object stimuli (Rust, 1994), but how can one find appropriate non-face stimuli in order to make this comparison? Overall, these findings suggest that faces capture and hold our attention and due to this, they are better remembered than other stimuli. The same argument could also be applied to Own Gender Bias. For example, if females remember more female faces, then it could be simply that their attention is being captured and is being held by the female faces. The aim of the first and the second study was to investigate whether attentional capture and retention have an effect on Own Gender Bias. More specifically, they examined whether there are differences in attentional capture and retention between male and female faces, and whether these differences were more prominent in male or female observers. An examination of participant's eye movements using an eye tracker was utilized, as a means of investigating attentional biases. The 1^{st} and the 2^{nd} Study concentrated on the role of attention on Own-Gender Bias, as attention plays a crucial role in memory. More specifically, the 1st Study investigated whether there was an interaction between the gender of the participant and the gender of the stimuli on the attentional capture task while the 2nd study investigated the same interaction on the attentional holding task. The Own Gender Bias literature suggests that female observers remember better other female faces, while no such Own Gender Bias is consistent for male observers, hence it was predicted that there would be differences in both attentional capture and retention, such that females' attention would be captured and retained by female faces, to a greater extent, than by male faces. While for male observers no such differences were expected.

2.3 **Study 1 –** An examination of the attentional capture properties of male and female faces when they are irrelevant to the experimental task: An eye movement study.

It has been argued that attentional capture is only purely driven in a bottom up fashion when the stimuli in question is task irrelevant (Jantis & Egeth, 1999), hence there is no direct motivation for the observer to pay attention to it. Therefore, Theeuwes (Theeuwes, 1991, 1992, 1994) developed a task (irrelevant singleton/additional singleton paradigm[10]), where the singleton under investigation was entirely task irrelevant. He investigated visual search for a target that was accompanied by a distractor whose properties were systematically manipulated. A comparison (for the time taken to search for the target item) is usually carried out between the two conditions; the condition in which an irrelevant item is present with the condition where this irrelevant item is absent. For example, Theeuwes (1992) showed participants displays containing coloured circles (or diamonds), arranged in a circular fashion (on the circumference of an imaginary circle). Both the coloured circles and the diamond shapes contained line segments of different orientations, and the participants' task was to determine the orientation of the line segment which was present in the target shape (singleton, as it was unique compared to the other shapes on the display, for example the target shape was a green diamond among a variable number of green circles). In this condition (no distractor condition), the green

[10] Singleton referring to the stimuli which stands out of the crowd

diamond was pretty easy to distinguish among the green circles, due to the different shape. Addition of an irrelevant red distractor item (in the distractor condition) led to an increase in time to respond to the orientation of the line segment among the green circles. Hence it is said that the coloured circle captured attention, and it has a detrimental effect on search performance. If the irrelevant item was a less salient colour than the singleton, in this case the search time is not affected (Theeuwes, 1992). Therefore, the author argued that only the most salient item drives early pre-attentive processing, hence attention is automatically and involuntarily captured and shifted to the salient item. A large body of evidence argues that the first sweep of information through the brain is stimulus driven (based on the salience of the objects); it is only in the later stages of processing that top down information is made available (Theeuwes, 2010).

In addition to automatic capture of attention by abrupt flashes or colours (Theeuwes, 1991, 1994), faces seem to display this property, possibly due to socio-biological value. A range of tasks have been used to demonstrate this effect: faces have been found to be unaffected by attentional blink (Awh et al., 2004), change blindness (Ro, Russell, & Lavie, 2001; Weaver & Lauwereyns, 2011), as well as yielding inhibition of return (delayed responding with a saccade) when compared with other objects/inverted faces (Theeuwes & Van der Stigchel, 2006).

More convincing evidence which suggests that faces capture attention originates from visual search studies, which have ensured that the face stimuli is completely task irrelevant to the experimental task. Langton and colleagues (Langton et al., 2008) asked participants to search for a non-face target item (i.e. a butterfly) in an array, which contained 6 items arranged in the circumference of an imaginary circle. In half of the trials a task irrelevant face was present. The results showed that participants' reaction times (for finding the butterfly) were slower in the face present condition in comparison with the face absent condition. The results seem to suggest that the face item had captured the participants' attention. Furthermore, in a second experiment where the face stimuli was inverted, the slowdown effect for the butterfly search was not present, the authors argued that this rules out any low level properties[11] of the image, and it suggests that it is the higher level representation of faces that produce the capture of attention. In other words, the attentional capture occurs even though the face stimulus was irrelevant to the task. The results were confirmed in a further experiment, where the item to be searched for was a face target (butterfly item being the distractor) for half of the participants, and for the other half of the participants, the search item was the butterfly (and the face was the distractor).

The ability of faces to capture attention in a bottom up fashion was also confirmed by Devue and colleagues (Devue, Belopolsky, & Theeuwes, 2012), who used a new task where all the items (6 items in total) were arranged in a similar manner to Langton et al. (2007). In this case all the objects were task irrelevant. The participants' task was to make a saccade to a uniquely coloured circle (i.e. a green circle among orange ones), each circle was positioned just above the items to be ignored. Participants' eyes went more often to the upright faces first than to inverted faces or butterflies. Furthermore, participants spent longer fixating on the upright faces than on butterflies. In comparison with the inverted faces and the butterfly, the search for the coloured circle was disrupted when the upright face was located away from the target circle, and it was facilitated when it was located next to it.

It is surprising that gender differences have not been taken into account, considering that females in general have been found to outperform males in tasks involving faces. The aim of the current study was to examine whether the male or the female face has such attention capturing properties. Since, most of the literature suggests that female faces are better remembered by other females, it could be the case that the female face cannot be ignored and captures the attention of other females. The present study used a modification of Langton et al. (2008) task, where attentional capture is operationalised "as a performance decrement produced by a task-irrelevant face" (Langton et al. 2008, p. 331), furthermore eye tracking was utilized to examine for any potential attentional biases. In line with Langton et al. (2008) it was expected that faces would capture attention resulting in slower reaction

[11] These are properties of the image such as edge density and its local contrast in relation with other objects in the array, these properties should remain the same when faces are inverted.

times in the face present condition, when compared with the face absent condition. Furthermore, a similar effect was expected to be found on the eye tracking measures of number of fixations (proportions), fixation durations (proportions), and saccadic reaction times. More specifically less fixations were expected to be made to the butterfly, as well as fixating less on the butterfly when the face was present. Furthermore, it was expected that participants would display longer saccadic reaction times to the butterfly when the face was present. In terms of gender differences, it was expected that the decrement on the reaction times and on the eye tracking measures would be more pronounced with female participants than on male participants, especially in those conditions where there was a female face stimuli on the display. No such decrement was expected for male participants when presented with an own gender face.

Two experiments were carried out to examine the above hypothesis. Experiment 1a presented the participants with arrays composed of six objects, where the main task was to search for the butterfly. The butterfly was present on half of the trials. In the butterfly absent trials the butterfly's location on the array was taken by one of the natural object categories. The irrelevant upright face stimuli did not appear on every trial, they were present only on half of the trials. In experiment 1b, the face stimuli was present inverted (rotated through 180 degrees). This experiment acted as a control, since it is thought that inverted faces are not processed configurally (Tanaka & Farah, 1993), while maintaining the low-level image based properties. Hence, if faces truly capture attention the effect should be found only on the upright faces.

2.4 Method

2.4.1 Participants

Fifty one participants (24 male and 27 female) took part in Study 1a and fifty two participants (28 male and 24 female) took part in Study 1b. The samples consisted of only Caucasian undergraduate and postgraduate students, aged 18 to 30 years. This was done, to control for potential effects of Own Race/Age Bias, as the face stimuli in the experiment consisted of Caucasian faces aged 18 to 30. The study was advertised as an attention study with no mention of faces; hence the participants were naïve to the true purpose of the study. This was deemed important, as the faces in the study needed to be completely task irrelevant. The study was conducted under ethical approval, granted by the University of Strathclyde Psychology Departmental Ethics Committee.

2.4.2 Stimuli

In line with Langton et al. (2008) study, the target stimulus was a butterfly, and the distractors consisted of pictures of vegetables, fruits, flowers, leaves, trees, houseplants and faces. The target stimuli consisted of 30 different pictures of butterflies. Each of the distractors also consisted of 30 different exemplars, i.e. 30 different types of fruits, vegetables etc. For the face stimuli, there were 15 pictures of female faces, and 15 pictures of male faces (all different identities - see below for further info on the face stimuli). In total 240 pictures were used. All the stimuli were converted in grayscale and were re-sized to fit within a 3 cm x 3 cm square, all picture modifications were carried out in Photoshop CS4. The stimuli for the experiment was arranged in the same fashion as Langton et al. (2008), the stimuli was presented in circular array of 6 objects on a white background, with a central fixation cross, where the centre of each object was 4.3 degrees of visual angle from the centre of the display. Sixty different arrays were created with target butterfly and distractor face present (30 arrays with male and 30 with female faces). The locations of the butterflies were tied as positions relative to the location of the face in a given trial, resulting in five possible distances of the butterfly from the face, since there were six locations on the display. This meant that there were 30 possible combinations of face and butterfly positions, essentially the butterfly and the face were in adjacent locations (i.e. butterfly at location 6 and the face at location 1) as well as being spaced out from each other (i.e. 1 space: butterfly at location 6 and face at location 2; 2 spaces (butterfly at location 6 and face at location 3; 3 spaces:

butterfly at location 6 and face at location 4, 4 spaces butterfly at location 6 and face at location 5, see Figure 4).

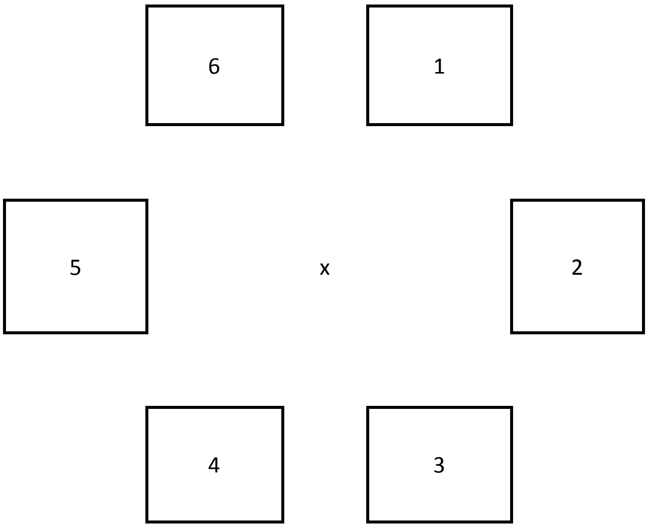


Figure 4. Schematic display of Study 1 stimuli locations

Since there were only 15 face stimuli of each gender, each face stimulus was presented twice. Research randomizer (http://www.randomizer.org/form.htm) was used for all randomisation purposes. Initially the butterfly images were assigned a number from 1 to 30, and were randomised. The same procedure was carried out for the male faces (assigned a number from 1 to 30). Four different filler categories were selected from the six available to be allocated to the four locations that were left. Hence, 30 sets of 4 numbers were drawn from a set of 6, in such a way that each number only appears once per set and that at the end each number has been drawn 20 times. This informed which filler categories to use in each trial. Next the exemplars for each of the categories were selected. Each of the 30 exemplars was allocated a number from 1 to 30, only the first 20 exemplars (out of 30) were required [12], the first number of the set was allocated to trial 1, second number to trial 2 and so on. To generate the arrays which contained female face stimuli, the male faces were

[12] 6 spaces in total x 30 trials = 180 spaces in total. 30 of these spaces are taken by faces, and 30 by butterflies, leaving us with 120 spaces in total. In these 120 spaces we have to fit the 6 categories, hence only 20 exemplars for each category are required

replaced with the female faces. Hence the displays for male and female faces stimuli were exactly the same in terms of the filler categories.

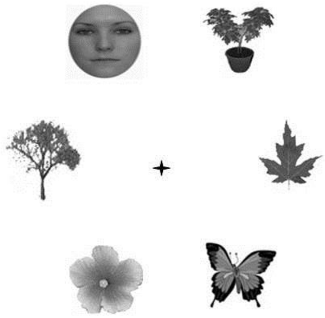
For the butterfly present – face absent arrays, since the face stimuli is absent an additional category was allocated randomly, with the constraint that the array could never contain two stimuli from the same category, and two pictures from the same exemplar. Hence, one random category was added, furthermore the remaining 10 exemplars for each category were allocated a number 1 to 10 and the first five were selected (since the face is absent, this leaves 150 spaces, which need to fit the 6 categories, resulting in 25 exemplars used for each category).

For the Butterfly absent – Face Present arrays a second randomization was carried out for the face stimuli, using similar procedures as in the Butterfly present – Face present array. Furthermore, the face stimuli were allocated in the same locations as in the Butterfly present – Face present array. The locations of the butterfly were replaced with the category that was left from the Butterfly Present – Face Absent arrays. For each category 5 exemplars were left, hence they were allocated a number from 1 to 5 and they were randomised, the first number was assigned to the 1st trial, the 2nd number to the 2nd trial and so on.

The last set of arrays, Butterfly Absent – Face Absent was composed of simply merging the Butterfly Present – Face Absent and the Butterfly Absent – Face Present conditions. Such that the filler categories for the Face Present – Butterfly Absent were used as a base, the face stimuli was replaced with the filler categories utilised in Butterfly Present – Face Absent arrays.

This resulted in 120 unique arrays being created, where each array was presented twice, thus resulting in 240 trials (See Figure 5 for stimulus array examples). For Experiment 1b, the exact arrays were utilised, however the same faces were inverted.

(a)



(b)

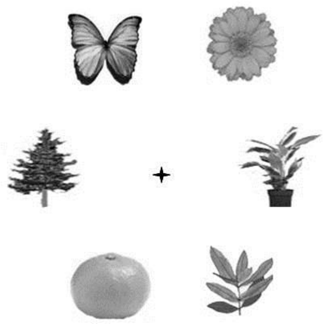


Figure 5 Examples of (a) Face Present and (b) Face Absent stimuli arrays (not in scale) utilized in Study 1

2.4.3 Piloting of the Face Stimuli

A pilot study was conducted to assess the age, attractiveness and distinctiveness, gender, masculinity or femininity of the face stimuli. 42 greyscale photographs of expressionless front view Caucasian male and female faces were downloaded from Productive Aging Lab Face DB (Minear & Park, 2004). Hair and background were removed as findings from Wright & Sladden (2003) indicate that hair accounted for approximately half of the Own-Gender bias. Adobe Photoshop CS5 Software was used to crop the photographs in an oval fashion, removing hair, ears, jewellery and contour of the face. The face recognition literature has shown that

Age, Attractiveness and Distinctiveness affect memory for faces (Shepherd & Ellis, 1973; Valentine & Bruce, 1986; Valentine & Moore, 1995; Wright & Stroud, 2002). The Gender, Masculinity/Femininity was also examined to make sure that the male and female faces could be easily distinguished from each other. All the faces were displayed one by one on the PC screen via e-prime and 42 participants rated them on Age, Attractiveness, Distinctiveness, Gender, Masculinity/Femininity. Participants were asked to type in the age and the gender of the faces. Attractiveness, Distinctiveness and Masculinity/Femininity were rated on a 10 point scale (attractiveness: *1 = very unattractive, 10 = very attractive*; masculinity for male faces only: *1 = not at all masculine, 10 = very masculine;* femininity for female faces only *1 = not at all masculine, 10 = very masculine; distinctiveness (defined as "How easy is it to find the face in a crowd): 1 = very hard, 10 = very easy*). Four participants were removed due to mistakes in the ratings, resulting in 38 participants (19 Males, 19 Females). The mean scores for each variable were calculated and 30 faces (15 male and 15 female faces) were subsequently picked to be used in Study 1 & Study 2. Only the faces which had 100 % agreement on gender were picked. These faces were matched on age, attractiveness, distinctiveness, gender, masculinity/femininity across and within gender; such that i.e. each face on the female set of faces was approximately the same age, same attractiveness and same distinctiveness, gender, and femininity. Furthermore each female face was approximately the same age, same attractiveness and same distinctiveness with the set of male faces. The masculinity of the male faces was approximately in the same level as the femininity of the female faces. Independent Sample t-test indicated that the female faces did not differ from the male faces on age (t (28) = - 0.28, p = .78), attractiveness (t (28) = -1.77, p =.09), distinctiveness (t (28) = -0.12, p = .91), ratings of masculinity compared to the levels of femininity[13] (t (28) = -1.20, p = .24) (Table 2).

[13] This was carried out to ensure that both male and female faces were representational of each gender to the same degree.

Table 2 *Mean Ratings on Age, Attractiveness, Distinctiveness and Masculinity/Femininity for Male and Female Face Stimuli (Standard Deviation in Parenthesis).*

Variable	Male Face	Female Face
Mean Age	25.74 (2.40)	26.02 (3.01)
Mean Attractiveness	5.07 (0.94)	5.77 (1.21)
Mean Distinctiveness	6.00 (0.87)	6.03 (0.67)
Mean Masculinity/Femininity	6.13 (0.85)	6.53 (0.97)

2.4.4 Design and Procedure

Behavioural reaction time analysis was subjected to an initial within groups design with two factors: butterfly (absent, present) and face (absent, present). To examine the effects of participant gender, face gender and any potential interactions between the two variables, the reaction times were examined in a mixed design with two within groups factors: butterfly (absent, present) and face (absent, female face, male face) and a between factor for participant gender (male, female). The eye movement data was subjected to a mixed design with one within group factor: face gender (absent, female face, male face) and one between group factor: participant gender (male, female).

The stimuli was presented on a 19 inch Viewsonic monitor with 1280 x 1024 pixel resolution and a 85 Hz refresh rate. Eye movement were measured with a SR EyeLink II eye tracking device (SR Research, Ontario, Canada) using the centre of the pupil to define pupil position. Eye movements were recorded at a 500 Hz sample rate at a spatial resolution of 0.01 degrees.

Prior to the experiment, the information sheet was presented. After providing informed written consent, participants were tested individually in a dimly lit room. Participants were seated 60 cm from the screen, controlled by means of a chin rest. Participants were fitted with the SR EyeLink II lightweight headset. Consequently, the calibration of the eye tracker was carried out, requiring participants to focus their eyes on a black dot with a diameter of 0.5 degrees, while the dot moved sequentially around the nine grid points on the screen. After successful calibration, the process was repeated in order for the validation process (re-confirming the calibration process) to be carried out.

Participants were presented again with instruction on the screen, and once they confirmed that they understood the task the experiment started. There was no mention of the face stimuli during instructions. Each trial began with a central fixation dot, once the participant was fixated on the dot (manually assessed), the presentation of the first array appeared. The participants were asked to determine as quickly and as accurately as possible the presence of the butterfly on the circular array. If the butterfly was present they were advised to press "Yes" and if it was not present to press "No" on the control pad, which was located at the right hand side (if they were right handed), and on the left if they were left handed. Each button press resulted in terminating the display, and starting the next trial (beginning with a central fixation dot). There were 240 experimental trials in total; each condition had an equal number of trials (60 per condition). The trials were presented in a random order for each participant; furthermore an opportunity for a break was given after the first 120 trials. Independently of whether the break was taken by the participants, the eye tracker was re-calibrated to ensure accuracy.

2.5 Study 1a Results

Reaction time analysis

Median reaction times (RTs) were calculated for each participant, and the means of these medians were used to carry out the analysis (Table 3). Seven participants (4 male and 3 female) were removed from the data due to high rate of errors in responses (30%-50%), resulting in 20 female and 24 male. Outliers (from two participants, approximately one outlier per condition) were replaced with the mean plus 2SDs as suggested by (Field, 2009).

As expected, in the butterfly absent condition participants took longer to respond. Furthermore, the presence of an irrelevant face on the display also seemed to slow down their reaction times. This deterioration on RTs seemed to be larger on the butterfly present condition. When the butterfly was absent, the presence of the face did not seem to have a big effect. When the gender of the face was taken into consideration, it seemed that the presence of a male face in the display had a more deteriorating effect on the butterfly search, resulting in greater RTs, especially on the butterfly present condition (Table 3). Furthermore, the percentage of errors[14] seemed to be greater when the face was present than when the face was absent, the same pattern was revealed for the male face in comparison with female faces.

Table 3 *Mean Reaction Time (ms), Percentage Errors and Standard Deviations*[15] *(SD in Parenthesis) for Each of the Conditions of Study 1a*

		Face absent	Face present	Female Face	Male Face
Butterfly Absent	RT	829 (209.29)	836 (204.16)	836 (202.33)	833 (206.50)
	% errors	2.88	4.54	4.10	4.72
Butterfly Present	RT	621 (104.29)	639 (107.07)	633 (104.97)	654 (122.84)
	% errors	5.09	6.25	7.87	9.05

An initial analysis[16] examined the basic effect of whether the irrelevant faces slow down the search for the butterfly. A 2 (Butterfly: absent, present) X 2 (Face:

[14] This was the overall percentage of error across all participants.
[15] It must be noted that in repeated measures analysis, standard deviations can be misleading as they illustrates how much on average scores differ from the mean, i.e. illustrates the variability across participants. In repeated measures we are interested in the effect of our manipulation within participants, hence whether participant 1 is slower or faster than participant 2, is not of interested (this is what the SD represents). The interest lays whether the manipulation affects both these participants in the same way.
[16] This was carried out to replicate Langton et al's procedure (i.e. analyse the data without regard to face gender before going on to consider face gender)

absent, present) repeated analysis of variance (ANOVA) was run on the mean RTs, with repeated measures on both factors.

The analysis of variance revealed that the main effect for butterfly was significant [F (1, 43) = 126.18, p < .001]. The results clearly suggested that when the butterfly was absent participants took longer to respond. The main effect of face was also significant [F (1, 43) = 7.49, p = .009]. The interaction between butterfly and face was non-significant [F (1, 43) = 1.10, p > .1]. The presence of the irrelevant face seemed to slow down the search for butterfly, however the non-significant interaction suggests that the slowing down is not affected by the butterfly being present or absent.

To examine for potential interactions between participant gender and face gender a 2 (Butterfly: absent, present) X 3 (Face gender: absent, female, male) X 2 (Participant gender: male, female) analysis of variance was carried out (Tables 4 and 5 providing descriptive details for male and female observers, respectively). A main effect of butterfly [F (1, 42) = 125.90, p < .001] and face gender [F (1, 84) = 2.05, p = .007] was revealed. Furthermore, a significant interaction between face and butterfly was found [F (2, 84) = 4.24, p = .018]. Participant gender did not have an effect [F (1, 42) < 1], nor did it interact with face gender [F (2, 84) = 2.05, p > .05] or butterfly [F (1, 84) < 1]. The three way interaction was also non-significant [F (1, 84) = 1.93, p > .05].

Table 4 *Mean Reaction Time (ms) for Male Observers and Standard Deviations (SD in Parenthesis) for Each of the Conditions of Study 1a*

		Face absent	Face present	Female Face	Male Face
Butterfly Absent	RT	866 (209.87)	854 (209.04)	854 (202.05)	855 (215.39)
Butterfly Present	RT	631 (90.17)	647 (89.60)	639 (82.53)	673 (121.63)

Table 5 *Mean Reaction Time (ms) for Female Observers and Standard Deviations (SD in Parenthesis) for Each of the Conditions of Study 1a*

		Face absent	Face present	Female Face	Male Face
Butterfly Absent	RT	798.12 (208.07)	820.73 (203.26)	821.39 (205.72)	814.06 (201.50)
Butterfly Present	RT	613.25 (116.06)	632.22 (121.24)	628.09 (122.13)	638.60 (124.24)

The significant main effect of face gender was further examined utilising Pairwise Main Comparisons (Keppel, 1992), revealing that the male face slowed down the butterfly search more than the female face [F (1, 84) = 16.33, $p < .01$], and the face is absent condition [F (1, 84) = 37.58, $p < .01$]. Furthermore, the female face slowed down the search, but only when compared with the face absent condition [F (1, 84) = 4.36, $p < .05$].

The significant interaction between face gender and butterfly was further examined utilising simple effects procedure (Keppel, 1992). This suggested that the significant effect lay on the butterfly present factor [F (2, 84) = 8.62, $p < .01$]. No significant differences were found on the butterfly absent factor [F (2, 84) < 1]. Further exploration of butterfly present factor utilising pairwise simple comparisons (Keppel, 1992) indicated that the slowing down effect for butterfly search was driven by the male face. The RTs for the male face condition were significantly slower when compared with the female face [F (1, 84) = 7.64, $p < .01$] and with the face absent condition [F (1, 84) = 17.57, $p < .01$]. The difference between the face absent and the female face was non-significant [F (1, 84) = 2.04, $p > .05$], confirming that the RTs slowdown for the butterfly search was mainly driven by the male face, since the RTs for the face absent and the female face condition were not significantly different.

Eye movement analysis

All eye movement analysis was carried out for butterfly present condition only. The items on the visual array were presented parafoveally (extending 4 degrees from the centre). The central 2 degrees of vision are the sharpest. During parafoveal vision (which extends to 5 degrees), this sharpness decreases, and vision is poorer in the periphery (extending beyond 5 degrees)[17]. Emotional objects have a greater ability to draw attention (Bradley, Cuthbert & Lang, 1996). Since, the items were presented parafoveally (4 degrees), and considering that the main task was to indicate the presence of the butterfly, it was reasoned that it was suitable to investigate the amount of attention that was paid to the butterfly in the presence and absence of the face stimuli.

The circular visual array was divided into 6 equal cone-like shape interest areas (IA)[18], and the eye movement data within these IAs were used for analysis (using Dataviewer, SR Research, Ontario, Canada). This procedure was followed since a full saccade was not necessary to be made to the butterfly in order to detect its presence (taking into account that the stimuli were presented in parafoveal vision), even a slight eye movement from the central fixation point toward the butterfly would have been sufficient to detect the butterfly.

In line with previous eye tracking research, trials where participants had anticipated the stimulus appearance by making a saccade with a reaction time shorter than 80 ms (Machado & Rafal, 2000) or were improperly fixated on the central fixation point (a deviation larger than 1 degree) at the start of the trial (Mogg et al., 2003; Mogg et al., 2005) were removed from the analysis. This resulted in 8.9 % of the data being removed. Furthermore, the 7 participants (mentioned on the RT analysis) who had a large error rate were completely excluded from the eye tracking analysis.

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[17] Controversy is present in the literature regarding the type of information obtainable from parafoveal and peripheral vision (Henderson & Hollingworth, 1998).

[18] This was carried out by using the shape tools in Dataviewer, SR Research software.

The following parameters were analysed (the first two measuring initial orienting of attention, while the latter measure maintenance of attention):

1. Time to initially fixate on butterfly (Saccadic Reaction Time, SRT)

This was calculated by the mean time per trial to initially fixate on the butterfly stimuli averaged for each participant separately for trials where the face was absent, female face present and male face present.

2. Proportion of 1st saccades to butterfly

Proportion of first saccades to the butterfly when the face stimulus was absent compared to when it was a female face or a male face, per participant.

3. Mean proportion of fixations to butterfly

For each trial the number of fixations to the butterfly was divided by the total number of fixations for that trial (i.e. calculating the proportion of fixations to butterfly). The average proportion of fixations was calculated for each participant. This was carried out for all the butterfly present trials. These trials consisted of groups of trials where the face stimulus was absent and groups of trials where the face stimulus (either male or female) was present. This method was used to control for the diversity of fixations generated during different trials.

4. Fixation duration on butterfly

The average fixation duration on the butterfly for each trial, for each participant was calculated.

Descriptive results for each of the parameters are presented in Table 6. Examination of Table 6 indicated that it took participants longer to initially saccade to the butterfly, when there was an irrelevant face present on the visual array, especially when this was a male face. Less attention seemed to be paid to the butterfly when the irrelevant face distractor is present, as indicated by the fewer proportion of 1st saccades and mean proportion of fixations on the butterfly. This seemed to be the case especially when the gender of the irrelevant face is male. The means for fixation duration on the butterfly does not seem to follow the above pattern.

Table 6 *Eye Movement Parameters on the Target (Butterfly) in Absence and Presence of a Male/Female Irrelevant Upright Face Distractor in Study 1a (Standard Deviation in Parenthesis).*

Eye movement parameter	Face absent	Female face present	Male face present
1. Time to initially fixate on butterfly (SRT) (ms)	346 (53.33)	357 (54.64)	365 (73.50)
2. Proportion of 1st saccades to butterfly	0.49 (0.14)	0.46 (0.16)	0.45 (0.16)
3. Mean proportion of fixations to butterfly	0.67 (0.09)	0.63 (0.08)	0.58 (0.07)
4. Fixation duration on butterfly (ms)	205 (22.93)	204 (33.49)	201 (30.06)

Each of the eye movement parameters was separately subjected to a 3 (Face: absent, female, male) X 2 (Participant gender: male, female) mixed analysis of variance.

Examination of the SRT parameter revealed significant main effects for face [F (2, 84) = 4.83, p = .01] and participant gender [F (1, 42) = 8.07, p = .007]. However, the interaction was non-significant [F (2, 84) = 3.02, p = .054]. Pairwise main comparisons (Keppel, 1992) examining the significant main effect for face revealed that both male and female faces, hindered the initial saccade to the butterfly ([F (1, 84) = 19.43, p < .01], [F (1, 84) = 5.86, p < .05], respectively). In other words, it took participants longer to move their eyes initially to the butterfly when there was a face present than when it was absent. The difference between male and female face was also significant [F (1, 84) = 3.95, p < .05], suggesting that the male face was driving the effect. Overall, it took male participants (M = 380.21ms) longer than females (M = 335.80ms) to initially fixate on the butterfly.

Proportion of 1st saccades to the butterfly did not reveal any significant results. The main effects for face and participant gender were non-significant ([F (2, 84) = 2.72, p = .07], [F (1, 42) < 1]). Furthermore, the interaction between the two factors was also non-significant [F (2, 84) = 1.40, p > .05].

Analysis on the mean proportion of fixations to the butterfly, revealed a main effect for face [F (2, 84) = 8.27, p = .001], a non-significant main effect for participant gender [F (1, 42) = 2.97, p = .09] and a significant interaction between the two factors [F (2, 84) = 4.41, p = .01]. Pairwise main comparisons suggested that participants made significantly fewer fixations on the butterfly when there was a male face than when there was a female face on the display [F (1, 84) = 5.29, p < .05]. Furthermore, participants made significantly more fixations on the butterfly when the face was absent than when there was a male or a female face present [F (1, 84) = 31.03, p < .01; F (1, 84) = 10.69, p < .01, respectively]. Simple main effects revealed that the difference was found mainly for the male participants. Additional examination of this variable using pairwise simple comparisons indicated that male participants made less fixations on the butterfly when there was a male face (M = 0.58) present on the array than when there was a female face (M = 0.62) [F (1, 84) = 16.90, p < .01] or no face present (M = 0.66) [F (1, 84) = 41.25, p < .01]. The difference between the female face and face absent condition was also significant [F (1, 84) = 5.35, p < .05], however as suggested by the significant difference between the male and the female face, the effect seems to be driven by the male face.

Analysis of the mean fixation duration parameter showed that the presence of the face did not seem to have an effect on the fixation duration on the butterfly [F (2, 84) < 1]. Neither did the gender of the participants [F (1, 42) < 1]. Moreover the interaction between the two variables was non-significant [F (2, 84) < 1].

2.6 Study 1b Results

Reaction time analysis

The same procedures as Study 1a were followed in calculating RTs and in dealing with outliers (approximately one per condition). As expected the presence of an inverted face did not have an effect on the search for butterfly (Table 7). Furthermore, the RTs seemed to be longer when the butterfly was absent.

Table 7 *Mean Reaction Time (ms), Percentage Errors and Standard Deviations (SD in Parenthesis) for Each of the Conditions of Study 1b*

		Inverted Face absent	Inverted Face present	Inverted Female Face	Inverted Male Face
Butterfly Absent	RT	864 (229.99)	876 (236.24)	865 (228.74)	881 (242.15)
	% errors	0.21	0.42	0.71	0.71
Butterfly Present	RT	652 (127.46)	648 (129.82)	649 (129.27)	642 (117.08)
	% errors	3.69	4.20	4.12	4.23

The initial 2 (Butterfly: absent, present) X 2 (Inverted face: absent, present) repeated analysis of variance revealed a main effect for butterfly [F (1, 51) = 115.64, p < .001]. As predicted, the main effect for inverted face and the interaction between butterfly and inverted face was non-significant [F (1, 51) < 1; F (1, 51) < 1, respectively], suggesting that presence of an inverted face on the display did not have a deteriorating effect on the RTs.

Face gender for the inverted faces did not have an effect on the search for butterfly [F (2, 100) < 1], independent of whether the butterfly was absent or present [F (2, 100) = 2.12, p > .05]. Participant gender did not have any effects either [F (1,

50) = 1.67, $p > .05$] nor did it interact with inverted face gender [F (2, 100) < 1]. No other effects were significant ($p > .05$).

Eye movement analysis

The same exact data analysis procedures as Study 1a were followed for the eye movement data analysis in the current study. Table 8 provides details of descriptive information for each of the eye movement parameters.

Table 8 *Eye Movement Parameters on the Target (Butterfly) in the Absence and Presence of a Male/Female Irrelevant Inverted Face Distractor in Study 1b (Standard Deviation in Parentheses).*

Eye movement parameter	Face absent	Female face present	Male face present
1. Time to initially fixate on butterfly (SRT) (ms)	337 (53.09)	338 (59.94)	340 (52.88)
2. Proportion of 1st saccades to butterfly	0.49 (0.14)	0.49 (0.17)	0.49 (0.17)
3. Mean proportion of fixations to butterfly	0.67 (0.09)	0.66 (0.09)	0.66 (1.11)
4. Fixation duration on butterfly (ms)	215 (37.58)	214 (40.61)	218 (43.48)

None of the eye movement parameter revealed significant results. Analysis of the SRT data on the butterfly showed non-significant results for the inverted face gender main effect, participant gender as well as for the two way interaction [F (2, 100) < 1; F (1, 50) = 2.67, $p > .05$; F (2, 100) < 1, respectively]. Analysis on the proportion of 1st saccades to the butterfly revealed that the main effect for inverted face gender, participant gender and the interaction between the two were non-significant [F (2, 100) < 1; F (1, 50) < 1; F (2, 100) < 1, respectively]. The analysis on proportion of fixations and fixation durations on the butterfly also showed that the presence of the inverted face did not have an effect on how many fixations and how long these fixations were made on the butterfly [all Fs < 1].

2.7 Discussion

The aim of these first two studies was to examine the contribution of attentional capture to Own Gender Bias. More specifically, the face capturing effect demonstrated in the literature was expected to be driven by the female face, mostly capturing the attention of female participants and thus suggesting a possible cause for female advantage in face recognition. No such effect was expected for the inverted faces, which acted as a control condition.

The results did not support an attentional capture account of female Own Gender Bias. The results suggested that the presence of an irrelevant face in the array had an effect on the search for the butterfly, the target item. More specifically in Study 1a participants took longer to find the butterfly (RTs), when an irrelevant face was present on the array; this was especially the case if the face was male. The reaction time results were complemented with the eye movement analysis. The eye movement measures partially confirmed attentional capture by male faces. Fewer proportion of fixations were made on the butterfly when the face present on the array displays was a male face than when it was a female face or when the face was absent. Furthermore, the significant interaction between face and participant gender suggested that it was male participants that made fewer fixations on the butterfly when the male face was present in the array. The other eye movement measurements did not reveal significant differences, except the SRTs (time to initially saccade) to the butterfly, which were significantly slower, when the face was present than when it was absent. In addition, it was demonstrated that both male and female participants took longer to make an initial fixation to the butterfly when a male face was present on the display. Study 1b, where the face stimuli was inverted, as expected did not reveal any significant results, confirming that the attentional capture properties by the face stimuli was not due to low level properties of face stimuli. It is speculated that this might be due to configural processing.

In line with previous literature (Devue et al., 2012; Langton et al., 2008), the basic finding that faces capture attention when they are task irrelevant was found. Furthermore, the present findings suggest that the male face is driving attentional capture for faces in both male and female participants. The female face did not seem to slow reaction times in finding the target (butterfly).

One factor that might be driving the male face capturing attention as recently suggested on the Own Race bias literature is familiarity. In other words, other race faces might capture attention as they might be seen as novel (unfamiliar). A recent study (Dickter, Gagnon, Gyurovski, & Brewington, 2015[19]) controlling for familiarity with other race faces (in terms of other close friendships) found no attentional capture by other race faces, even when the other race faces was not associated with threat. Hence, they conclude that close friendships with out-group members is extremely important and is associated with decreased attentional allocation to the other race faces. In terms of the current study, the contact hypothesis cannot account for the results. Both males and females have close contact with the opposite gender, and the quality of contact is quite high (friendships, romantic and family relationships). Hence, if this is taken into account then there is no reason as to why the male face would capture attention.

Recent findings from visual search studies examining Own Race Bias (Sun, Song, Bentin, Yang, & Zhao, 2013), where the face is the target object rather than task irrelevant, replicated Levin's findings of faster detection of other race faces among own race faces compared to finding an own race face among other race faces. This was replicated however only with Chinese participants for both upright and inverted faces; for Caucasian participants no significant differences were found. This confirmed Levin's (2000) finding where inversion did not eliminate the search advantage for other race faces. The authors suggest that cultural perspectives might

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[19] Using a dot probe task they examined whether the other races attentional capturing properties were moderated by the amount of close contact one had with the other race faces, this was found to be the case for both black and asian faces

account for the asymmetries found, where Westerners think analytically, while East Asians think more holistically (Nisbett et al., 2001). This explanation could be plausible, however it must be pointed out that Sun et al.'s (2013) face stimuli were not piloted nor were they all neutral, hence confident conclusions cannot be drawn. Many studies using emotional faces in a visual search paradigm have been confounded, due to low level visual features such as teeth, wide-open eyes or mouth, resulting in inconsistencies as to whether angry faces capture attention in the literature (Savage, Lipp, Craig, Becker, & Horstmann, 2013). The fact that the same results were found on the inverted faces condition on the Sun et al. (2013) study might indicate that this might be a possibility. Findings from recent studies show that visible teeth in photorealistic emotional faces capture attention in a visual search task (Horstmann, Lipp, & Becker, 2012). Hence, controlling for emotionality and making sure that all stimuli are uniform (i.e. mouth closed) is absolutely necessary and it is a point that future studies should take into consideration. For the present study this possibility is ruled out as all the faces used were all neutral with mouth closed. Furthermore, the present study ensured that both male and female faces were matched on distinctiveness, age, attractiveness, masculinity/femininity, hence these variables cannot account for the attentional capture driven by the male face. In addition, no capturing effects were found for the inverted face condition, therefore the low level visual features factor can be ruled out.

It has been suggested that humans might have a predisposition to view novel/unfamiliar stimuli as threatening, hence capturing their attention (Young & Claypool, 2010). Recent findings seem to suggest that male faces might capture attention as they might be perceived more threatening than female faces, by both male and female observers. Cattaneo et al. (2014) in a series of three experiments examined gender differences in orienting of attention by male or female faces in a task where the participants are required to estimate the midpoint of a line (the line bisection task). Male faces capture attention more than female faces, it was argued that the male face captured attention due to greater levels of perceived threat; the finding was replicated across their three studies with new sets of stimuli and different participant samples. The role of threat has also been emphasised on Own Race Bias studies. In fact Al-Janabi and colleagues (Al-Janabi, MacLeod, & Rhodes, 2012) found that male faces were rated as more threatening than female faces. However, the level of perceived threat for male faces was modulated by race, where black male faces were rated as more threating than East Asian, followed by white faces. They found no significant differences on the perceived levels of threat between the different races for the female faces. Considering these findings it is possible that the present face effect driven by the male face might be due to the male faces perceived as more threatening. The present study, similarly to Cattaneo et al. (2014) found no overall participant gender differences, with the exception of the eye movement analysis on the proportion of fixations, where male participants fixated less on the target (butterfly) when the male face was present (in comparison with the female face being present, or in the face absent condition). In terms of an evolutionary account, this might prove to be beneficial, as less attention might be paid to the task at hand in order to keep an eye on predators or male competitors. This might be a point worth investigating in future research.

On a more general note the present study provides further support for Langton et al. (2007) findings, where they propose that attentional capture by faces might be due to their configural processing rather than due to low-level feature characteristics as suggested by Devue et al. (2012) findings, where partial attentional capture was also found for inverted faces. Their inverted and upright stimuli was used in a within measures design, hence the effect might have occurred due to the oddness in part of participants wondering why sometimes the faces are upright and in some trials are inverted. In the present study, the upright and inverted stimuli were kept in separate experiments to avoid confusion in participants. The finding for the inverted faces was consistent across the behavioural results and the different eye tracking measures, suggesting that faces might indeed capture attention due to their configural processing. However, the finding that it might be the male face that captures attention might come as a surprise at first. It is indeed an area of research that deserves further consideration, especially since it seems to modulate race bias, especially in terms of capturing attention.

The male faces capturing initial attention might be interpreted in terms of the cognitive disregard hypothesis (Rodin, 1987), who suggested that one cannot afford to process all the visual information, leading to one being an “attentional miser”. Therefore, cognitive resources are allocated to only information which is relevant to the perceiver, in this particular case face gender (which might be considered one of Rodin’s “disregard cues”). The irrelevant stimuli, in this case the male face, which initially capture one’s attention, might then be cognitively disregarded, since it is not the participants’ task to pay attention to the male face. Even though attention has been suggested to play a role on Own Race Bias, studies on Own Race Bias have only recently started exploring the importance of the components of attention to faces. These studies seem to suggest that the other race faces capture rather than hold our attention (i.e., Al-Janabi, MacLeod and Rhodes, 2012). The implications of disentangling the attentional components are important, a person capturing ones attention does not necessarily suggest future opportunities for social interaction. This initial orientation of attention might be considered as a brief categorization as to whether future opportunities for social interactions might be desirable or threatening. If this is not the case then the person initially captured might be disregarded, as suggested by Rodin. The attentional holding component might have a different role, and it is argued to be important for encoding (Porges, 1980; Richards & Hunter, 1998). It may be the case that maintenance of attention is more involved with the Female Own Gender Bias. Hence, it was the aim of Study 2 to examine whether face gender modulates maintenance of attention.

In conclusion, the present study confirmed that faces capture attention even when they were task irrelevant. Furthermore, extending the existing literature the current study found that gender of the face modulated this effect; it was the male face that was driving the face capturing the effect. In light of the current literature this novel finding was interpreted in term of the male face being perceived as more threating, hence capturing attention even when the face stimuli was task irrelevant. The gender of participants did not have an effect on face capturing overall, nor did it interact. While this was surprising it might be an indicator that participant gender might be more important on the later stages of attention, and face encoding rather than in the pre-attentional stages of attention.

Chapter 3

3.1 **Study 2a –** Investigating whether the female face retains attention of female observers in a go/no-go task.

Study 1a and 1b suggested that it is the male face rather than the female face that slows down the search for a target butterfly. While, the male face might capture initial attention, it might be that the female face exerts a "hold" on attention that makes disengagements difficult, especially for female participants. Sustained attention is a basic requirement for information processing. Almost all aspects of cognitive processing including encoding, storage and many more occur during the sustained attention phase (Porges, 1980; Richards and Hunter, 1998).

Posner and Petersen (1990) basing their findings on neural mechanisms, have argued that there are three processes of attention, namely 1) disengagement of attention from the current focus of attention 2) shifting of attention towards a new target 3) engagement of attention upon the new stimulus. The disengagement of attention occurs before the initial orienting to that stimulus, and it is considered that the other stimuli surrounding the current stimulus, is processed less efficiently; while all the attentional resources are retained by the stimulus in focus. Engagement of attention on the other hand, makes one more aware of the spatial location of the stimuli and improves their processing. These abilities all belong to the posterior attention system, which is stimulus driven and is utilized when an unexpected and potentially important stimulus is presented (Corbetta & Shulman, 2002). The posterior attentional system involves the parietal lobe, which is responsible for disengaging attention from its present focus; the midbrain area, whose function is to shift the index of attention to the area of the target object; while a portion of the thalamus (the pulvinar area) is engaged in reporting information from the indexed location of attention (Posner & Petersen, 1990). Even though these areas of the brain communicate with each other, they carry out separate attentional functions, as it has been demonstrated by several attentional disorders such as neglect, ADHD, and Autism (Posner & Rothbart, 2007).

The face processing literature as well as Study 1 have demonstrated that faces are able to capture attention (Belopolsky, Devue, & Theeuwes, 2011; Devue et al., 2012; Langton et al., 2008; Sato & Kawahara, 2014). Furthermore, faces have also been found to hold attention, i.e. it is difficult to disengage attention from them (Bindemann et al., 2005). In a series of experiments Bindemann and colleagues (Bindemann et al., 2005) found that upright faces which appeared in the location of an attended go/no-go signal hindered the time taken to classify a peripheral target, taking participants longer to disengage attention from the face stimuli when compared with non-face and inverted stimuli. The go/no-go task offers an improvement from previous attention processing tasks such as the dot-probe paradigm (MacLeod et al., 1986), which makes it difficult to disentangle between engagement and disengagement of the stimuli presented. The distinction between attention being captured and held as stated previously was examined in Al-Janabi and colleagues study (Al-Janabi et al., 2012) on Own Race Bias. Utilizing a variation of the dot-probe task; they found that the other race faces, which capture attention do not seem to hold attention. In the present thesis, Study 1 found that male faces captured attention, hence the aim of present study was to examine whether male faces would hold attention. In line with Al-Janabi et al. (2012) it was predicted that the male face would not hold attention. As mentioned previously, sustained attention is crucial for encoding and storing items in memory, therefore if female faces are remembered better by female observers, it would be expected that the female faces should sustain their attention. The simple go/no-go classification task devised by Bindemann and colleagues (Bindemann et al., 2005) was used to investigate whether the gender of the face modulates maintenance of attention to faces in a sample of female participants. The participants were asked to focus on a central go/no-go signal (designated by a green dot and a red dot, respectively, superimposed on the stimuli), which was followed by the classification of a peripheral line target. On go trials (green dot) they were requested to make speeded judgments regarding the location of the vertical line target (which were located either to the left or the right of the fixation) via keyboard keys. On no-go trials (red dot) they were requested to press the spacebar key to start the next trial. Blank trials, inverted face stimuli and fruit stimuli acted as control conditions. It was expected that female faces would hold the attention of female observers, hence increasing their reaction times. Similar results were expected with eye-tracking data, an increase in saccadic reaction time for female observers when viewing female faces.

3.2 Method

3.2.1 Participants

Nineteen Caucasian participants (all female) aged 18 to 30 took part in the study, none of whom had taken part in the previous studies or the pilot study. In line with Study 1a and 1b, the experiment was advertised as an attention study; hence all participants were naïve to the true nature of the experiment. The study gained approval by the Psychology Department, University of Strathclyde Ethics Committee.

3.2.2 Stimuli

The signal stimuli consisted of a green and red dot (measuring 0.2 degrees of a visual angle in diameter). A black vertical and horizontal line (0.1 x 0.4 degrees of visual angle), acted as targets appearing on either side of the central signal dot (4.6 degrees of visual angle from the centre of the display). The signal dot was superimposed on (1) a blank white display, (2) an upright unfamiliar face (3) an inverted unfamiliar face, or (4) a meaningful non-face image, a fruit image (all images measured 2.3 x 2.9 degrees of visual angle). All picture modifications were carried out in Photoshop CS4. The same face and fruit stimuli used in Study 1a and 1b were used in this study, with the exception that less face stimuli were needed, hence 8 male and 8 female faces were picked at random from the pool of 30 faces (15 male/15 female). T-test confirmed that the male and the female faces did not differ from each other on age [t (14) = -1.55, p = .14], attractiveness [t (14) = -0.55, p = .88], distinctiveness [t (14) = -0.17, p = .86], masculinity/femininity scores [t (14)

= -0.72, *p* = .48]. There were in total 16 unfamiliar upright faces (8 female and 8 male faces – all different identities), and 16 different types of fruit. In the inverted faces condition, the upright faces were inverted, hence resulting in 16 inverted faces.

3.2.3 Design and Procedure

A repeated measures design was utilized with one factor: condition (blank (no image presented), upright face, inverted face and fruit image). The stimuli were presented on the same monitor and the eye movements were recorded as in Study 1a and 1b.

After informed written consent was provided, participants were seated 60 cm from the screen (by means of a chin rest, where they were tested individually). The same procedures as Study 1 were followed regarding fitting participants with the SR EyeLink II headset and the calibration and the validation procedures.

The instructions were repeated also on the screen prior to the experiment, and once confirmation was given that they understood the task the experiment was initiated by the participant. Once the participants fixated on the central fixation dot (manually assessed), the presentation of the first display appeared. The participants initially completed 36 practice trials (no image presented centrally). Each display contained the signal dot (appeared at the centre of the monitor screen), which was green on go trials and red on no-go trials. On go trials the participants were asked to report the location of the vertical line, which appeared either on the left or the right of the signal dot. This was indicated via the button press box, pressing either left or right (depending on which side the vertical line was located). The vertical line was always accompanied by a horizontal line, which always appeared on the opposite side of the vertical line. On no-go trials, the participants were required to ignore the red dot and press the red button on the button press box to initiate the next trial. The signal dot was superimposed on a blank image, an upright female/male face, an inverted male/female face and on a fruit image. These resulted in 4 different conditions, presented as 4 different blocks with 96 trials within each block. The trials were randomized within each block for each participant, as well as counterbalancing the presentation order of the blocks for each participant (See Figure 6 for display examples). In line with Bindemann et al. (2005) the go trials occurred twice as frequently as the no-go trials, as they (no-go trials) acted as filler trials to compose the task. The calibration and the validation procedure were carried out before the presentation of each block. To allow measurement of the eye movements, instead of presenting the stimuli for only 200 msec as Bindemann et al. (2005), the stimulus was left on the screen until a decision was made, which initiated the next trial.

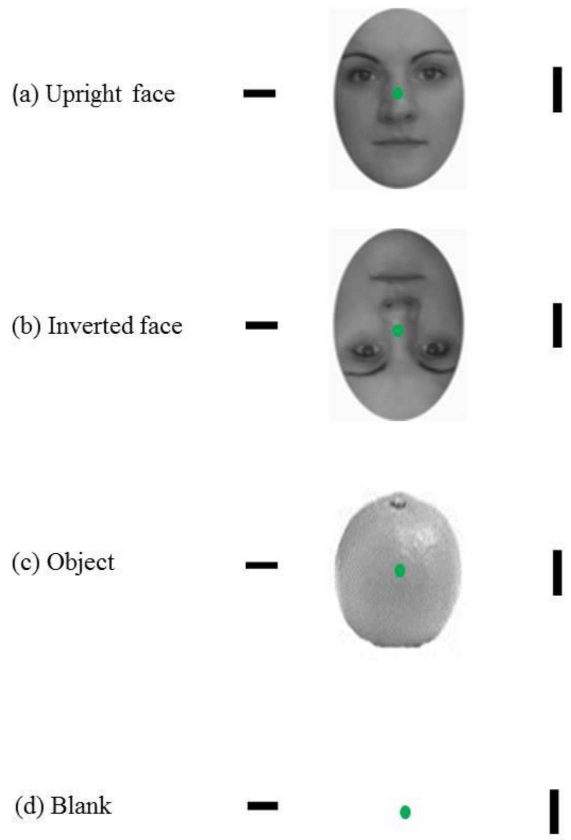

Figure 6 Example displays (not in scale) for Study 2 for Go Trials according to experimental condition

3.3 Results

The analysis for the present study concentrated on the median reaction times for the correct responses on the go trials. The means of median reaction times and the error rates are presented in Table 9. Initially a one-way ANOVA (on RTs for blank vs object vs inverted face vs upright face) was run to examine whether the face holds attention when compared with other objects, then a separate one-way ANOVA was run by splitting the face condition according to face gender (Male and Female), to examine for potential influences of face gender. The initial ANOVA showed an effect of condition [F (3, 54) = 5.05, p = .004]. Further examination of the main effect (Tukey HSD test) demonstrated that responses were significantly faster on the blank condition in comparison with object (p = .005) and inverted faces (p = .03). The responses for the blank condition were not significantly faster than the face condition (p > .05). Surprisingly, the reaction times for the upright face were not significantly slower than all the other conditions (p > .05). Similarly, the reaction times for the object and the inverted face condition were not significantly different from each other (p > .05).

In line with Bindemann et al. (2005) analysis, the present study also examined the no-go trials. The one-way ANOVA showed a similar pattern of results as the go trials [F (3, 54) = 4.82, p = .005]. Examination of the significant main effect (Tukey HSD) indicated that the reactions for the blank condition were significantly faster than the other conditions (object, p = .002; inverted face, p = .02) with the exception of the upright face condition, which did not differ significantly from the blank condition (p > .05). The reaction times for the upright face condition did not differ significantly also from the object and face conditions (p > .05). The reaction times for the object and the inverted face condition did not also differ significantly (p > .05).

Table 9 *Mean Reaction Time (ms), Standard Deviation and Percentage Errors for Each of the Conditions of Study 2a*

Condition	Go Trials			No-Go Trials		
	RT	SD	% Error	RT	SD	% Error
Blank	556.38	97.58	0.03	537.58	78.22	0.06
Object (Fruit)	629.17	125.68	0.03	588.34	82.89	0.06
Inverted face	631.37	137.78	0.03	591.19	102.87	0.08
Upright face	586.37	122.50	0.02	574.27	92.45	0.07

Splitting the upright face and inverted face conditions according to face gender also revealed similar results (Table 10). The reaction times for go trials, showing a main effect for condition [F (5, 90) = 3.97, p = .003], with Tukey HSD indicating that the reaction times in the blank condition were only significantly faster in comparison with the fruit condition (p = .012). The reaction times for the male inverted faces conditions showed a pattern at slowing down the reaction times when compared to the blank condition (however the significance level of .05 was not reached, p = .07). No other comparisons were significant (p > .05).

For the no-go trials a similar pattern was demonstrated, showing a main effect for condition [F (5, 90) = 2.52, p = .03]. Tukey HSD indicated that the reaction times for the blank condition were only significantly faster than fruit (p = .006) and inverted female face conditions (p = .01). No other comparisons were significant (p > .05).

Table 10 *Mean Reaction Time (ms), Standard Deviation and Percentage Error for Each Condition of Study 2a When Face Gender is Taken into Account*

Condition	Go Trials			No-Go Trials		
	RT	SD	% Error	RT	SD	% Error
Blank	556.38	97.58	0.05	537.58	78.22	0.06
Object (Fruit)	629.17	125.68	0.03	588.34	82.89	0.06
Inverted female face	633.32	141.62	0.04	591.84	98.56	0.05
Inverted male face	632.34	139.75	0.04	590.07	115.58	0.05
Upright female face	592.57	129.72	0.04	575.41	97.98	0.04
Upright male face	578.32	115.23	0.04	581.00	103.04	0.05

The eye tracking analysis was not feasible as most of the participants had made less than ten saccades per condition; hence it was decided to slightly change the task in Study 2b, where participants indicated the location of the vertical line by making an eye movement to it.

3.4 Discussion

The main aim of the present study was to examine whether male or female faces hold attention in a sample of female participants. Previous studies suggest that faces in general retain attention, and they are usually remembered better than any other objects (Dobson & Rust, 1994). It was reasoned that since female observer display a memory bias for other female faces, hence it was predicted that faces of their own gender would maintain their attention, considering that sustained attention is crucial for encoding and storage processes in memory.

Reaction time analysis for both the go trials and no-go trials suggested that the presence of an irrelevant upright face did not retain attention, hence it did not result in significantly slower reaction times, when these were compared with the blank, object and inverted faces condition. The results indicated that the object condition was significantly slower than the blank condition, similar results were also found for the inverted faces condition (i.e. inverted faces vs blank condition). However, the inverted faces condition was not significantly different from the object condition; hence in terms of attentional holding properties they did not differ from each other. They (object and inverted faces condition) also were not significantly slower than the upright face. These findings demonstrate that the upright face does not seem to hold attention. The fruit (object) and the inverted faces slow down the reaction times only when compared with the blank condition, suggesting that they might be retaining attention, however they both do not significantly seem to differ from the upright face condition; hence drawing firm conclusions as to whether they retain attention is quite difficult.

Bindemann et al. (2005) found that the blank condition had the fastest responses compared with all the other conditions; furthermore they found that the upright face condition had the slowest reaction times when compared with the other conditions. These findings were not replicated in the present study, even though the same task was utilized. The present study used a greater variety of stimuli, which was not expected to produce different results. In fact, if faces truly hold attention, then they would be expected to hold attention independent of the type and variety of stimuli used in experiments. In total the current study utilized 16 different identities for the face stimuli and 16 different types of fruits, while Bindemann et al. (2005) in all of their studies, they presented only 3 different identities for the face stimuli, and 3 for the object stimuli. The participants in Bindemann's study might have habituated to the 3 different types of non-face stimuli (fruits and inverted faces), and they found it easy to disengage their attention from them. It has been suggested that one of the main functions of visual attention is to enable detection and analysis of new object in the environment (Yantis, 1996). However, habituation occurs when stimuli might or might not be followed by significant information, and this reduced ability to capture attention again is thought to be one of the causes of inhibition of return effect (Hu, Samuel, & Chan, 2011; Lupiáñez, 2010). Therefore, in the Bindemann et al. study, it might be the case that participants got habituated to the three (fruits, flags) object stimuli, while it was still difficult to disengage attention from the biologically relevant upright faces. Furthermore, loss of novelty might have also occurred (in Bindemann's study), considering that there were only three objects, repeated over the

96 trials; loss of novelty has been found to hinder detection processes (Lupiáñez, 2010). Therefore it was probably easier to ignore the objects rather than the upright faces, which have biological value. In the present study it might have been more difficult to get habituated to the object (fruit) stimuli, due to the greater variety (16 different types of fruits, each fruit was repeated only 6 times, while in the Bindemann study each fruit picture was repeated 32 times). The same logic could be applied to the inverted faces, inverted faces are processed in an object like manner, and hence a greater variety would be slightly harder to get habituated to. The fact that the reaction times in the object and the inverted conditions were not significantly slower than the reaction times in the upright faces conditions, suggests that there might not have been any real retention of attention, if this was the case then a significant difference between the stated comparisons would have been displayed.

When the gender of the face is taken into consideration, on the go trials the inverted female face shows slower reaction times when compared to the blank condition; while on the no-go trials the male inverted face seems to show slower reaction times. The results do not demonstrate any retention of attention by upright faces, and gender of the face does not seem to have an effect. It has been argued that when examining the time course and components of attentional biases reaction time analysis might not be enough[20], this has been demonstrated by certain modifications of classic paradigms, as well as adding eye movement measures (Weierich, Treat, & Hollingworth, 2008; Weirich et al., 2011). Considering that it was not possible to examine the eye movements in the current study, as well as the contradictory findings, it was deemed necessary to further examine whether face gender modulated attention retention to faces in Study 2b.

[20] The monitoring of eye movements gives a direct measure of attentional allocation (Field et al., 2004) in contrast with the indirect measures such as reaction times. Eye movement analysis will allow a direct examination of the role of attentional maintenance.

3.5 Study 2b – Examining whether the female face holds the eyes of female observers.

Considering the discrepancies in Study 2a and the lack of eye movement data Study 2b was set up. In Study 2a, an examination of the eye tracking data indicated that participants were not making enough saccades to the target stimuli; hence, in this study (Study 2b) the task instructions were changed. Participants had to make an eye movement (saccade) to the vertical line, instead of indicating its location via the button press device. In this instance, the maintenance of attention by the distractor (the face) was measured via the saccadic reaction times. It was expected that the time taken to make an endogenous (voluntary) saccade to the vertical line would take longer when a face distractor was present than when it was absent. More specifically it was predicted that the female face would hold the attention of female participants.

3.6 Method

3.6.1 Participants

The sample for the present study consisted of twenty eight Caucasian participants (all female) aged 18 to 30 years, none of whom had taken part in any of the previous studies.

3.6.2 Stimuli

The same stimuli were utilized as in Study 2a.

3.6.3 Design and Procedure

The present study followed the same design and procedure as Study 2a with the exception of the following: the participants were instructed to make an eye movement to the vertical line as soon as it was detected. Once the eyes moved to the location of the vertical line, this initiated the next trial.

3.7 Results

The saccadic reaction times (SRT, the time taken to initially move one's eyes from the central stimuli to the peripheral vertical line) were measured via the eye-tracker. This was calculated by the mean time per trial to initially fixate on the peripheral vertical line averaged for each participant separately for trials on the blank, face, fruit and inverted face condition. The analysis was based only on go trials. The descriptive statistics are presented on Table 11.

Table 11 *Mean SRT (ms) and Standard Deviations for Each Condition in Study 2b*

Condition	Go Trials	
	SRT	SD
Blank	374.27	63.63
Object (Fruit)	419.23	94.92
Inverted face	428.70	97.18
Inverted female face	448.36	146.58
Inverted male face	417.96	88.16
Upright face	403.18	73.01
Upright female face	412.64	90.16
Upright male face	404.77	82.17

Initially a one way ANOVA was run on the SRT (saccadic reaction times) (blank vs object vs inverted face vs upright face) to examine whether the SRTs would be slower in the presence of an upright face, considering that Study 2a did not find the basic effect for upright faces holding attention. Similarly to Study 2a, a main effect of condition was found [F (3, 81) = 5.28, p = .002]. Tukey HSD revealed that the

SRTs were faster for the blank condition only when compared to the inverted faces condition (*p* = .002) and the fruit condition (p = .01). No other comparisons were significant (*p* > .05).

When the face condition was split according to face gender, the condition main effect remained significant [F (5, 135) = 3.27, p = .008], similarly Tukey HSD revealed that the SRTs were faster for the blank condition when compared to the fruit (object) (*p* = .04) and male inverted face (*p* = .03). No other comparisons were significant (*p* > .05).

3.8 Discussion

Study 2b utilized only the eye tracker to examine whether face gender modulated attention retention to faces. Similarly to Study 2a upright faces were not found to retain attention. It was only the inverted faces, especially the male inverted face and the object condition which displayed slower saccadic reaction times than the blank condition. It must be noted though, that the inverted faces condition and the object condition were not significantly slower than the upright faces condition, hence they only retained attention more than the blank condition. In both Studies 2a and 2b, the inverted faces condition seemed to display slower reaction times in general. While, it was not the main aim of this thesis to examine whether or not faces retain attention, it is a question that should be further pursued in the literature. The present study started with the assumption that faces retained attention, and the main aim was to explore whether this effect was modulated by face gender. Several studies have demonstrated that face detection might only be affected minimally by face inversion (Lewis & Edmonds, 2005). Upright faces are rapidly detected when presented among non-face objects; however this effect is not present when the upright face is presented among inverted faces (Brown, Huey, & Findlay, 1997; Lewis & Edmonds, 2005). Furthermore, Bindemann and Burton (2008) demonstrated in a series of experiments that attention can be biased effectively towards inverted and upright faces, when they are in direct competition for attentional resources. In the present study, each face was presented one at a time; hence there was no direct competition with other face stimuli. Bindemann et al. would suggest that only upright faces would retain attention; however the present studies did not manage to replicate such an effect. Bindemann et al. seems to be the only study that suggest that faces retain attention, hence it is suggested that the literature would benefit from future research in this topic to clarify the extent to which upright faces retain attention.

Examining attentional capture and retention did not provide sufficient results in answering the main question of this thesis "why female observers display an Own Gender Bias, and why male observers lack an Own Gender Bias". Studies 1a and 1b indicated that the male face seemed to capture one's attention. It was difficult to conclude from Studies 2a and 2b whether male or female faces retained attention as the main finding of faces retaining attention was not replicated. As such it was reasoned that a face memory task, where eye movements are tracked during encoding and recognition stages might provide more effective explanations in answering the main question in this thesis. In fact several recent studies on both Own Race as well as on Own Gender Bias have been conducted, indicating that internal features of the face are paid different levels of attention, especially during encoding (Goldinger et al., 2009; Heisz et al (2013). The next chapter will address the role of attention on encoding in Own Gender Bias, while controlling the levels of expertise in a simple yes/no recognition task.

Chapter 4

4.1 **Study 3 –** Examining gender difference and the influence of differential categorisation of faces on the perceptual characteristics that are utilised at encoding of faces.

As is evident from the literature review on Own Gender Bias, explanations for this phenomenon have been offered, however the studies that have actually tested their hypothesis are limited. The interest hypothesis of McKelvie and colleagues (McKelvie, 1981; McKelvie, Standing, Jean, & Law, 1993) has been left unexplored. Rehnman and Herlitz (2007) were not able to find any relationship between gender schema and face recognition memory. Recent attempts to examine Own Gender Bias have been made in the literature (Lovén et al., 2011; Lovén, Svärd, Ebner, Herlitz, & Fischer, 2014; Palmer et al., 2013), as discussed previously (see Section 1.7) discrepancies in their findings are present. Lovén et al. (2011) argue that the divided attention did not impair female observers' recognition performance for female faces, and conclude that female observers might have greater perceptual expertise, hence even under shallow processing the advantage[21] is still present. On the other hand Palmer et al. (2013) results suggest the opposite. In this thesis, Studies 1 and 2 set out to examine the role of attention; more specifically the attentional capture and attentional retention properties of male and female faces. Male faces were found to capture attention in Study 1a, while no such properties were present when the faces were inverted (Study 1b). Study 2 (a & b) demonstrated that neither of the face genders retained attention. Considering that Studies 1 and 2, did not provide any adequate explanations regarding the main aim of this thesis, and the several studies on Own Race bias, which have investigated the role of attention at encoding (by examining the amount of attention paid to the internal features of same race and other race faces); it was the primary aim of this study to investigate the role of attention at encoding by employing eye tracking technology.

[21] The authors argue that female participants have greater perceptual expertise than male observers as a result their perceptual expertise is not affected by divided attention

In recent years eye movements have proven to be an effective way to examine what information has been taken in, such that they provide an index to the allocation of visual attention (Findlay & Gilchrist, 2003; Yarbus, 1965). Eye movements can help to investigate attentional processes (Henderson, 2003) without relying on experimental manipulations such as the divided task (used by Loven and Palmer). Furthermore, it has been suggested that face learning may be affected by specific eye movements, such that fixations on or near specific features help to encode those features or their interrelations (Henderson, Williams, & Falk, 2005). Eye movement has been used recently in examining gender differences in face memory (Heisz, Pottruff, & Shore, 2013; Lovén et al., 2012) and in general face processing. Eye movement research on Own Race Bias has shown that observers tend to display different patterns of eye movements when presented with own race versus other race faces. Own race faces are more actively scanned with a larger number of short fixations and also more frequent saccades (Wu, Laeng, & Magnussen, 2012). Wu and colleagues confirmed that overall observers spent half the time looking on the eyes, with only 16.9 % at the nose and 7.3 % at the mouth region. More attention was paid to the eyes of own race faces than the eyes of the other race faces, a finding previously obtained by Goldinger, He & Papesh (2009). Wu, Laeng & Magnussen (2012) argued that the greater eye movement activity demonstrated for the own race faces is an indication of a more proficient processing for own race faces. The greater cognitive effort for the other race faces was demonstrated by the pupillary response data when other race faces were viewed (i.e. greater pupil dilation). Furthermore, it has been found that internal features, such as eyes, nose and mouth are more important than the external features (forehead, chin, cheeks, ears and hair) when identifying a person. More attention allocated to these features often results in greater recognition accuracy (Caldara, Zhou, & Miellet, 2010; Gosselin & Schyns, 2001). Considering the importance of eye movements, recent efforts have been made to incorporate it in examining gender difference in face recognition.

Eye tracking gender differences in face recognition.

A few studies have used eye tracking to examine gender differences in face recognition, however no definitive conclusions have been drawn regarding which face features might play a role on Own Gender Bias. Lovén et al. (2012) aiming to investigate the influence of face and participant gender on visual attention and memory for own and other race faces, used a surprise memory test for faces where same gendered faces from own race and other race (side by side on the same trial) were presented in a free viewing task, while eye movements were recorded. A female Own Gender Bias (for both own and other race faces) was found, as well as males showing a better memory for female faces than male faces (only for own race faces). The eye movement analysis demonstrated that other race male faces captured attention, while the own race female faces were viewed for longer periods than other race female faces. Furthermore, the additional time spent on the female faces did not account for better recognition of female faces. Considering that recognition accuracy is closely related to the amount of attention paid to the internal features of the face, Lovén et al. (2012) suggest that "the gaze patterns for female and male faces might differ, and that women might have a gaze pattern optimized for processing female faces" (p. 329).

The eye movements taking place within male and female faces were examined by Heisz and colleagues (Heisz et al., 2013), who combined eye tracking with a face recognition paradigm. The aim was to examine the visual processes taking place during encoding and retrieval of male and female faces. They revealed that during initial encoding females made more fixations than males. However, no gender differences were found in the distribution of fixation across the inner features of the face. Interestingly though, during repeated exposures females made a greater proportion of fixations to the eyes of female faces compared to the eyes of male faces, this was not observed for male participants. It must be noted here that at the initial encoding the participants were only presented with 10 faces, it might be the case that 10 faces were not enough to produce a gender effect. Typical old/new recognition studies have at least 25 to 40 faces presented at the encoding stage.

Hence, the gender differences for the fixation proportions directed to the different features were made evident in the repeated exposure. A significant correlation was found between the number of fixations made at encoding and the memory performance. Furthermore, this finding was translated into the gender differences on memory accuracy, such that males making fewer fixations resulted in lower memory accuracy than females who made a greater number of fixations. The authors also point out that the gender differences originate at encoding since repeated exposure resulted in no gender differences, which suggests that with repeated exposure of the same face stimuli males seem to reach the same level as females.

Another study which illustrates the importance of internal feature is Rennels and Cummings (2013) who examined gender differences in facial scanning across different age groups, more specifically infant (aged 3-4 months, 9-10 months) and adults in a free viewing task. Each face stimuli belonging to a familiar or unfamiliar race was presented on the screen for 5 seconds. The areas of interest did not concentrate on specific features of the face, rather the face was divided into internal (i.e. facial features) versus external (hair including forehead, ears and most of the cheek and chin area) interest areas. The main finding of interest (which is consistent during infancy and adulthood) was that males made more fixation shifts between the internal and external areas, while females showed a pattern for more internal-internal features. This was interpreted such that when presented with faces males take a holistic approach, while females show a more second-order relational processing (i.e. encoding the shape of and spacing between internal features, Maureer, Le Grand & Mordloch, 2002), which might help them in consequent memory. Furthermore, females made more fixations in total which were shorter in duration when compared to males.

It can be concluded from the above findings that females seem to pay more attention to faces in general, however the gender of the faces does not seem to make a difference in particular for the Heisz et al. (2013) study. As mentioned previously, Heisz and colleagues, used only 10 face stimuli in the initial encoding stage, which is a small number of stimuli which might be reducing the reliability of the test. The Rennel and Cummings study did not find any face gender differences in the scanning patterns; however their eye movement analysis was limited such that they examined only differences between the internal and external features, the main features of the face were not taken into consideration. Previous behavioural studies, as reviewed previously usually show an advantage for the female observers on female faces (Herlitz & Lovén, 2013), with the exception of Sommer et al. (2013) and Weirich et al. (2011), who only found a female advantage overall.

Considering the different structure of male and female faces, it is important to find out whether males and females follow different eye movement patterns, depending on the gender of the face that is being viewed. Loven et al (2012) rightly suggests that the eye movement patterns for male and female faces might be different, and that females might be equipped with such patterns that might be optimal for female faces.

Rehnman, Lindholm & Herlitz (2007) in an attempt to examine the underlying processes pertaining Own Gender Bias, manipulated participants' perception of face gender[22] by using non-gender specific (androgynous) faces. A female Own Gender Bias was found, despite the faces being the same androgynous faces. This was interpreted as evidence against a perceptual expertise explanation however they make the assumption that differential categorisation of faces does not influence the perceptual characteristics that are utilised in encoding and retrieval processes. Evidence (as reviewed below) suggests that male and female are physiognomically different, as well as processed by different mechanisms (i.e. (Cellerino et al., 2004). It must be established that changing the observer's categorisation of the face does not alter the perceptual information that is used to encode and subsequently retrieve face representations from memory to rule out a perceptual expertise account. Hence, the present study used a similar methodology as Rehnman, Lindholm & Herlitz (2007) combined with eye tracking technology, to monitor the scan path that the eyes follow during the study phase and determine whether these differ between androgynous faces that are labelled as male and the same faces that are subsequently labelled female with another group of participants.

[22] The authors led participants to believe that the androgynous faces were either male (in the male condition), female (in the female condition), or simply faces (faces condition, where face gender was not specified).

The next section explores physiognomic and perceptual differences between male and female faces.

Are male and female faces physiognomically and perceptually different?

Different mechanisms have been proposed to underlie gender perception. One emphasising the importance of holistic cues (Zhao & Hayward, 2010; Yokoyama, Noguchi, Tachibanam Mukaida & Kita, 2014), while the other hypothesis emphasises the importance of individual features.

One evident difference between male and female faces is the vertical distance between the eyelids and the eyebrows, which is greater in females than in males (Burton et al. 1993, Campbellet al. 1999). Shepard (1989) also suggests that the cheeks of females are fuller and this might be used to classify a face as female. However, Enlow (1982) indicate that the noses of males are larger and this is what makes a face male. This was later on supported by Robert and Bruce (1988) who found that concealing the nose has a detriment effect on male versus female classification reaction time. Nevertheless, Bruce et al. (1993) observed that the eyes, including the eye brows, had the greatest effect on gender judgements. The importance of the eyebrows on gender judgement is also supported by Yamaguchi, Hirukawa & Kanazawa (1995), who found that both the eyebrows and the jaw line were important. The lips have been considered sexually dimorphic, with females having fuller lips; developing due to higher levels of oestrogen (Farkas, 1981; Fink and Neave, 2005).

‘Bubbles’ (Gosselin and Schyns, 2001), a method originally devised to isolate recognition information where the visual stimuli is randomly sampled with Gaussian apertures, has shown that different face features are used for specific purposes. The visible information from the ‘bubbles’ of each trial is reversely correlated with a measure of interest e.g., performance accuracy during a categorisation task, resulting in a classification image (Murray, 2011). The classification image indicates which parts of the image are diagnostic for making correct categorisation decisions. Schyns, Bonnar & Gosselin (2002) suggest that different features are diagnostic dependent on the task at hand. They found that the eyes and the mouth were important to identify faces, as well as the relationship between the two eyes and the mouth. However, for gender classification the relationship between the left eye and both corners of the mouth, as well as the left corner of the mouth and the nose were important. In simpler terms these findings suggests that the relationship between the eyes and the mouth as a whole is important for identifying a face. For gender classification, the importance lies in the relationship between the left eye and both corners of the mouth as well as the relationship between the left corner of the mouth and the nose. While for emotion, the corners of the mouth and their relationship with the eyes are important. The importance of the nose in gender classification becomes apparent as suggested by Enlow (1982) and Robert and Bruce (1988). It should be noted though the importance of the cheeks and the importance of the eyebrows was not tested by Schyns, Bonnar & Gosselin (2002), as their analysis was restricted to only the five space areas (the left eye, the right eye, the nose, the left and the portions of the mouth) which are considered to be the most important in face recognition (Tanaka & Sengco, 1997).

The bubbles study is also supported by a recent eye tracking study; Peterson and Eckstein (2012) using eye tracking suggest that gaze behaviour varies with the perceptual task at hand. It is argued that eyes move to locations within the face that maximize performance, and these locations are dependent on the information that needs to be extracted from the face. For example, in identity tasks the main focus was the eye region with some variability[23] up the tip of the nose. This variability increased all the way to the mouth regions for the emotion task, while for gender discrimination tasks, the main focus was the eyes, with reduced variability.

Research seems to suggest that male and female faces are processed differently, for example Cellerino et al. (2004) using a spatial filtering method to make gender classification more difficult, found that male faces can still be classified as such even if image quality is poor. This was not the case for female faces. These

[23] Spread of participants' eye movements

results indicate that less information is required to recognize male faces than it is required to recognize female faces. In addition, the study confirmed the female advantage with female faces, a similar pattern was demonstrated for male participants with male faces, but did not reach significance. The female advantage with female faces was also confirmed by Megreya, Bindeman and Havard (2011) even when memory demands were eliminated. In addition, male participants found it particularly difficult to identify whether two stimuli are different, especially when the stimuli in question were the external features of female face stimuli (i.e. hair). Furthermore, external features were found to be more important in the identification of male faces, when the two male stimuli were different identities.

The above findings reiterate the importance of examining the assumption made by Rehnman, Lindholm & Herlitz (2007). As mentioned previously, they concluded that female observers attend more to female faces than to male faces, resulting in better recognition performance. Even though the same androgynous faces were presented across the three conditions[24], suggesting that perceptual expertise is controlled in terms of the face stimuli, it is problematic to simply assume that categorisation does not alter the perceptual information used to encode the faces. Own Race Bias research using race ambiguous face stimuli emphasise that the categorisation process drives the observer's motivation to carry out holistic processing. The next section gives an overview of key studies which have made use of race ambiguous faces to examine Own Race Bias.

Research using race ambiguous faces to examine Own Race Bias.

Previous research on Own Race Bias using racially ambiguous faces has provided evidence supporting the social cognitive perspective of Own Race Bias. It has been found that one single physical feature on the ambiguous face is sufficient to produce the Own Race Bias. MacLin and Lapass (2001) created race ambiguous faces which were identical in terms of the facial features and facial configurations,

[24] Female condition, Male condition and Faces condition (where face gender was not specified)

however with the aid of racial markers, such as stereotypical hairstyles they would be perceived by observers as either Hispanic or Black. In other words, the hairstyles would help to categorise faces as one race or the other. Maclin (2003) suggests that categorization appears to modify how faces are stored in memory and their subsequent recognition. These authors suggest that other race faces are processed differently than same race faces as a result of the categorization process. They argue that the racial marker is used for classification purposes in the early stages of face recognition, which determines whether the face will be perceived as an own or other race face, and this will in turn drive the configural process. Hence, this difference does not rely on our perceptual expertise with the face, but on our motivation to carry out holistic processing. Social information has been suggested to affect how physical features are seen and recalled (Eberhardt, Dasgupta & Banaszynski, 2008). Furthermore, it has been found that participants' perception of face race is influenced by semantic information in name form (Hilliar & Kemp, 2008). More specifically, race ambiguous faces with Asian names were rated as significantly more Asian, while the same faces with European names were rated as more European looking (Hilliar & Kemp, 2008). Racial labels have also been found to affect memory for faces. Pauker, Weisbuch, Ambady, Sommers, Adams (2009) showed that white participants had a better memory for those racially ambiguous faces that were labelled white, similar findings were obtained for black participants, mirroring the Own Race Bias on ambiguous face (for contradictory results see Rhodes, Lie, Ewung, Evangelista and Tanaka, 2010).

It can be concluded from the summary above that racial labels or racial cues seem to affect face perception as well as face recognition. Own Race Bias is mirrored on ambiguous faces providing support for the social cognitive accounts. The social cognitive perspective emphasizes the participant's categorisation of the faces, whether they are considered to be from their own race group or from another race group; hence the physical characteristics and the level of exposure are not important. The importance lays in the differential encoding of social in-group and out-group faces (e.g. Sporer, 2001). More recently, it has been proposed by the Categorization-Individuation Model (CIM) that both motivation and experience interact (Hugenberg et al., 2013). On the other hand, the perceptual expertise perspective suggests that racial groups vary from each other on one or more dimensions and participants have different exposure to these racial groups.

Aims and predictions

The current study builds on Rehnman, Lindholm & Herlitz (2007) using androgynous faces (gender ambiguous faces – a morph consisting of 50% male and 50% female) in a between subjects old/new memory experiment where eye movements were recorded. There were three conditions: the male, female and the faces condition. In the male condition participants were instructed to carefully observe and look at the male faces and try and remember them as their memory would be tested afterwards. The same instructions were given for the female and faces conditions with an emphasis of gender category in the female condition and no specification of gender category was given in faces condition. To make sure that the participants did not doubt the gender of the face, the faces were inter-mixed in each of the conditions, such that for example in the female condition the androgynous faces were randomly intermixed with female faces (consisting of a female face morphed with a different female face), in the male condition the same androgynous faces were intermixed with male faces (consisting of a male face morphed with a different male face), and in the faces condition, the same androgynous faces were inter-mixed with further androgynous faces. Using the same methodology, Rehnman and colleagues found a Female Own Gender Bias despite the faces being the same androgynous faces across conditions. The findings were interpreted as evidence against perceptual expertise, as well as emphasising that attention paid to the female face plays an important role on the Female Own Gender Bias. The present study aimed to extend Rehnman, Lindholm & Herlitz (2007) and examine whether differential categorisation of faces influences the perceptual characteristics that are utilised at encoding. In other words the present study explored whether the change in observers’ categorisation alters perceptual information that is used at encoding. Initially a Female Own Gender Bias was expected to be found in terms of behavioural analysis of recognition accuracy. The main goal was to use the eye tracker to inform on the location of fixations within the face throughout the encoding stage; if Rehnman, Lindholm & Herlitz's (2007) claims were correct then it would be expected that the perceptual information extracted from the face would not differ across the androgynous faces in the three conditions. In order to carry out the eye tracking analysis, the face was divided into the following areas of interest: eyes, nose and mouth, as well as the brow area, whose importance has been emphasized in gender judgement (Yamaguchi, Hirukawa & Kanazawa (1995) as well as in identity (Sadr et al. 2003).

The second aim was to examine observers' gender differences on the attention paid to specific facial features, as well as any possible interactions between observer gender and face gender. More specifically it was hypothesised that female observers would be making more fixations on the androgynous faces labelled female than on the androgynous faces labelled male, and especially on the eye region, which is more specific for identity (Schyn et al. 2001). In accordance with the Own Race Bias literature it was expected that these fixations would be greater in number as well as shorter in durations, which would suggest a more efficient processing of the area viewed (Goldinger, He, & H. Papesh, 2009; Wu et al., 2012). If this was the case, then perceptual expertise would not be a plausible explanation for Own Gender Bias, as these two sets of androgynous faces are exactly the same. Socio-cognitive models would predict that male and female faces would be processed differently such that in-group faces would be individuated (for example a female observer viewing a female face would be attending to those features that distinguish one female face from another female face), while out-group faces would be processed to a categorical level (for example a male observer viewing a female face would be paying attention to those features which differentiate a female face from a male face, the features which categorise the face as female). By employing eye tracking the type of processes would come to light. More specifically, the number and duration of fixations to the specific facial features for each face gender, and any interactions with observer gender would be revealed.

The third aim was to examine gender differences in high and low memory accuracy performers on their eye movement behaviour for the specific facial features. It is usually found that female observers outperform male observers, and why they remember better female faces compared to male faces, still remains unexplained. Heisz et al. (2013) found that this might be due to females more frequent scanning behaviour. It has also been found that higher memory performers usually pay more attention to the eye region (Sekutchi, 2013). Hence, it was of interest to examine whether there would be any gender differences on both high and low performers regarding the allocation of attention on face features depending on the gender of the face, especially in the present case where perceptual expertise is controlled for. This analysis would give a better indication as to which features of the face are used at encoding by those observers that perform well in accuracy memory and those that do not. This would clarify as to which features of the face are worth paying attention to, and which ones are less informative, and whether male and female observers differ in the way that scan the faces. It was predicted that high performers would be paying more attention to the more informative features such as the eye region. In line with Heisz and colleagues it was predicted that female observers would to be directing more attention to the eyes of those androgynous faces believed to be females than on those believed to be males/faces. No such differences were expected for male observers.

4.2 Method

4.2.1 Participants

173 participants took part in the present experiment (see Table 12 for further details), ages were constrained to be from 17 to 31 years due to Own-Age bias and all were Caucasian due to Own-Race bias. All participants were naïve with regard to the true nature of the experiment and all had normal to corrected vision (self-reported).

Table 12 *Participant Details for Each of the Conditions of Study 3*

	Faces Condition		Female Condition		Male Condition	
N	29 Male	29 Female	26 Male	30 Female	29 Male	30 Female
Mean Age (years)	21.58	22.79	19.93	21.38	22.41	21.07
SD	3.71	3.79	2.30	2.55	3.17	3.14
Age Range	17-29	18-30	18-28	18-28	18-31	18-29

4.2.2 Apparatus

The stimuli was presented centrally on a 19 inch Viewsonic monitor with 1280 x 1024 pixel resolution and an 85 Hz refresh rate. The SR EyeLink II eye tracking device (SR Research, Ontario, Canada) was used to record eye movements, which uses the centre of the pupil to define pupil position. Eye movements were recorded by two small cameras mounted on the head band (just below the eyes) which sent the pupil position data at a 500 Hz sample rate (at a spatial resolution, typically of 0.01degrees) on the host computer. The position of the head was monitored by another camera mounted centrally on the headband, which recorded illumination from four infra-red emitting LED markers mounted on the edges of the display computer’s screen, which compensated for small head movements.

4.2.3 Stimuli Preparation

Four pilot studies were carried out in order to create the stimuli used in the in the current study.

Pilot 1A

294 images (149 male faces and 145 female faces) were collected from 4 different face databases (FACES database, the Productive Aging Laboratory (PAL) Face Database (Ebner et al, 2010), Glasgow Unfamiliar Face Database (GUFD) (Burton, White and McNeill, 2010), NimStim Datase (Tottenham et al., 2009), FRI CVL Face Database (Solina, Peer, Batageli, Javan, & Kovac, 2003). The faces selected were all in frontal view of individuals aged roughly 18 to 30 years, with neutral expressions and free of facial hair, glasses and jewellery. Three different types of morphed faces were created: Male-Female Morph (Androgynous Faces), Male-Male Morphs, and Female-Female Morphs. Faces were randomly morphed[25] using FantaMorph software (Abrosoft, 2005). In order to account for the different lighting and contrast effects between the different databases, it was deemed necessary to randomly morph faces across the different databases. The template from PsychoMorph was used as a guide, as to where the location of the nodes[26] would be placed on the parent faces[27] approximately 140 nodes were places on key features of the each of the parent faces. A continuum of 41 morphed images was created, and the image which was a 50% morph (similarly to the race ambiguous studies) was chosen to be included in this Pilot Study (Pilot 1A). A total of 147 morphed face stimuli were created, 74 M-F pairs, 37 M-M pairs and 36 F-F pairs. The final stimuli was cropped and placed into an elliptical shape to remove the hair and the jaw line (all face editing was carried out on Photoshop Cs4). Twenty seven participants (12 males and 15 females) rated the faces on the following variables (age, attractiveness, distinctiveness (how is it to find the face in a crowd), gender, masculinity/femininity). Each question was accompanied by the face, and it appeared on the right hand side of the face, where the participants used the keyboard to type in the answer to the questions. Attractiveness, Distinctiveness, Masculinity for male faces and Femininity for female faces, were all rated on a scale of 1 to 10 (1 meaning “Very Unattractive”, “Very Hard”, “Not at all masculine or not at all feminine

[25] Faces were given a number as well as a letter (indicating their gender, F for female and M for male) e.g. 1F, 2M, 3F… and then face number 1F was morphed with face number 2M, no particular strategy was used.

[26] Little dots used the indicate the location of features within the face

[27] The initial faces which were morphed

(depending the face gender)", respectively and 10 meaning "Very Attractive, "Very Easy", "Very masculine or very feminine (depending the face gender)" respectively). For Age, they were asked to provide a number, and for Gender, participants were required to type in Female or Male. The stimuli measured 19 x 13 cm and were presented centrally on the computer screen viewed from 57 cm. The stimuli were presented at the same size as in the actual memory study. The mean age, attractiveness, distinctiveness, gender agreement and masculinity/femininity was calculated for each of the morphed faces. It was reasoned that for a face to be judged as androgynous, the agreement rate among the participants would be low, such that half of the participants might decide that the face was a female and the other half might think it was a male, accompanied with low femininity and low masculinity ratings. Furthermore, it was expected that there would be no disagreement for the F-F morphs and the M-M morphs in the gender decision making, and medium to high masculinity/femininity ratings. The results demonstrated that most of the disagreement was conveyed by the F-F morphs, especially images 2FF, 3FF, 7FF, 14FF, 15FF. Furthermore, the pilot demonstrated that most of the M-F morphs were perceived as Male Faces, rather than Androgynous. 54% of the images were rated as Males (70% + of the participants rated these faces as Males), only 23% were rated as Females (70% + of participants rated these faces as Females) and only a very small proportion of the images (only 14 images, 19%) were images which would have been ok to be used as Androgynous Faces. It was concluded that these images were not enough to conduct the Memory study, as a total of 60 Androgynous M-F Faces, 30 F-F morphs, and 30 M-M morphs were needed. This led to further piloting of the parent images described below (Pilot 1B).

Pilot 1B

It was concluded from Pilot 1A that the image which was a 50% morph of a Male and Female parent image was not necessarily an Androgynous Face. It was reasoned that a masculine female face morphed with a male face (even slightly low in masculinity) would lead to a M-F morph, which might be perceived as a male. Initially rating the parent faces would overcome this problem, such that a highly feminine face morphed with a highly masculine might be more likely to produce an androgynous face. Similarly to Pilot 1A, the images were manipulated on Photoshop. In this pilot study (Pilot 1B), it was decided that the 148 face stimuli would be rated initially on the same variables as Pilot 1A (age, attractiveness, distinctiveness, gender, masculinity/femininity), however participants found this task very tedious (taking approximately 2 hours to complete), hence it was deemed suitable to divide the images in two groups of 124 images. Group 1 images (55 female faces and 69 male faces) were rated by 45 participants (25 Males and 20 Females), and Group 2 images (56 female faces and 67 male faces) were rated by a different group of 43 participants (24 Males and 19 Females). After the images were rated they were again manipulated on Photoshop to remove make up traces and also any 5 o'clock shadow on the male faces. The images then were subjected to the morphing procedure in Fantamorph. The M-F morphs were created only with parent Male and Female faces which had 100% gender agreement. Furthermore, only those parent faces with the highest ratings of Masculinity/Femininity (ratings of 7+) were used. The F-F morphs and the M-M morphs were created with parent faces which were medium to high in femininity/masculinity (ratings of 6+). A total of 98 M-F morphs, 36 F-F morphs, and 32 M-M morphs was created. The morphing of the images was carried on Fantamorph, as described in Pilot 1A. For each morph set a total 41 images was saved, representing the transformation from one parent face to the other. These images were subjected to further piloting in Pilot 1C and Pilot 1D. Instead of picking the 50% morph image for the morph faces, it was decided that the participants themselves would pick the face that seemed most androgynous (Pilot 1C), and the most feminine/masculine face (Pilot 1D).

Pilot 1C

Fifty three participants (27 Female and 26 Male) took part in this pilot study (Pilot 1C). In total the participants were presented with 98 M-F morphs. Each M-F morph, measuring 19 x 13 cm was centrally presented on the computer screen. Each M-F morph set comprised of 41 images, the participants were able to go through the continuum of the 41 images with the aid of the two arrows at the bottom at the image, one pointing to the left and one to the right. The participants were advised to familiarize themselves with the whole continuum of images before deciding which face seemed the most androgynous. After they decided on the most androgynous face, they clicked on the image and the image number was recorded. There was some disagreement regarding the images which were picked as most androgynous. This was most likely due to the large number of faces in the continuum of faces (where the face transformed from one gender to the other). A systematic approach was used in discarding the images where there was disagreement and in selecting the face which participants picked as the most androgynousness. The continuum of 41 images was divided into 4 clusters (Images 1 to 10, Images 11 to 20, Images 21 to 30, and Images 31 to 41). The number of times that each of the images within each cluster was noted, they were added up and converted to percentages (i.e. images 1 to 10 were selected 30%). The cluster with the highest percentage was selected as the cluster where most participants agreed on the androgynousness of the face. The image within this cluster which was picked most frequently was selected as the final androgynous face. Those clusters which had similar percentages were discarded. Two images had to be excluded due to experimental error. This method led to only 60 images (M-F morphs) to be used in Study 3.

Pilot 1D

Fifty two participants (26 Males and 26 Females) took part in Pilot 1D. Half of the participants were presented first with the F-F morphs and the other half were presented first with the M-M morphs. The participants were instructed to pick the most feminine face from the F-F morphs and the most masculine for the M-M morphs. In order to avoid the parent faces being picked as the most feminine/masculine, this was considered necessary as the androgynous faces needed to be as similar to the F-F/M-M morphs in terms of image quality or image manipulation. Hence, the mean minimum image number and the mean maximum image number that the participants picked from Pilot 1C were calculated. This resulted in image 13 and image 31 (mean min and mean max, respectively). Hence, from the 41 F-F/M-M image continuums created only images 13 to 31 were selected to be used in Pilot 1D. In total there were 78 image sets, 36 F-F morphs and 42 M-M morphs, the participants had to selected the most feminine/masculine face from a choice of 19 images. The same experimental set up was used as in Pilot 1C, such that the image was displayed centrally and the participants clicked on the image when a decision was made. The same systematic approach as Pilot 1C was taken when examining the results. The images were divided into 3 clusters (Images 1 to 6, Images 7 to 12, and Images 13 to 19), and the frequencies for each cluster were added up and converted into percentages, the images with similar percentages were discarded; only 30 M-M morphs and only 30 F-F morphs were kept to be used in Study 1. The mode within the cluster with highest frequency was chosen as the final images.

Details of the final stimuli used

All face stimuli were grey scale, they were presented centrally on the computer screen, measuring 19 x 13 cm. As mentioned above there were 30 M & M morphs, 30 F & F morphs, and 60 M & F morphs. The M & F morphs were divided into two groups: group 1 was the androgynous faces and group 2 was the filler androgynous faces, which was used in the Faces condition (See Figure 7 for example of androgynous face stimuli). Due to lack of stimuli, the filler androgynous faces were composed of the same parent faces that constituted the F & F and M & M morphs. This was not deemed to be a problem as the experiment was between subjects.

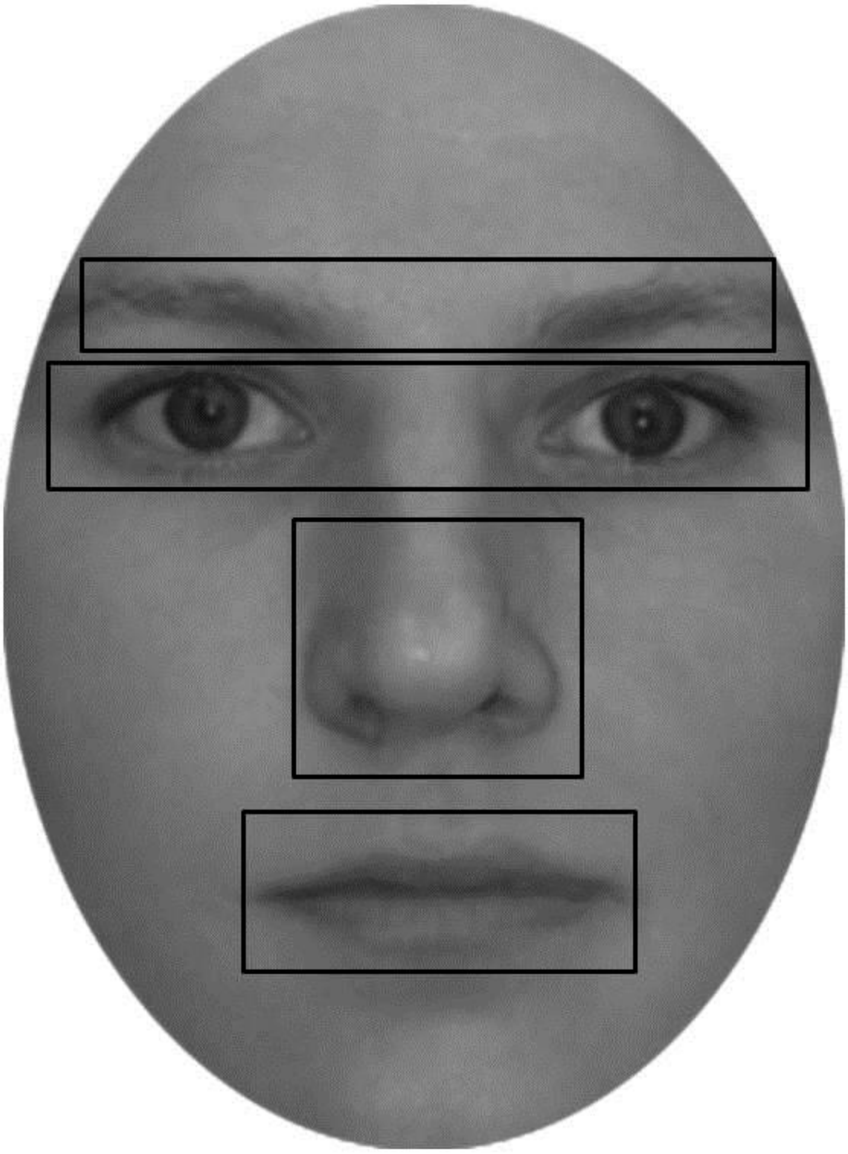

Figure 7 Example of gender ambiguous (androgynous) Face Stimuli used in Study 3 (not in scale). The boxes around the eyebrows, eyes, nose and mouth regions represent the interest areas in which the face was divided during the eye movement data analysis. These boxes were not present during the actual study

4.2.4 Procedure

Prior to giving informed written consent the participants were asked to read the information sheet and consequently sign the consent form. The participants were tested individually in a dimly lit quiet room. They were informed that they would complete a face recognition experiment consisting of learning and a recognition stage. Participants were instructed that in the learning stage they would be presented with a number of faces on the computer screen and should try and memorize them in order to recognize them later. All participants were required to rest their chin on the chin rest, which made sure that the distance between the eyes and the monitor was 57 cm. Next participants were fitted with the lightweight headset. Even though the cameras record from both eyes, only the data from the eye with the best spatial accuracy (determined by the calibration and validation procedure) was used in the analysis. Prior to the learning and the recognition stage, the 9-point grid calibration and validation procedure was carried out. This involved the participant saccading to a dot (0.5 degrees in diameter) which randomly appeared at 9 points on a 3 x 3 grid on the computer screen. On successful calibration the same procedure was repeated for the validation process, after which the participants were again presented with simple instructions on the computer screen to place emphasis on the type of faces that they would be presented with. In total there were 6 separate groups in wholly between-groups design: male/female observers looking at "female" faces; male/female observers looking at "male" faces and males/females looking at "unspecified gender" faces. For example, if they were in the Female Condition, the instructions on the screen were "*You will be presented with Female faces. Your objective is to remember the Female faces*". The instruction were similar for the Male Condition and for the Faces condition, such that the word Female was replaced by Male or Faces (without specifying the face gender). The gender of the faces to be presented was again reinforced by the experimenter, priming the participants as to what gender type the faces would be. During the learning stage 30 target faces (15 Androgynous and 15 F & F morphs/M & M morphs/M & F morphs – referred to as filler male/female or androgynous faces from this point, depending on the experimental condition) were randomly presented on the computer screen for 3 seconds, the inter-stimulus interval was the time taken to carry out the drift correction, where the participants were asked to fixate on a dot before being presented with the next face stimuli. A standard visuo-spatial distractor task (Rey's Complex Figure) was given to complete in – between the learning and the recognition stage, which appeared on the computer screen for 2 mins. The task took approximately 6 minutes to complete. Before the recognition task began, the participants were instructed that they would see a series of faces (again placing emphasis on the gender of the faces, depending on the experimental condition), some of which they had seen during the learning stage (old faces – targets) and some of which they had not seen (new faces – foils). They were instructed to press the appropriate key (yes/no) on the keyboard to indicate whether they had or had not seen the face during the learning stage. Sixty faces were displayed in the recognition stage – comprising the 30 faces presented in the learning stage (15 Androgynous and 15 filler faces and 30 new faces (15 Androgynous and 15 fillers), randomly displayed for each participant. Ten seconds were allowed for each recognition judgment, with a warning to make a response on the 7th second if they not already done so.

Due to the fact that it was not possible to control for factors such as attractiveness and distinctiveness for the faces used in the presented experiment (due to a limited number of androgynous faces), it was decided that for each participant 15 filler target faces were randomly selected from a pool of 30 filler faces, and 15 androgynous target faces were randomly selected from a pool of 30 androgynous faces. The remaining 15 filler faces were used as filler foils for that participant, similarly the remaining 15 androgynous faces were used as androgynous foils. This procedure made sure that any effects found were not necessarily due to the face stimuli used, but it was due to the experimental manipulations.

4.3 Results

H1: Are Rehnman and colleagues' (2007) findings replicable?

Behavioural data analysis

Signal detection measure of sensitivity d-prime was used to calculate accuracy based on formulae from Macmillan and Creelman (1991).

D-prime, a parametric test is used to determine the accuracy of the participants in response to test stimuli. The proportion of Hits (H) and proportion of False Alarms (FA) are utilized in the d' calculation. A d' score of 0 is indicative of chance performance, while higher scores indicate more accurate performance. The following analysis is carried out only on the androgynous faces that were present in all the three conditions.

There were two independent variables: gender labelling condition (faces, female and male), observer gender (male and female). The dependent variable was the mean d-prime scores. Exploration of the data led to outliers being detected. The outliers (approximately 3 outliers per condition) were replaced by the mean plus two times standard deviations as suggested by Field (2009).The mean d' scores are presented in Table 13 for the three experimental groups and the observers. Both males and females observers seem to score above chance level (d' > 0). This was confirmed by one sample t-tests for each of the conditions for both male and female observers[28].

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[28] Female condition: Female observers [t (25) = 8.91, p < .001], male observers [t (29) = 6.25, p < .001]; Male condition: Female observers [t (29) = 11.92, p < .001], male observers[t (28) = 6.82, p < .001]; Faces condition: Female observers [t (29) = 7.72, p < .001], male observers [t (28) = 8.81, p < .001]

Table 13 *Mean and Standard Deviation (in Parenthesis) Recognition Accuracy (d') for Faces, Female and Male face conditions by Male and Female Observers for Study 3*

		Face Gender		
		Faces	Female	Male
Observer Gender	Male	0.77 (0.47)	0.48 (0.42)	0.47 (0.37)
	Female	0.68 (0.47)	0.76 (0.44)	0.73 (0.33)

A 3 (Gender Labelling Condition: Faces, Female, Male) X 2 (Observer Gender: male, female) between groups analysis of variance (ANOVA) was run on the d' scores for the recognition test. The main effect for gender labelling condition was not significant [F (2, 167) = 1.51, $p > .05$]. However, there was a significant main effect for observer gender [F (1, 167) = 5.46, p =.02] with female observers (M = 0.72) demonstrating a better recognition accuracy than male observers (M = 0.57). More importantly, there was a significant interaction between gender labelling condition and observer gender [F (2, 167) = 3.62, p =.03]. The interaction was examined by using simple effects analysis (Keppel, Saufley, & Tokunaga, 1992), this type of analysis simplifies the original ANOVA by separately paying attention to "one IV while the other is held constant", it has been has been said to "illuminate" the interaction, rather than obscure it (Keppel, Saufley & Tokunaga, 1992, p. 288). The factorial design was split into two single factor experiments, into the simple effects of the Gender Labelling Condition Variable and the simple effects of the Observer Gender Variable. The simple effect of Gender Labelling Condition for Male Observers was significant [F (2,167) = 4.77, $p < .05$], while for Female Observers there was a non-significant effect [F (2, 167) < 1]. The significant simple effect for Male Observers was further examined by utilizing Pairwise Simple Comparisons (Keppel, 1992), indicating that Male Observers performed better with the androgynous faces labelled Faces, than those labelled Female or Male [F (1, 167) = 7.34, $p < .01$; F (1, 167) = 6.66, $p < .01$, respectively]. The analysis for the simple effect of the Observer Gender Variable demonstrated significant gender differences only for the Male condition [F (1, 167) = 6.87, $p < .01$], such that Female Observers outperformed Male Observers only in recognizing those androgynous faces labelled Male. A similar pattern of results was also shown for the Female Condition [F (1, 167) = 2.96, $p > .05$]; however it missed the significance level of $p < .05$.

Analysis of the filler faces[29] (Male-Male morphs, Female-Female morphs, Androgynous-Androgynous morphs) revealed a significant main effect only for the observer gender [F (1, 167) = 5.38, $p = .02$]. Overall, female observers performed better than male observers (M = 0.66; M = 0.50, respectively). The main effect for gender labelling condition and the interaction was non-significant [F (2, 167) <1; F (2, 167) = 1.47, $p > .05$ respectively]. The usual Female Own Gender Bias[30] was not found.

Summary of behavioural data

Female observers have clearly demonstrated an advantage in recognition accuracy. Overall female observers outperformed male observers, more specifically significant gender differences favouring female observers were shown for the Male condition; a similar pattern was also demonstrated for the Female condition. The analysis also revealed that male observers demonstrated better recognition accuracy when face gender was not stated than when the androgynous faces were categorised as female or male. It might be the case that the categorisation process led male observers to attend to category-diagnostic information, rather than individuating information.

[29] Similarly to the androgynous faces, the DV for the filler faces was the d-prime scores
[30] I.e. female observers demonstrating a better memory for female faces than for male faces

H2: Does gender categorisation alter the perceptual information that is used to encode faces (androgynous)? Are there any gender differences in the perceptual information that is encoded from the androgynous faces in each of the gender labelling conditions?

The eye tracking technology was utilized to further examine the above questions. Initially the eye tracking data processing procedure are described, followed by the eye tracking measures which were taken during the experiment and are used in subsequent data analysis.

Eye tracking Data Processing

Trials were excluded if (1) participants anticipated the stimulus appearance by making a saccade with latency (saccadic reaction time) shorter than 80ms (2) they improperly fixated the central stimulus (deviation larger than 1 degree) (3) the amplitude of the eye movement was less than 1 degree (Machado & Rafal, 2000). This meant that for each of the gender labelling conditions < 10 % of the data was excluded.

Eye Tracking Measures

The eye movement analysis was only carried out on the Androgynous faces in each of the conditions. The analysis was divided into the learning stage and the recognition stage. Eye movements were measured in terms of the fixations made to the each of the features of the faces; hence interest areas were defined on each face using Dataviewer (SR Research, Ontario, Canada). Each face was divided into 4 areas of interest, the eyebrows, the eyes, the nose and the mouth (see Figure 7 for examples of interest areas used).

The following parameters were analysed for the learning stage:

- Proportion of fixations on each feature of the face

The total number of fixations on each feature compared to the total number of fixation for the whole face was calculated for each participant for each trial. The average of these proportions was then calculated for each participant separately for trials consisting of the androgynous faces (only the analysis for the androgynous faces was of interest). This procedure was deemed suitable to control for the different number of fixations generated in different trials.

- Fixation durations on each feature of the face

For each pre-defined face area, the average fixation duration for each participant, for each trial was calculated only for the androgynous faces. Only the analysis for the androgynous faces was of interest.

For both fixation number and fixation duration a 3(Gender Labelling Condition: Male, Female, Faces) X 2(Observer Gender: Male, Female) between groups ANOVA was carried out for each of the face features (eyebrows, eyes, nose and mouth. More fixations in a particular area indicate an increase in interest, while longer fixation durations suggest that the area might be a bit difficult to extract the information from or more engaging in some way (Poole et al. 2004).

Number of Fixations

The eye region

The descriptive statistics for fixation proportions on the eye region during the encoding of androgynous faces are presented in Figure 5. There were no significant differences for observer gender or for gender labelling condition [F (1, 169) < 1; F

(2, 169) = 1.34, *p* > .05 respectively). Also the interaction was non-significant [*F* (2, 169) < 1].

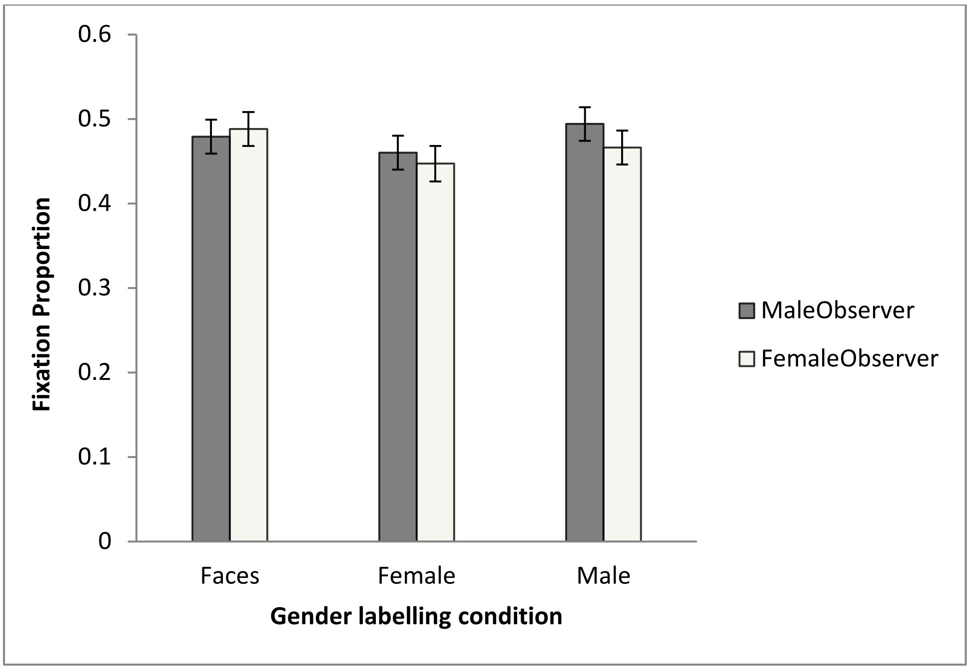

Figure 8 Fixation proportion for the eye region during the encoding of androgynous faces according to gender labelling conditions (error bars show means +/- 1 standard error)

The eyebrow region

The descriptive statistics for fixation proportions on the eyebrow region during the encoding of androgynous faces are presented in Figure 6. The main effects were non-significant for both Observer Gender and for Gender Labelling Condition [*F* (1, 169) = 1.60, *p* > .05; *F* (2, 169) < 1, respectively]. However, there was a significant interaction [*F* (2, 169) = 3.76, *p* = .025]. The interaction was examined by the simple effects method as described by Keppel (1992). This indicated that there was a significant simple effect for the Gender Labelling Variable for the Female Observers, which when further examined with Pairwise Simple Comparisons showed that Females made more fixations on the eyebrows of those Androgynous faces labelled Faces than those labelled Female [*F* (1, 167) = 7.41, $p < .01$] or Male [*F* (1, 167) = 3.53, $p < .05$, respectively]. Analysis for the simple effect for the Observer Gender Variable suggest that Female Observers were making more fixations on the eyebrow region than Male Observers on those androgynous faces labelled Faces [*F* (1, 167) = 12.6, $p < .01$]. However, for the same androgynous faces labelled Female, the Male Observers were making more fixations than the Female Observers [*F* (1, 167) = 3.15, $p < .05$].

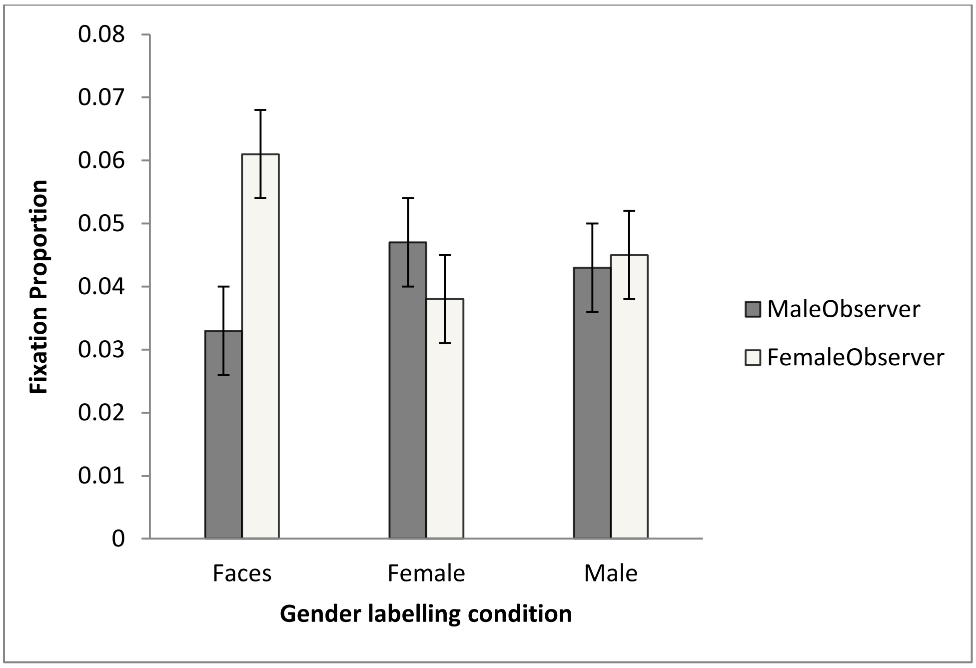

Figure 9 Fixation proportion for the eyebrow region during the encoding of androgynous faces according to gender labelling conditions (error bars show means +/- 1 standard error)

The mouth region

The descriptive statistics for fixation proportions on the mouth region during the encoding of androgynous faces are presented in Figure 7. The between groups ANOVA did not reveal any significant effects for gender observer or for gender labelling condition [*F* (1, 169) < 1; *F* (2, 169) = 2.12, $p > .05$, respectively]. The interaction was also non-significant [*F* (2, 169) = 1.13, $p > .05$].

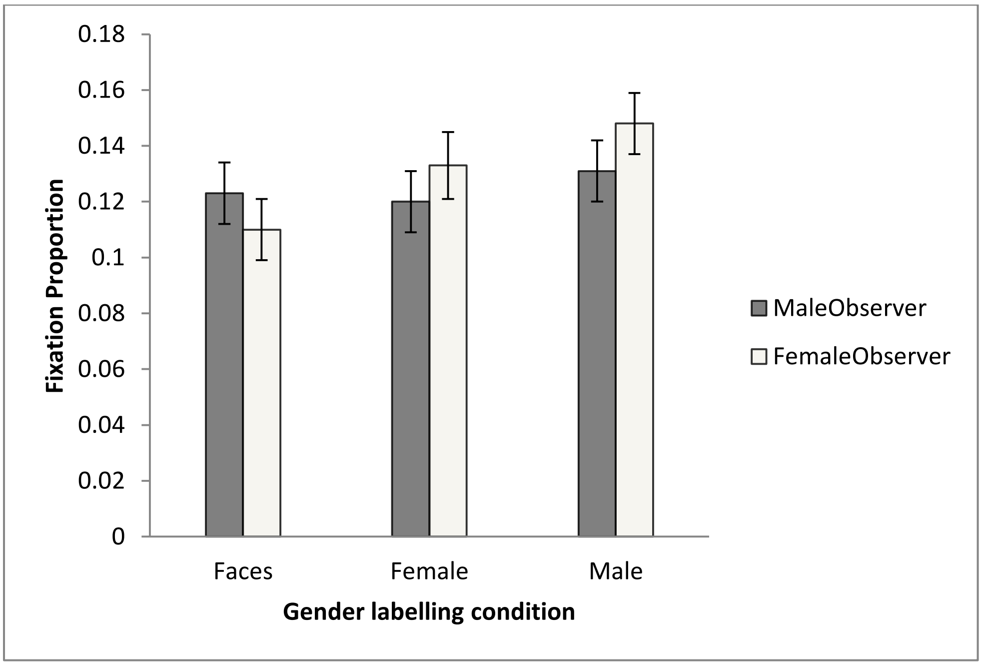

Figure 10 Fixation proportion for the mouth region during the encoding of androgynous faces according to gender labelling conditions (error bars show means +/- 1 standard error)

The nose region

The descriptive statistics for fixation proportions on the nose region during the encoding of androgynous faces are presented in Figure 8. The main effect for observer gender was not significant [F (1, 169) < 1], however the main effect for gender labelling condition was significant [F (1, 169) = 5.57, p = .005], demonstrating that overall more fixations were made on the androgynous faces labelled female than those labelled male. The interaction between the observer gender and the gender labelling condition was also significant [F (2, 169) = 3.78, p = .025]. The simple effects method (Keppel, 1992) did not show significant simple effects for the Gender Labelling Variable (male observer: F (2, 169) = 2.50, p > .05; female observer: F (2, 169) < 1), however there was a significant effect for the Observer Gender Variable, such that Male Observers made more fixation than Female Observers on the nose region of those androgynous faces labelled Faces [F (1, 169) = 4. 09, p < .05]. No other comparisons were significant [F (1, 167) < 1].

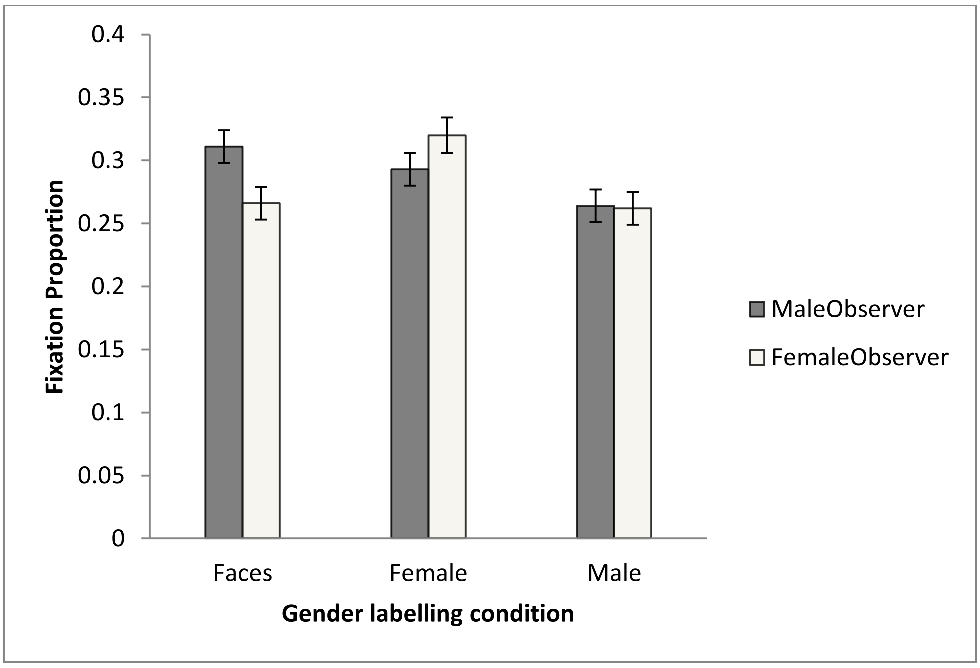

Figure 11 Fixation proportion for nose region during the encoding of androgynous faces according to gender labelling conditions (error bars show means +/- 1 standard error)

Summary of findings for fixation number

During the face learning task the following pattern of number of fixations were revealed. The significant differences were in the eyebrow and on the nose regions. Female observers made more fixations than male observers on the eyebrow region of the androgynous faces labelled Faces, while for those androgynous faces labelled Female, Male observers were making more fixations than Female Observers. Overall for the nose region more fixations were made on the androgynous faces labelled Female than those labelled Male. Also, male and female observers differed on how many fixations were made on the nose region, such that more fixation proportions were made by male observers than female observers only for the gender labelling condition of faces, no gender differences were found on the other conditions.

Fixation duration

Eye Region

The descriptive statistics for fixation duration on the eye region during the encoding of androgynous faces are presented in Figure 9. There was a significant main effect for Observer Gender [F (1, 169) = 6.39, p = .01], with male observers fixating for longer than female observers (Mean = 286.40; Mean = 270.06, respectively). The main effect for gender labelling condition was also significant [F (2, 169) = 3.28, p = .04]. The interaction was non-significant [F (2, 169) < 1]. The main effect of the Gender Labelling variable was further examined utilizing pairwise main comparisons (Keppel, 1992), this showed that overall, observers made longer fixation durations on the eye region of those androgynous faces labelled Females than those labelled Males [F (1, 169) = 4.63, p < .05]. No other significant differences were present.

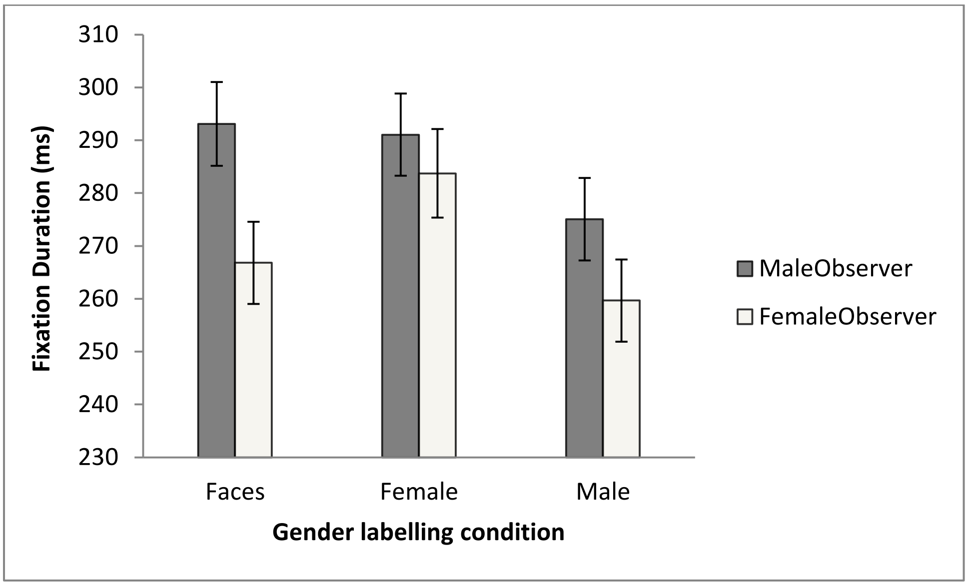

Figure 12 Fixation duration on eye region during the encoding of androgynous faces according to gender labelling conditions (error bars show means +/- 1 standard error)

Eyebrow Region

The descriptive statistics for fixation duration on the eyebrow region during the encoding of androgynous faces are presented in Figure 10. There were no significant differences for the eyebrow region for the observer gender main effect, the gender labelling main effect or for the interaction on the brow region [F (1, 148) = 1.34, $p > .05$; F (2, 148) < 1; F (2, 148) < 1, respectively].

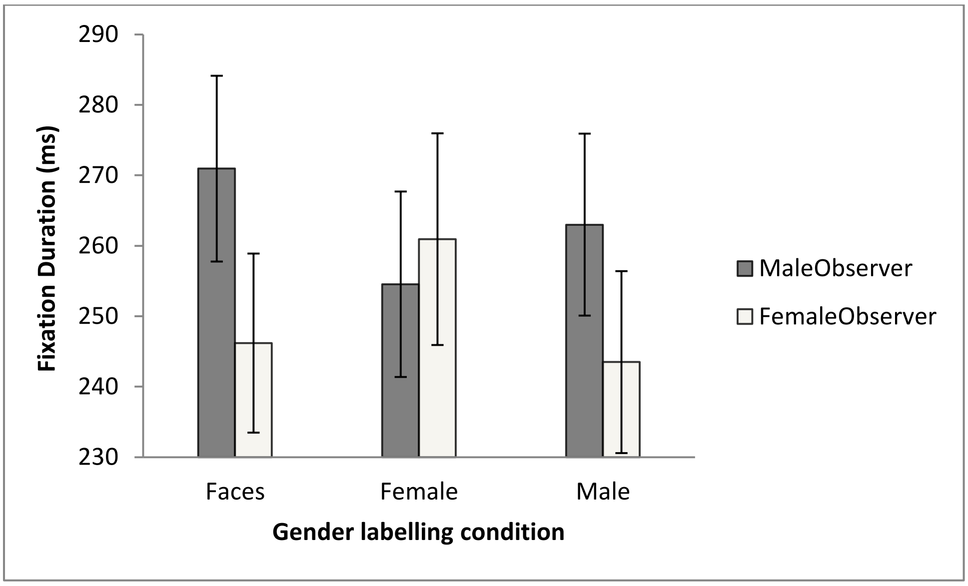

Figure 13 Fixation duration on eyebrow region during the encoding of androgynous faces according to gender labelling conditions (error bars show means +/- 1 standard error)

Nose Region

Figure 11 shows the fixation durations on the nose region during the encoding of androgynous faces. There were also no-significant differences for both main effects and the interaction on the nose region [F (1, 169) = 1.59, $p > .05$; F (2, 169) < 1; F (2, 169) = 1.09, $p > .05$, respectively].

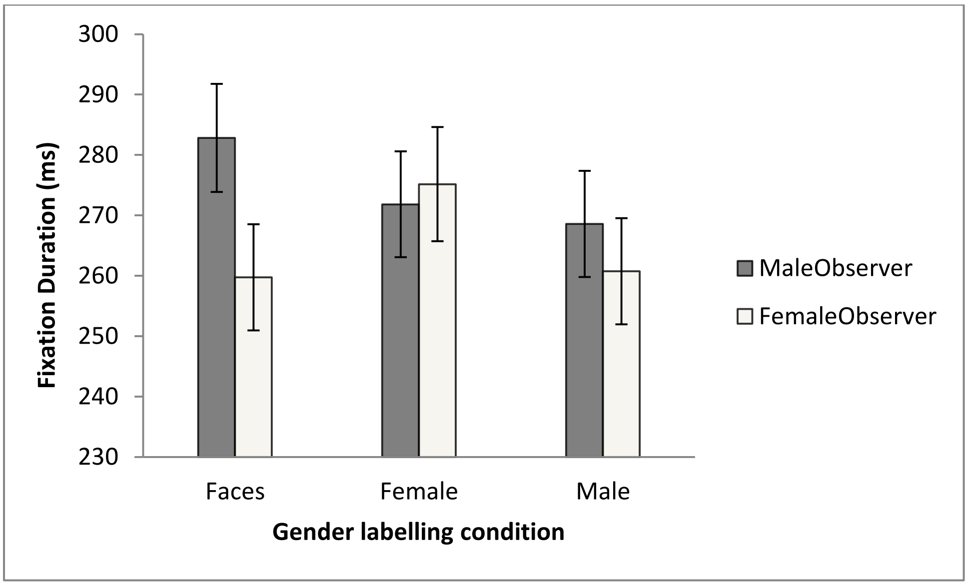

Figure 14 Fixation duration on nose region during the encoding of androgynous faces according to gender labelling conditions (error bars show means +/- 1 standard error)

Mouth Region

The descriptive statistics for fixation durations on the mouth region during the encoding of androgynous faces are presented in Figure 12. The main effect for Observer gender missed significance at p = .065 with male observers fixating longer on the mouth region than female observers [F (1, 168) = 3.45, p = .065]. The main effect for gender labelling condition and the interaction was non-significant [F (2, 148) < 1; F (2, 148) = 1.09, p >.05, respectively].

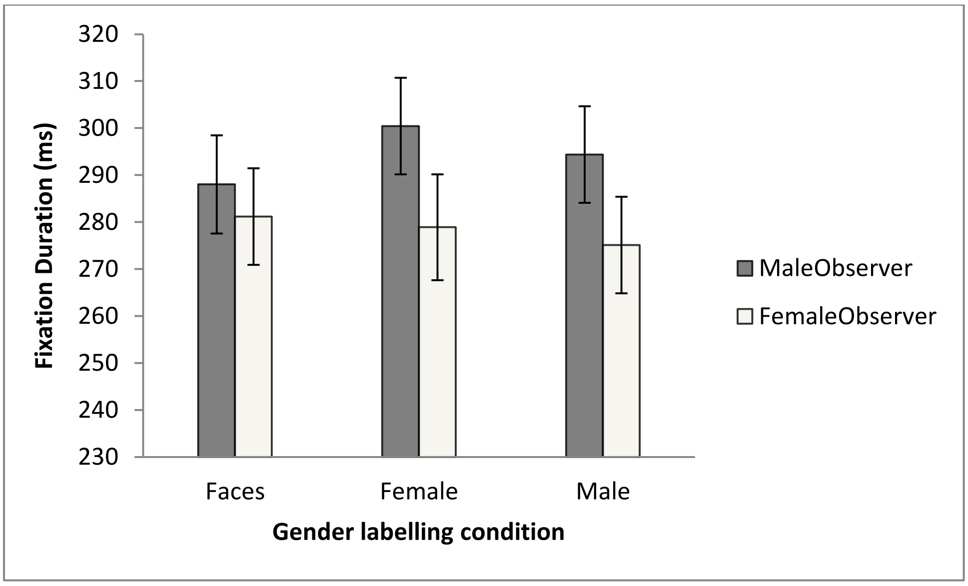

Figure 15 Fixation duration on mouth region during the encoding of androgynous faces according to gender labelling conditions (error bars show means +/- 1 standard error)

Summary of fixation duration findings

The significant differences lay on the eye region, with the androgynous faces labelled Females receiving longer fixations than those labelled Males. Furthermore, male observers fixated longer than the female observers on the eye region. Furthermore, a similar pattern which missed the significance level of .05 was demonstrated for the mouth region, with Male observers showing longer fixations than Female observers.

H3: Allocation of attention during encoding of androgynous faces for high and low memory accuracy observers. Do high scorers pay more or less attention to any particular features? Are there any gender differences in high/low scores on the eye movements?

In order to examine which features are paid most attention to by those who perform better in face recognition, it was necessary to make sure that high and low memory scores were significantly different. Hence, the participants were divided into high memory scores and low memory scores. Furthermore, as it was of interest to explore whether different features were involved in the recognition of male or female faces, hence rather than collapsing across gender labelling condition, the high and low scores were selected within each of the gender labelling conditions. Initial examination of the d prime scores suggested that there would have been an unequal split of male and female participants, within each gender labelling conditions. Hence, only the top ten and bottom ten d prime scores for male and for female participants were utilized in the analysis (this resulted in 60 male (30 high scorers, 30 low scores) and 60 female observers (30 high scorers, 30 low scorers)), the rest of the participants were excluded from the analysis (Excluded participants for each of the gender labelling conditions: Male Gender Labelling Condition: 9 Males, 10 Females; Female Gender Labelling Condition: 10 Males, 6 Females; Faces Gender Labelling Condition: 9 Males, 9 Females). This made sure that the high memory scoring group was significantly different from the low scoring group in each of the gender labelling conditions. (Male Gender Labelling condition: t (38) = -11.21, $p < .001$; Female Gender Labelling condition: t (38) = -11.05, $p < .001$; Faces Gender Labelling condition: t (38) = -15.98, $p < .001$). Eight different Between Groups ANOVAs were carried out with the DV being the fixation proportions and the fixation duration and the IVs being the Gender Labelling Condition (Male, Female, Faces), Observer Gender (Male, Female) and Memory Scoring Group (High, Low). The analysis was carried out on each of the features of the face (eyebrow, eye, nose and mouth).

Eyebrow region

Fixation Proportions

The descriptive statistics for fixation proportions on the eyebrow region during the encoding of androgynous faces are presented in Figure 13. The 2 x 2 x 3 between groups ANOVA on fixation proportion on the eyebrow region yielded only one significant interaction between Gender Labelling Condition and Memory Accuracy [F (2, 108) = 4.19, $p = .018$]. The simple effects analysis (Keppel, 1992) indicated that the significance lay within the High Scoring Group Variable [*F* (2, 108) = 3.60, *p* < .05]. While the simple effect for the Low Scoring Group was non-significant [*F* (2, 108) = 1.89, *p* > .05]. The Pairwise Simple Comparison (Keppel, 1992) was used to further examine the High Scoring Group Variable, it indicated that high memory performers made significantly less fixations on the eyebrows of the androgynous faces in the female condition than on the male condition [*F*(1,108) = 6.86, *p* < .05]. No other comparisons reached significance. Examination of the Gender labelling condition variable indicated that the fixation proportion on the eyebrow region was significantly different only for the Female Condition [*F* (1, 108) = 9.610, *p* < .01], such that the observers who had low scores made more fixations to the eyebrow region than the observers who had high scorers. A similar pattern of results was present for the androgynous faces in the Faces condition; however it missed the significance level of *p* < .05.

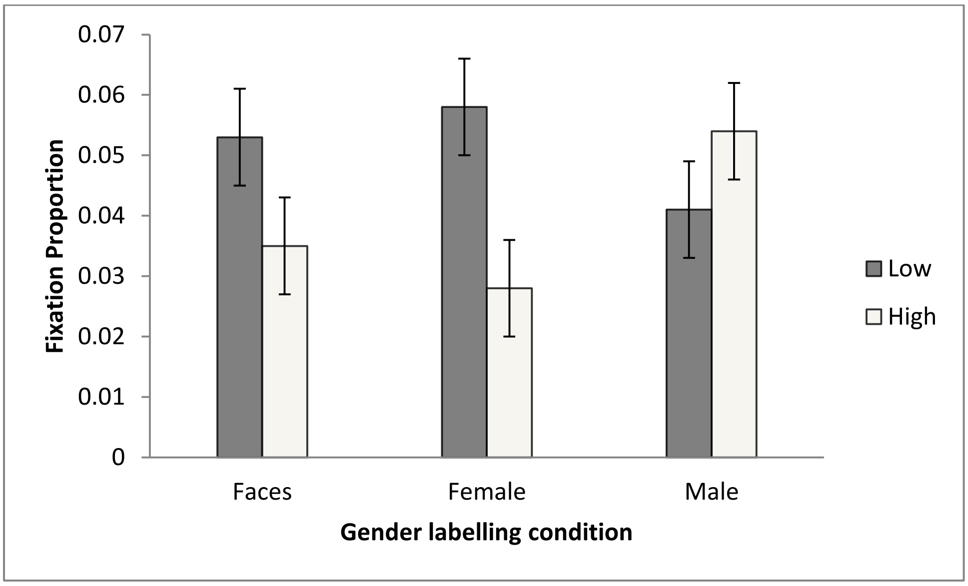

Figure 16 Fixation proportion on eyebrow region during the encoding of androgynous faces according to gender labelling conditions (error bars show means +/- 1 standard error)

Fixation Duration

The same analysis as above was carried out on the Fixation durations (Figure 14). A similar pattern of results was also revealed in the fixation durations for the eyebrow region. There was a main effect for Memory Accuracy condition, such that the high performers fixated for less time on the eyebrow region than the low performers [$F(1, 108) = 4.96$, $p = .028$]. The interaction between Gender Labelling Condition and the Memory accuracy Group was also significant [F (2, 108) = 5.86, p = .004]. Simple effects indicated that the significance lay on the High Scores variable [F (2, 108) = 4.18, $p < .05$], the Low score variable did not reach significance level of p < .05 [F (2, 108) = 2.08, $p > .05$]. Pairwise comparisons suggested that those observers who scored high fixated for less time on the eyebrows of the androgynous faces in the female condition than the androgynous faces in the male condition [F (1, 108) = 4.16, $p <.01$], the other comparisons were non-significant. The simple effects for the Memory accuracy variable revealed that observers who scored high fixated for less time on the eyebrows than those observers that scored low, and this was only the case for the androgynous faces in the female condition [F (1, 108) = 15.49, $p < .01$].

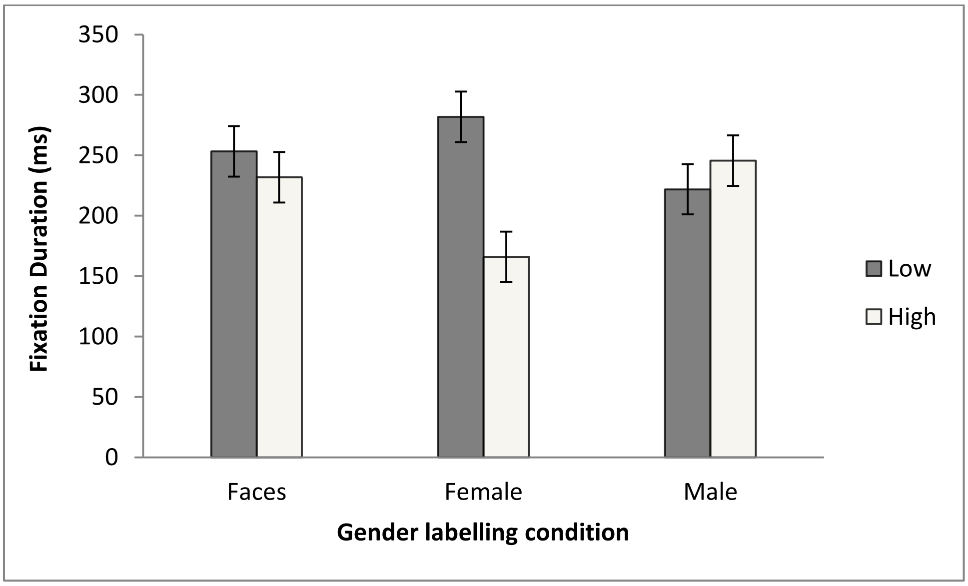

Figure 17 Fixation duration on eyebrow region during the encoding of androgynous faces according to gender labelling conditions (error bars show means +/- 1 standard error)

Eye region

The 2 x 2 x 3 between groups ANOVA on *fixation proportion* on the eye region did not reveal any significant differences for the proportion of fixations on the eye region [Participant gender, memory score, gender labelling condition main effects: F (1, 108) < 1; F (1, 108) = 1.15, p > .05; F (1, 108) = 1.45, p > .05, respectively]. All interactions were also not significant [F (2, 108) < 1].

Similar analysis performed on *fixation duration* on the eye regions revealed no significant results [Participant gender, memory score, gender labelling condition main effects: F (1, 108) = 3.56, p > .05; F (1, 108) < 1; F (1, 108) = 2.60, p > .05, respectively. No interaction were significant F (2, 108) < 1].

Nose region

For the nose region the 2 x 2 x 3 between groups ANOVA on *fixation proportion* revealed a main effect for Gender Labelling Condition [F (2, 108) = 7.54, p = .001]. Pairwise Main comparisons revealed that more fixation were made on the nose region of those androgynous faces in both the female and the faces conditions than those on the male condition [F (1, 108) = 14.88, p < .01; F (1, 108) = 4.90, p < .05, respectively]. No other significant differences were found. The 2 x 2 x 3 between groups ANOVA on *fixation durations* on the nose region also revealed no-significant differences.

Mouth region

The 2 x 2 x 3 between groups ANOVA revealed no significant differences for *fixation proportions* on the mouth region, however a main effect for the *fixation duration* for Observers Gender was found [F (1, 108) = 7.96, p = .006], with male observers fixating for longer periods on the mouth region than female observers. No other significant differences were found.

Summary of findings for H3

Dividing participants into high and low recognition scores indicated that high scorers seem to pay less attention (proportion of fixations) to the eyebrow region especially on those androgynous faces labelled female. A similar pattern of results was found for fixation duration, with high scorers spending less time fixating on the eyebrow region, similarly when the target face was an androgynous face labelled female. For the eye region no significant findings were revealed. Independently of memory scores, more fixations were made on the nose region of the androgynous faces labelled faces and female than those labelled male. Lastly for the mouth region it was demonstrated that male observers fixated longer on the mouth region than female observers.

4.4 Discussion

The present study initially aimed to replicate the behaviour data reported by Rehman, Lindohlm and Herlitz (2007) who demonstrated a Female Own Gender Bias, despite face stimuli being identical across the three gender labelling conditions (identical androgynous faces labelled as Females, Males and Faces). Rehman, Lindohlm and Herlitz (unpublished) suggested that attention played a crucial role on Own Gender Bias, and this was interpreted as evidence against perceptual expertise, as perceptual expertise was essentially controlled (the same androgynous faces were presented across conditions). However, the authors do not take into consideration the possibility that the categorisation process itself alters the perceptual information used to encode the faces, hence the second aim of the present study was to utilise eye tracking technology to inform on the fixations within the face throughout the encoding stage. The present study also aimed to investigate potential gender differences between high and low recognizers regarding the allocation of fixations on face features depending on the gender of the face.

The behavioural data analysis indicated that the usual Female Own Gender Bias was not found. However, the usual female advantage in recognition accuracy when compared to male observers was confirmed. More specifically, female observers outperformed male observers in the recognition of those androgynous faces labelled male and a similar pattern was also demonstrated for androgynous faces labelled female. Surprisingly, male observers seemed to perform better when gender labels were not present. More specifically, male observers demonstrated a better recognition with the androgynous faces in the Faces condition than those in the Female and Male conditions. An examination of the filler faces, did not however reflect the same pattern of results, the only pattern reflected was the finding that Female Observers performed better than Male Observers overall. This might suggest that the finding that Male observers performed better with the androgynous faces labelled Faces than the androgynous faces labelled Female/Male might not be very stable. However, it might also suggest that the androgynous faces might have been more memorable than the filler androgynous faces, since it was not possible to control for distinctiveness due to the limited number of stimuli. Furthermore, it has been argued that sexuality of participants might be an important factor in explaining the lack of consistency for the Male Own Gender Bias (Steffens, Landmann, & Mecklenbrauker, 2013). According to Steffens and colleagues a male Own Gender Bias is revealed when the participant pool consists of homosexual men, while no such bias is present when heterosexual males are involved. Moreover, homosexual males have been found to have better face recognition skills than heterosexual males (Brewster, Mullin, Dobrin, & Steeves, 2011). Reflecting on the between subject design of the current study and considering that sexuality of the participants was not taken into account, it might be the case that in the faces condition more homosexual males might have been present resulting in a similar recognition as female participants for the Faces condition. Therefore, future studies examining gender differences should be taking into consideration participants' sexuality. The only effect that seems to be stable is that female observers perform better overall than male observers. This finding is in line with most of the literature on gender differences (Lewin & Herlitz, 2002; Rehnman & Herlitz, 2006, 2007; Weirich et al., 2011; Sommer et al., 2013), as well as Rehman, Lindholm and Herlitz (2007) study. Similarly to our study, Rehman, Lindholm and Herlitz (2007) found that female observers outperformed male observers in the recognition of the androgynous faces and the filler faces. This finding has been widely replicated across different studies in face recognition. Recently a large cross sectional study (Gur et al., 2012) examined age and gender differences in children, adolescents and young adults (ages 8 to 21), and found a clear female advantage across all age groups on the face memory tasks amongst other tasks (attention, working memory, social cognition).

In the present study, the usual Female Own Gender bias was not found. This directly contradicts the Rehman, Lindohlm and Herlitz (2007) as well as the majority of studies on Own Gender Bias. It must be noted (as mentioned on the literature review) a few studies examining gender differences in face recognition have not been able to replicate the Own Gender Bias in face recognition (e.g., Sommer et al., 2013). In the current study female observers showed better recognition of all faces, independent of the gender labelling condition. Furthermore, no such pattern was present for the filler faces. Hence, it is difficult to draw any firm conclusions. Shapiro and Penrod (1986) in their review concluded that female observers show better face recognition than male observers. Furthermore, Lewin, Wolgers, & Herlitz (2001) and Weirich et al. (2011) reported similar findings, such that female observers outperformed male observers in face recognition. The female observers' superiority over male observers is also confirmed in Sommer et al (2013) in two separate experiments with two separate sets of stimuli. Female observers outperform male observers not only in face memory but also in face perception. Their findings suggest that social involvement is partially important in their performance in face memory. Similarly to the present study no Own Gender Bias effect was found in either face perception or in face memory. Considering the consistency of the usual female advantage in face recognition which is not accompanied by the Female Own Gender Bias perhaps it would be reasonable to examine Own Gender Bias in a basic face recognition experiment, where several variables which affect face memory are controlled. It is surprising that only studies by Loven and colleagues (Loven, Herlitz & Rehnman, 2011; Loven et al., 2012) and the present studies in this thesis have controlled for attractiveness and distinctiveness of their stimuli. Furthermore, none of the studies controlled for sexuality, which as suggested by Steffens and colleagues might be responsible for the Male Own Gender Bias.

The second aim of the current study was to examine with the aid of eye tracking technology whether the categorisation process alters the perceptual information which is used to encode faces. The eye movement data confirms that the categorisation process has a small influence on the way faces are encoded, and this is dependent on the gender of the observer. The eye tracking analysis revealed that some of the perceptual information used during encoding differed for the androgynous faces labelled male and those labelled female. Initially, it was found that overall, independent of observers' gender, more fixations were made on the nose region of those androgynous faces labelled female than those labelled male. Furthermore, a similar pattern was found on the time spent on the eye region of the androgynous faces labelled female. Female observers in comparison with male observers showed a greater number of fixations on the eyebrow region on the androgynous faces which were labelled Faces. It could be argued that female observers might be using this region to distinguish between the face genders considering that eyebrows are one of the features that distinguish a male face from a female face. In fact, female observers made more fixations on the eyebrow region when face gender was not specified as when it was (in the Female/Male conditions). Female observers might be using this feature to discriminate one face from another and in a group of faces where gender is not specified this might be a reasonable step. The results suggest that male observers seem to be using this feature (eyebrows) when encoding female faces only. Male observers compared with female observers made more fixations on the eyebrow region on the androgynous faces labelled Female. This might be indicative that males are encoding female faces superficially, i.e. making more fixations on features which are not informative of identity, but are informative on the gender category; hence in this case the female gender category is directing their attention to gender specific information which might not be fit for the purposes of the task. In fact when recognition scores are divided into high and low scores, the results indicated that high scorers fixate less and spend less time fixating on the eyebrow region of the androgynous faces labelled female than those labelled male. Furthermore, low scorers make more fixations than high scorers on the eyebrow region only in the female condition (where the androgynous faces are labelled as females). These findings suggest that paying attention to the eyebrow region has a detrimental effect in face recognition; furthermore it seems that this is the case only for those androgynous faces labelled female. It is speculated that when male observers view female faces they might be fixating on features which confirm gender rather than features which are informative of identity, hence showing poorer recognition than female observers. The social cognitive model would argue that male observers are processing female faces at a categorical level, paying attention to a feature which is often used to differentiate a female face from a male face. It is less clear whether the social cognitive model would support the female observers' patterns, which use this category specific feature during the encoding of non-gender specific faces.

Overall observer gender differences were found on the fixation duration analysis, which revealed that male observers seem to fixate for longer periods than female observers, this was the case for the eye region and a similar pattern was demonstrated for the mouth region. Usually a greater number of fixations with a shorter duration are indicative of a more efficient processing of the area viewed (Colombo et al. 1991; Rose, Jankowski & Feldman, 2002). To some extent the present results indicate that male observers might be processing the faces less efficiently than females, spending more time fixating in the eye region, as well as on the mouth region, with the latter being not be very informative for identification purposes (Gosselin & Schyns, 2001). The literature suggests that the eyes are a key feature for face recognition (Sekiguchi, 2011). The present findings suggest that overall observers fixated for longer periods on the eye region of the androgynous faces labelled female than on the androgynous faces labelled male. This finding seems to be partially in line with previous literature (Heisz et al., 2013), which suggests that female observers pay more attention to the eyes of other females than the eyes of males, a finding which was not demonstrated for their male participants. The authors claimed that female's advantage might be related to paying attention to those regions (i.e. the eyes) which are considered informative. However, their eyebrow and the eye region were considered as one, hence it's not obvious whether the gender differences found in their study lay in the eye region or the eyebrow region. The present results suggest that gender differences might lay on the eyebrow region (as per fixation proportions) and the eye region (as per fixation duration findings). More importantly, the present results indicate that it is the additional attention to the eyebrow region that contributes to male observers' poor performance with the recognition of female faces. It is speculated that male observers might be processing faces less efficiently, directing their attention to category specific features during encoding, which results in poorer performance during recognition.

Unlike the eyebrow region, the nose region is the central point of the face, and it gives an overview for all the face, which has been termed as preferred landing position for face recognition (Hsiao & Cottrell, 2008). Therefore, it might not be surprising that male observers compared with female observers made more fixations on the nose region on the androgynous faces labelled Faces. As mentioned previously on the recognition accuracy test male observers performed better with the androgynous faces labelled Faces than those labelled Female/Male. Thus, it is speculated that the great number of fixations on the nose region might have contributed to a more holistic view of the faces resulting in better encoding, however it should be noted that when participants were divided into high and low scorers, no significant differences were found between these groups in terms of attention paid to the nose region. Hence, it is difficult to conclude that male participants showed a better memory for those androgynous faces labelled Faces, as a result of paying more attention to the nose region.

To summarise, the eye movement analysis indicates that the gender social categorisation process seems to affect male and female observers in different ways. In other words, it seems to direct their attention to different features of the face and this appears to be depend on the perceived gender of the androgynous faces. It seems that male observers are placing attention on visual information which specifies face gender when the faces are perceived to be female. This information might not be ideal for discriminating one female face from another, in fact as demonstrated too much attention to this area leads to poor recognition performance. These findings are in line with Levin's feature selection model, who suggests that poor recognition of other race faces arises due to coding of information that is ideal for categorisation and not for individuation. Some insight as to why male observers use the eyebrow region only in the female social category might be provided by Sporer's in-group/out-group model. Unlike Levin's model, Sporer's model is said to account for other biases, including Own Gender Bias. According to this model, the female faces in this case are perceived as an out-group straight away due to some cue that is triggered. In our case, this cue is the social categorisation process itself, and the eyebrows might be used as feature to confirm the cue given by the experimenter. As Sporer suggests the detection of this feature is automatic and this elicits a different processing mechanism, which is less effective than configural processing. This claim also seems to be in line with the present results which suggested that paying attention to the eyebrow region leads to poorer recognition performance. However, none of the social cognitive theories are able to explain why the same strategy (paying attention to the eyebrow region) used by female observers (in faces condition) does not result in poorer recognition for female participants in general. This might be explained by the fact that female observers fixate for less time than male observers on the eye region and a similar pattern was also displayed on the mouth region. As discussed above deeper processing is associated with a greater number of fixations with shorter durations, hence the longer periods of durations that male observers seem to display might be also hindering their recognition performance. It was speculated that the nose region might have contributed to male observers' good recognition performance with the androgynous faces in the Faces condition (where face gender was not specified). The most recent model used to explain Own Group Biases, CIM argues that it is motivation (especially in the case of Own Gender Bias) which is responsible as to whether the faces will be individuated or processed at the categorical level. Hence, the last study of this thesis takes into consideration observers' motivations.

To conclude, the current study did not find any evidence of an Own Gender Bias for female or male observers; however the usual female advantage in face recognition was confirmed. The eye tracking data analysis also did not provide any indication of an Own Gender Bias. The categorisation process seemed to have demonstrated only small perceptual differences such that overall more fixations were made to the nose region and longer time was spent fixating on the eye region of androgynous faces labelled female than those labelled male. It seems that the categorisation process influenced male and female observers in different ways. Observer gender was implicated on the perceptual information for the eyebrow region. The results indicate that male and female observers use this feature for possibly different purposes. It was speculated that male observers might be making more fixations on features which are not useful for identity when encoding female faces. Even though these findings might be interesting they certainly do not provide an account for the underlying mechanisms regarding the Female Own Gender Bias. Considering that no indication of Own Gender Bias was found during this thesis, as well as the importance of the observers sexuality and the lack of stimulus control on the previous studies examining Own Gender Bias it was the aim of the next study to investigate its presence through a simple yes/no recognition task. Study 4 aimed to control several variables which affect memory for faces, as well as observer sexuality. Furthermore, it examined Own Gender Bias by taking a social cognitive perspective with an evolutionary standpoint.

Chapter 5

5.1 **Study 4 –** Re-examining Own Gender Bias in face recognition taking a social cognitive perspective: An investigation of the role of motivation.

The studies carried out during this thesis did not provide any definitive answers regarding the role of attention in Own Gender Bias in face recognition. The main components of attention (capture and retention) did not offer adequate results for conclusions to be drawn, other than suggesting that male faces seem to capture attention. The main finding from the Study 3 was that female observers outperformed male observers, with no indication of Own Gender Bias being present. The eye tracking analysis revealed that some of the perceptual information used during encoding differed for the androgynous faces labelled male and those labelled female. However, only the eyebrow region was found to be implicated on gender differences and recognition accuracy.

While no Female Own Gender Bias was found in this thesis, the literature demonstrates a preference for female faces, which seems to be observed in both male and female observers. Israel and Strassberg (2009) found that females viewed same-sex pictures longer than males did. Furthermore, males viewed opposite sex pictures longer than females did, although both genders viewed opposite sex pictures longer than same sex pictures. This suggests that men tend to concentrate more on opposite gender than women do, and women on the other hand concentrate more on same gender. The reasons behind this effect still remain unclear. It has also been demonstrated that males are more category specific when it comes to sexual attraction; they are attracted to either males or females, whereas females tend to show some degree of sexual attraction to both sexes (Lippa, Patterson, & Marelich, 2010).

The recent framework of CIM (Hugenberg et al., 2013) emphasises the importance of motivation in explaining Own Group Biases. The importance of motivation becomes apparent in the findings of a recent study examining gender differences in face recognition. Steffens et al. (2013) have suggested that participants' sexual orientation should be taken into account especially in cases where gender differences are being investigated. More specifically they examined whether participant sexual orientation moderated the Own Gender Bias in face recognition. It was found that female observers recognized more female faces independent of their sexual orientation, while this was not the case for male observers. Female faces in comparison with male faces were recognized better by the heterosexual males, while male faces were recognized better by homosexual males. Furthermore, heterosexual males outperformed homosexual males on female faces, and homosexual males outperformed heterosexual males on male faces. Taking account of personal aspects of observers has proven to be particularly fruitful in this case, for several reasons. Firstly, to some extent it explains the inconsistency of the Male Own Gender Bias as previous samples might to some degree have differed in sampling of homosexual males. The authors suggest that this possibility cannot be completely excluded. Secondly, it places emphasis on the importance of mating motivations, which drive human and animal behaviour. While the motivations for mating purposes might be obvious regarding heterosexual males and homosexual females[31], the motivations for heterosexual females might be less so[32]. While attractiveness in a partner is important for both genders, an extensive literature has demonstrated that males seem to place greater importance on physical attractiveness than females (Buss & Schmitt, 1993; Li, Bailey, Kenrick, & Linsenmeier, 2002). However knowing this, heterosexual females regularly judge the attractiveness of other females due to the threat that they might pose to their relationship with males (Anderson et al., 2010). Females on the other hand, do not place such great importance on attractiveness as males do, they place more importance on social status, dominance, wealth, and charisma, and these are all the traits that males tend to use to show off (Li et al., 2002; Miller, 2000). Hence it could be argued that females have more valid reasons to pay more attention to the faces of other females. This can be the case when they are competing for mates as well as trying to ward off romantic rivals.

[31] Both heterosexual males and homosexual females mating partners are other females; hence for mating purposes they would show a greater interest in females.
[32] Heterosexual females' mating partners are males; therefore their interest in paying attention to other females cannot be explained in terms of mating.

Mate guarding is beneficial considering the polygamous sexuality tendencies of humans (Barash & Lipton, 2002). It is not surprising that vigilance toward attractive intrasexual competitors is both automatic and powerful (Maner, Gailliot, & Miller, 2009; Maner, Gailliot, Rouby, & Miller, 2007). When primed with the threat of infidelity, both males and females' attention is captured by same-sex members who are attractive (Maner, Miller, Rouby & Gailliott, 2009). Maner and colleagues (Maner et al., 2007; 2009) used guided imagery to elicit jealousy feelings to examine the effects of visual attention in warding off intrasexual competitors. It was demonstrated that those in the jealousy condition (compared to control condition), and specifically those who were constantly worrying about infidelity paid more attention to attractive same sex targets. This effect was also produced in memory and social evaluation, where those primed with jealousy showed better memory for attractive faces, as well as a negative evaluation of these faces (Maner et al., 2009). These threats could be perceived as more serious by those who are more romantically jealous, who perceive that they might lose a beloved to a rival.

Males and females seem to differ in who they direct their jealousy to, females' jealousy emotions are directed more at their rival (other females), whereas males' is directed at their partner (Schützwohl, 2008). Considering the above situation, females might judge and routinely pay attention to other females and those who exhibit higher levels of romantic jealousy would be more prone to this type of behaviour. The general attractiveness of the rival might be facial or body (waist/hip ratio), either way it is usually sensible to remember the rival, hence faces might be more tied in with romantic jealousy in terms of identifying the rival.

Males and females seem to also differ largely on their inclination to engage in short-term and/or long-term mating (Gangestad & Simpson, 1990). The literature suggests that females have a tendency to be more sexually restricted, a tendency to prefer long-term monogamous relationships, while males are sexually unrestricted, more open to short-term mating without commitment. Sexually unrestricted individuals report a greater number of previous sex partners and place a greater importance on physical attractiveness of potential partners (Simpson, Gangestad, Christensen, & Leck, 1999). Furthermore, Duncan et al. (2007) found that unrestricted males allocated attention selectively to attractive opposite sex faces, while no such differences were found among females. In terms of the motivation component of the framework of Hugenberg et al (2013), it could be argued that the reason behind the rarely found Male Own Gender bias could be explained via their inclination to engage more often in short-term mating, which results in paying more attention to the opposite sex members (Duncan et al., 2007).

The aim of this study was to examine the role that motivation plays on Own Gender Bias. As the literature suggests those individuals that have greater jealousy tendencies, tend to be competitive among same-sex members. It is predicted that they would be more inclined to show a better recognition for same gender faces, since they are routinely 'checking out' the same-sex members in order to ward off any potential rivals. This is expected particularly to be the case for female participants. Male participants on the other hand were not expected to display a male Own Gender Bias, since in the current study only heterosexual participants took part (Steffens et al., 2013). Participants' jealousy, competitiveness with same gender members (intrasexual competition) and their interest in committed vs not committed sexual relationship were measured using self-reports. In addition, their motivation to appear socially desirable was measured to point out any individuals who were concerned with social approval[33]. Following the literature reviewed above; there would be no motivation for males to remember same sex members. It was in fact expected that they would be displaying a better memory for female faces, considering that males are usually more inclined to be more unrestricted than females. Furthermore, similar predictions were also made for females who were unrestricted. Considering that we were not able to find any evidence of Own Gender Bias in the studies run during this thesis, it was decided to use a simple yes/no recognition memory task without manipulating the face stimuli, while controlling for various variables which affect face memory.

[33] Individuals who scored high in social desirability were removed from the analysis as they probably have answered the questions for the other questionnaires in a socially desirable manner

5.2 Method

5.2.1 Participants

Initially 40 participants (19 males and 21 females, one female removed due to extreme scores on the social desirability scale) were recruited through posters advertised throughout university. Initial examination of the jealousy data indicated that there was a small spread of participants at both extreme ends of the jealousy scale, hence instead of recruiting more participants it was decided to screen a large number of participants on their jealousy levels, and invite the high and low scores to take part in the study.

From 537 participants screened (via online jealousy questionnaire) only 441 participants were aged 18 to 30 years, from which only 357 were Caucasian. Only 117 (44 Males, 75 Females) from the Caucasian sample agreed to take part in future psychology studies. Participants who scored high and low on the jealousy scale (one standard deviation above and below the mean, respectively) were emailed a few months later, informing them that a new psychology study was taking place, and they were invited to take part. Only a small number of participants actually agreed to take part in the main memory study (N = 16). The final sample consisted of 55 heterosexual participants (25 males & 30 females; 39 participants were from the initial participant group and the additional 16 were recruited from the online questionnaire). The ages were constrained to be from 18 to 30 years old due to Own-Age bias (Wright & Stroud, 2002) and all were Caucasian due to Own-Race bias (as the face stimuli were all Caucasoid and aged between 18-30). All participants were naïve with regard to the true nature of the experiment and had normal-to-corrected vision (as per self-report). The main study and the online jealousy study were both given Ethical approval by University of Strathclyde, School of Psychological Sciences and Health Ethics Committee.

5.2.2 Design

Initially a 2(participant's gender: male, female) X 2(face gender: male, female) mixed quasi-experimental design was used with participant's gender as a between-measures factor and face gender as repeated-measures factor. Similarly to Study 3 the parametric d' test was used to determine the accuracy of the participants in response to test stimuli. There were two Independent Variables: the gender of the participant and face gender. The dependent variable was the d prime scores. This design was carried out to examine the presence of an Own Gender Bias. Thereafter, participants are divided into high and low scorers depending on the variables under investigation (this being Jealousy, Intrasexual Competition and Sociosexual Orientation). This third variable was always a between measures, with two groups: High and Low, resulting in 2(participant's gender: male, female) X 2(face gender: male, female) x (variable under investigation: high, low).

5.2.3 Materials

A selection of stimuli used in Pilot 1B (Study 3) were utilised in this study. Initially, the raw (not morphed) image ratings for age, attractiveness, distinctiveness and masculinity/femininity were examined. Only the images which had similar ratings were used in the current study. The ratings for each of the variables that female and male faces were rated on are presented in Table 14. Independent t-tests were used to assess if there were any significant differences between targets and foils. Analysis was conducted separately for male and female faces. Analysis demonstrated that all the female images used as target faces did not differ from the female images which were used as foils. The male faces used as targets also did not differ from the male faces used as foils. Further independent t-tests were used to examine any significant differences between male and female faces (see Table 15). Analysis indicated that the male faces did not differ from the female faces on distinctiveness and femininity/masculinity ratings. The differences on age and attractiveness were significantly different between male and female faces (on age: [*t* (78) = 2.62, *p* = .01]; attractiveness [*t* (78) = -3.63, *p* < .001]), examination of the means suggested that they might be statistically significant; however in real life it would be extremely difficult to notice such differences[34].

Table 14 *Means and Standard Deviations (in parenthesis) for Each Variable that Affects Memory for Faces (Targets vs Foils)*

Variable	Female Faces			Male Faces		
	Targets	Foils	Sig.	Targets	Foils	Sig.
Age	23.85 (2.22)	24.66 (2.30)	>.05	25.18 (1.62)	25.87 (2.44)	>.05
Attractiveness	5.50 (0.82)	5.35 (1.18)	>.05	4.68 (1.03)	4.48 (0.91)	>.05
Distinctiveness	5.73 (0.75)	6.10 (0.85)	>.05	5.85 (0.59)	5.95 (0.60)	>.05
Femininity	6.52 (0.72)	6.75 (0.72)	>.05	n/a	n/a	n/a
Masculinity	n/a	n/a	n/a	6.52 (0.72)	6.78 (0.66)	>.05

[34] The means for age were 25.53 years for male faces and 24.25 years for female faces, it is not possible to distinguish the ages at this level of accuracy in real life.

Table 15 *Means and Standard Deviations (in parenthesis) for Each Variable that Affects Memory for Faces (Male vs Female)*

Variable	Faces		
	Male	Female	Sig.
Age	25.53 (2.08)	24.25 (2.27)	= .011
Attractiveness	4.58 (0.96)	5.37 (1.00)	< .001
Distinctiveness	5.90 (0.59)	5.91 (0.82)	> .05
Fem/Masc.	6.65 (0.69)	6.64 (0.71)	> .05

The stimuli were 80 (40 targets/40 foils) photographs of front-view expressionless Caucasian male and female faces. Adobe Photoshop CS5 Software was used to resize the images to approximately 19 cm x 13 cm and each face was then placed on white background. Each face was displayed centred on a 27 cm x 32 cm PC screen. E-prime was used to present the faces in a randomised order for each participant and to record responses.

Four types of questionnaires were administered: Multidimensional jealousy scale; Scale for Intrasexual Competition; the revised Sociosexual Orientation Inventory and the Social Desirability Scale.

Jealousy was measured using Pfeiffer and Wong's (1989) Multidimensional Jealousy Scale (MJS). The scale consists of three, eight item subscales which measure cognitive, emotional and behavioural components of jealousy. The behavioural and cognitive jealousy items ranged on a 7 point Likert scale from 1 never to 7 all the time. The emotional jealousy items range on a 7 point Likert scale from 1 very pleased to 7 very upset. The subscales represent dimensions underlying overall jealousy and they are only moderately correlated. The cognitive scale measures the frequency of suspicious thoughts and worries. The emotional scale measures the intensity of jealous feelings experienced within the relationship and the behavioural scale measures the frequency of jealous related behaviour. MJS has good construct reliability with reported Cronbach's alpha ranging between 0.83 – 0.92 (Pfeiffer & Wong, 1989). Similarly to previous research (Maner et al., 2007), a composite measure of jealousy was obtained by averaging responses across all the items. Higher scores were an indication of greater levels of jealousy and a greater concern of threats posed by romantic rivals.

The Intrasexual Competition Scale (ICS; Buunk and Fisher, 2009) comprises of 12 items, which measure the degree to which the individual sees confrontations with same gender in competitive terms, especially in contexts with the opposite sex. Intrasexual competition is seen as an attitude, where participants indicate on a 7 point scale how applicable the statements on the scale are to them. This scale has been found to have good construct reliability with reported Cronbach's alpha of 0.83 (Buunk and Fisher, 2009).

The Revised Sociosexual Orientation Inventory (SOI-R, Cronbach's alpha of 0.83; Penke, 2010) was used to measure the individuals' interest in committed vs not committed sexual relationships comprising of nine questions about their behaviour, attitudes and desires. Higher scores indicated unrestricted sociosexual orientation, a tendency to engage more in short-term sexual relationships.

Finally, the Marlowe-Crowne Social Desirability Scale (Crowne & Marlowe, 1960) was used as an indicator of socially desirable reporting (Paulhus (1991), since the above measures were based on self-reports. The scale takes the form of 33 questions, which use a forced choice, True-False format. Higher scores suggested that the individuals were highly concerned about social approval by others, hence as mentioned previously one participant was removed from the analysis due to her high score in this measure.

5.2.4 Procedure

After informed consent was given, the participant was seated in front of the computer approximately 57 cm from the screen. They were told that they would complete a face recognition experiment consisting of learning and a recognition stage followed by a set of questionnaires on personality. Participants were instructed that in the learning stage they would be presented with a number of faces on the computer screen and should try to memorise them in order to recognize them later. During the learning stage 40 target faces (twenty males and twenty females) were displayed in a randomized order. Each face was displayed for 2000 ms, with an inter-stimulus interval of 1000 ms. All the faces were matched for age/attractiveness/distinctiveness/masculinity/femininity (as described above). A standard visuo-spatial distractor task[35] was given to complete in between the learning and the recognition stage. This task took 5 min to complete. Before the recognition task began, the participants were instructed that they would see a series of faces, some of which they had seen during the learning stage (old faces – targets) and some of which they had not seen (new faces – foils). They were instructed to press the appropriate key on the keyboard to indicate if they had or had not seen the face during the learning stage. 80 faces were displayed in the recognition stage – comprising the 40 target faces (presented in the learning stage) and 40 foils (the new faces – 20 males/20 females), displayed in a randomized order for each participant. The participants were told to be as accurate as they could on the recognition test, with no mention of speed. Thus each face was displayed in the screen until a response was made, and then the next trial began. They were then asked to complete the set of questionnaires on Jealousy, Intrasexual Competition, Sociosexual orientation and social desirability. At the end they were all thanked and debriefed.

[35] The visual spatial distractor task was Rey-Osterrieth Complex Figure, which is a neuropsychological assessment. Participants had 2 minutes to memorise the figure and 3 minutes to draw it from memory.

5.3 Results

The aim of this study was initially to examine whether an Own Gender Bias would be present, as well as to determine whether jealousy, intrasexual competition and sociosexual orientation had an effect on memory for faces and in particular Own Gender Bias.

H1: Is there an overall Female Own Gender Bias?

The means and standard deviation for d' accuracy scores[36] are presented in Table 16. A 2 (Face Gender: Male/Female) x 2 (Observer Gender: Male/Female) mixed ANOVA was run on the d prime scores for the recognition test. The analysis of variance revealed that the main effect for face gender was significant [F (1, 53) = 26.33, p < .001], female faces (Mean = 1.2, SD = 0.69) were recognized better than male faces (Mean = 0.37, SD = 0.95). Inspection of the means (Table 16) seemed to suggest that both male and female observers showed better recognition memory for female faces than for male faces. There is also an indication that female observers seem to perform better than male observers on female faces. However, the interaction between face gender and observer gender was non-significant [F (1, 53) = 1.53, p > .05], suggesting that no Own Gender Bias was found for either female or male observers. Observer gender did not have an effect either on recognition memory for faces in general [F (1, 53) = 0.14, p > .05], with female (Mean = 0.75, SD = 0.75) and male observers (Mean = 0.80, SD = 0.90) performing at the similar levels.

[36] One sample t-tests were carried out on the d-prime scores to make sure that participants were performing above chance level. The t-tests confirmed that this was the case for female observers memorising female faces [t (29) =11.79, p < .001]; male observers memorising female faces [t (24) = 6.98, p < .001]; male observers memorising male faces [t (24) = 2.12, p < .05]); only female observers memorising male faces seemed to perform below chance level [t (29) = 1.89, p = .069]

Table 16 *Means and Standard Deviations (in Parenthesis) of D' Accuracy for Male and Female Observers*

Observer Gender	Face Gender	
	Female	Male
Female	1.06 (0.76)	0.30 (0.88)
Male	1.31 (0.61)	0.44 (1.03)

H2: Do jealous females or males show an Own Gender Bias in face recognition?

Participants (N = 55) were divided into high and low scorers depending on their jealousy scores (approximately 0.5 SD above and below the mean, respectively). Independent t-test confirmed that the low jealousy group (N = 16, Mean = 63.50, SD = 5.44) significantly differed from the high jealousy group (N = 16, Mean = 99.94, SD = 16.86), [t (30) = -8.23, p < .001].

A 2 (Face Gender: Male/Female) x 2 (Jealousy Score: High/Low) x 2 (Observer Gender: Male/Female) mixed ANOVA was run on the D prime scores. A main effect of Face Gender was found [F (1, 28) = 9.14, p = .005], female faces (Mean = 1.13, SD = 0.68) were better remembered than male faces (Mean = 0.51, SD = 1.01). Female observers (Mean = 0.85, SD = 1.01) displayed a slightly better recognition for faces than male observers (Mean = 0.79, SD = 1.01), however this difference was non-significant [F (1, 28) < 1]. The usual Own Gender Bias was not found, as revealed by the non-significant Face Gender x Observer Gender interaction [F (1, 28) < 1]. The main effect for Jealousy was also non-significant [F (1, 28) < 1]. No other interactions were significant (Face Gender x Jealousy [F (1, 28) = 2.92, p = .10]; Face Gender x Observer Gender x Jealousy [F (1, 28) = 1.92, p = .18]; Observer x Jealousy [F (1, 28) = 1.59, p = .22].

H3: Do females and males who score high on intrasexual competition shown an Own Gender Bias in face recognition?

Participants (N = 55) were divided into high and low groups according to their intrasexual competition scores (approx. 0.5 SD above and below the mean, respectively). The high intrasexual competition group (N = 16, Mean = 25.06, SD = 6.92) differed significantly from the low group (N = 16, Mean = 48.62, SD = 8.22) as confirmed by the independent t-test [t (30) = -8.77, p < .001].

A 2 (Face Gender: Male/Female) x 2 (Intrasexual Competition Score: High/Low) x 2 (Observer Gender: Male/Female) mixed ANOVA was run on the d prime scores. A main effect for face gender was revealed [F (1, 28) = 15.18, p = .001], female faces (Mean = 1.20, SD = 0.74) were recognized better than male faces (Mean = 0.28, SD = 1.09). The main effect for participant gender was non-significant [F (1, 28) = 2.03, p = .17]. The interaction between face gender and observer gender was also non-significant [F (1, 28) = 0.85, p = .36]. In addition, the three way interaction was non-significant [F (1, 28) = 1.63, p = .21]. The main effect for intrasexual competition, and the rest of the two-way interactions were non-significant ([F (1, 28) = .18, p = .68; Face Gender x IntraSexual Competition [F (1, 28) = 1.85, p = .19; Observer Gender x IntraSexual Competition [F (1, 28) = .63, p = .44], respectively).

H4: The effects of sociosexual orientation on face recognition.

Participants (N = 54, scores for one participant were not included due to experimenter error) were divided into high and low groups according to their score on the RSOI (approx. 0.5 SD above and below the mean, respectively). The independent t-test revealed that the high (Mean = 55.06, SD = 7.79) and low groups (Mean = 21.75, SD = 6.23) significantly differed [t (30) = -13.35, p < .001].

A 2 (Face Gender: Male/Female) x 2 (RSOI Score: High/Low) x 2 (Observer Gender: Male/Female) mixed ANOVA was run on the D prime scores. A main effect of face gender was shown [*F* (1, 28) = 11.85, *p* = .002], female faces (Mean = 1.13, SD = 0.78) were recognized better than male faces (Mean = 0.40, SD = 0.90). Observer gender did not have any effects on the face recognition [*F* (1, 28) = 0.41, *p* = .53]. A significant main effect was revealed for RSOI [F (1, 28) = 5.03, p = .03], low scores on the RSOI (Mean = 1.00, SD = 0.84) demonstrated better recognition memory than high scorers (Mean = 0.53, SD = 0.77). The two way interactions between face gender and observer gender/RSOI were non-significant [*F* (1, 28) < 1], as well as the two way interaction between observer gender and RSOI [*F* (1, 28) < 1]. The three way interaction was also non-significant [*F* (1, 28) < 1].

5.4 Discussion

The main aim of this study was to examine the role of motivation on Own Gender Bias. It was reasoned that if Own Gender Bias has its roots in motivation then it would be expected that certain personality variables such as romantic jealousy, intrasexual competition and sociosexual orientation would be good motivators considering that they have been found to influence behaviour (i.e. automatic allocation of attention to same sex or other sex members). An initial examination of the face memory part of the study showed that female faces were generally recognized better than male faces, hence both males and females performed better with female faces than with male faces. Overall, there were no gender differences for face memory. Furthermore, the usual interaction between face gender and participant gender was not significant; suggesting that no Own Gender Bias was present. The literature on face recognition points out that female faces are remembered better than male faces; a finding that most of the studies on Own Gender Bias have been able to replicate (Slone, Brigham & Meissner, 2000; Rehnman & Herlitz, 2006, 2007; Experiment 1 in Loven, Herlitz & Rehnman, 2011; Loven, Rehnman, Wiens, Lindholm, Peitra & Herlitz, 2012).

Surprisingly no gender differences were found in memory for faces, male and female participants performed at similar levels. The Own Gender Bias literature has mostly demonstrated a females advantage over male participants (Lewin & Herlitz, 2002; Rehnman & Herlitz, 2006, 2007; Experiment 1 Loven, Herlitz & Rehnman, 2011; Loven, Rehnman, Wiens, Lindholm, Peitra & Herlitz, 2012; Weirich, Hoffmann, Meissner, Heinz & Bengner 2011; Sommer, Hildebrant, Kunina-Habenicht, Schacht & Wilhelm, 2013). However a few studies do not seem to show the female advantage over male participants as a main effect (Wright & Sladden, 2003; Experiment 2 and 3 in Loven, Herlitz & Rehnman, 2011; Slone, Brigham & Meissner, 2000).

Even though it was found that female observers better remembered female faces in comparison to male faces, an Own Gender Bias was not present either for females or for males. In fact, an examination of the means indicated that males also performed better with female faces than with male faces. In terms of evolutionary psychology this was expected given that heterosexual males mating interest would be females. This finding is in line with some of the literature on face recognition, which suggests that males also tend to show better memory for female faces (Lovén et al., 2011), while only a couple of studies have found an Own Gender Bias for males (Wolff et al., 2014; Wright & Sladden, 2003). Steffens et al. (2013) results suggest that one possible explanation for the inconsistencies regarding the male Own Gender Bias might be the different proportions of homosexual males within each of the studies. Considering that the present study consisted of only heterosexual males[37], a male Own Gender Bias was not expected. Hugenberg et al. (2013) suggest that Own Gender Bias is largely dependent on motivational factors. Hence, these findings are in line with CIM's predictions on motivation, which suggests that when perceivers are motivated they are able to shift their attention from categorical specific features to identity diagnostic information. Considering heterosexual males' mating interest it is in fact expected that males would be showing a better memory for female faces.

It could be argued that the absence of a female Own Gender Bias could simply be an anomaly. One possible explanation could also be the sample size in the current study. The sample sizes vary comparably to the studies which have found a Female Own Gender Bias, as well as those which have not. In fact, a full cross Own Gender Bias has also been found with sample sizes similar to this study (36 – 52

[37] Only heterosexual participants were recruited (see section 5.2.1 page 133).

participants; Weirich et al., 2011; Loven et al., 2013; Loven et al., 2012; Loven, Herlitz & Rehnman, 2011 (Exp 2); Wright and Sladden, 2000). Therefore, it is unlikely that the sample size is an issue, hence it is worth investing more time in examining how consistent the Own Gender Bias is, as well making sure that certain variables such as participants' sexuality and variables that affect memory for faces are controlled for.

It was expected that an Own Gender Bias would be present especially on those groups who are highly motivated to remember same sex faces, in particular those female participants scoring high in romantic jealousy and intrasexual competition. Both high and low groups on jealousy and intrasexual competition demonstrated similar face recognition memory; furthermore there was no interaction with face gender and participant gender, confirming the absence of an Own Gender Bias. Participants scoring high in jealousy have been found to display an attentional bias and better memory for attractive faces (Maner et al., 2007; 2009). It might be the case that the female faces in the current study were not perceived as attractive enough (due to the faces being only average in attractiveness); hence they might not have been perceived as rivals. The present study kept the attractiveness levels intentionally at the average level, as it was intended to control for variables which affect memory for faces. It is suggested that future studies which might need to control for attractiveness, they might manipulate some other aspect of the faces (such as informing participants on the attractiveness ratings of the faces that they need to memorise[38]), in this way one can control for attractiveness and give some context to the study, which might be considered a limitation for the present study.

The present study examined internal motivators of behaviour related to mating and mate guarding, however no context was provided to elicit these feelings. Even though internal traits might be strong motivators and the high jealousy/intrasexual competition groups were significantly different from the low groups, there was no context in which jealousy could have been evoked. In previous studies a prime (imaging a scenario) was utilized to elicit jealousy feelings (Maner et

[38] This would help in creating a sense of rivalry, considering that physical attractiveness is valued by females (Anderson et al., 2010)

al., 2007). Furthermore, a possible factor that might be relevant in this end is satisfaction within romantic relationships. Previous research has indicated that jealousy emerges in situations of relationship uncertainty (Knobloch & Solomon, 2005), hence those who might be more dissatisfied might be more prone to feelings of insecurity and might be paying more attention to other females. Moreover, while a measure of relationship satisfaction might be useful, a measure of relationship status might need to be considered too.

No female Own Gender Bias was found throughout this thesis. Two recent studies (Sommer et al., 2013; Weirich et al., 2011) while finding an advantage for females over males in face recognition, also did not find a female Own Gender Bias, hence it is speculated that the hormonal changes during the menstrual cycle might be a variable that might prove to be fruitful when examining Own Gender Bias in future studies. Research has shown that female's mating preferences change across the menstrual cycle (Gangestad & Thornhill, 2008). A preference for more masculine (Penton-Voak et al., 1999) and symmetrical faces (Thornhill et al., 2003) has been observed for those females who are in their fertile phase. Furthermore, it has been found that hormonal changes associated with fertility increase female sensitivity to intrasexual competition (Durante, Li, & Haselton, 2008; Fisher, 2004; Haselton, Mortezaie, Pillsworth, Bleske-Rechek, & Frederick, 2007), suggesting that when women are most competitive with same sex members when they are most fertile. It has also been found that during this time they derogate their competitors i.e., by rating photographs of other women as lower in attractiveness (Fisher, 2004). The use of hormonal contraceptives has also been shown to be associated with increased levels of jealousy and mate guarding behaviour, especially those contraceptives containing higher doses of synthetic oestrogen (Welling, Puts, Roberts, Little, & Burriss, 2012).

To conclude, a great deal of research still needs to be carried on Own Gender Bias, initially aiming to establish its consistency, while controlling for potential factors that affect memory for faces in general as well as sexuality of the participants. The present results showed no evidence that jealousy, intrasexual competition and sociosexual orientation had an effect on Own Gender Bias. Considering that Own

Gender Bias is not consistent, as well as the importance of hormonal changes on female behaviour it was suggested that future studies might need to consider taking these factors on board.

Chapter 6

General discussion

6.1 Overview

The face recognition literature has suggested that female observers show an advantage in recognition of faces when compared to male observers. Furthermore, female observers tend to demonstrate a better memory for other female faces, displaying an Own Gender Bias. This finding has been found to be less consistent for male observers. An own group recognition advantage has also been shown for other social categories such as race, age and many more. The present thesis used the plethora of research on Own Race Bias to guide the investigation of Own Gender Bias. The role of attention was found to be particularly important in examining Own Gender Bias.

The overarching aim of this thesis was to examine underlying mechanisms of Own Gender Bias. Considering the close relationship between attention and memory, the findings of Rehnman et al. (2007), the inconsistencies between Loven and Palmer studies as well as the recent development of the Categorisation Individuation Model (Hugenberg, Wilson, See, & Young, 2013), the present thesis explored the attentional hypothesis put forward by the Own Gender Bias literature. Account was taken of the subcomponents of attention, namely attentional capture and retention, hence Study 1 and Study 2 examined these components (respectively). Study 3 addressed the role of attention on encoding gender of ambiguous face, where gender perception was manipulated, specifically to determine whether the differential categorisation of faces influences the perceptual characteristics that are used at encoding. In addition the relationship between attention to specific facial features and recognition performance was investigated. The last study, while controlling for several variables which affect memory for faces, took a social cognitive perspective with an evolutionary standpoint. It was the aim of Study 4 to explore internal motivators such as partner guarding and mating traits as potential explanations underlying Own Gender Bias in face recognition.

The results of the four studies will now be discussed in relation to the current Own Gender Bias literature as well as the main accounts offered for Own Race Bias, especially the CIM model. Lastly, some of the limitations identified over the course of the studies and future research ideas will be examined and discussed.

6.2 Summary of results

The findings from Study 1 (Chapter 2) in line with previous research confirmed that upright faces capture attention (Study 1a), while inverted faces do not (Study 1b); even when the face is irrelevant to the task. The findings suggested that it was the upright male face which had a detrimental effect on the search for target item. These results were partially supported by eye movement data. The fixation proportion and the saccadic reaction time data indicated that less attention was paid to the target item when the upright face was present in the display. In addition the fixation proportion data indicated that less attention was paid to the target item when upright male faces were present, and this was especially the case for male observers.

Study 2 (Chapter 3) did not find any evidence for attention retention by face stimuli. This finding was consistent across the two studies (Study 2a and 2b), both reaction time and eye tracking data found no indication of attention being held by faces. Observers' gender and face gender also did not have effect in attention retention.

Study 3 (Chapter 4) found no evidence of a female or a male Own Gender Bias. However, the usual female advantage over male observers in face recognition was replicated. The female observers outperformed male observers in the recognition of the androgynous faces labelled male and also a similar pattern was demonstrated for the recognition of the androgynous faces labelled female. Gender differences, favouring male observers were also found for the recognition of the androgynous faces with no gender labels. This pattern of results was not replicated for the filler faces, only the female advantage over male observers was replicated.

The eye movement data suggested that to some extent the categorisation processes altered the perceptual information that was used during encoding and this was influenced by observers' gender. Initially, it was found that overall, independent of observers' gender, more fixations were made on the nose region of androgynous faces labelled female than those labelled male. Furthermore, a similar pattern was found on the time spent on the eye region of the androgynous faces labelled female. Gender differences were found on the fixation proportions of the eyebrow region of androgynous faces labelled faces and those labelled female, with female observers making more fixations in the former and male observers in the latter condition. Furthermore, female observers made more fixations on the eyebrow region on the faces condition than on the female/male condition. Attention to the eyebrow region was found to impair recognition performance for those androgynous faces that were labelled female. High scorers in face memory were found to fixate less and spend less time on the eyebrow region of the androgynous faces labelled female than those labelled male. Furthermore, low scorers were found to make more fixations than high scorers on the eyebrow region only in the female condition. Gender differences were also found on the time spent on the eye region, with male observers fixating longer in this region than female observers. A similar pattern was found for the mouth region. Further gender differences were found on the nose region, with male observers making more fixations on this region (nose) when compared with female observers. The nose region was speculated to have contributed to male observers' performance with the androgynous faces labelled faces, considering that male observers recognized more androgynous faces labelled faces than those labelled female/male.

Study 4 (Chapter 5) found the female faces were recognized better than male faces with no evidence of an Own Gender Bias or a female advantage over male observers. Jealousy, intrasexual competition and sociosexual orientation were not found to have an effect on Own Gender Bias.

6.3 Attention and Own Gender Bias

Little research has actually been carried out examining the relationship between attention and Own Group Bias, even though social cognitive accounts suggest that categorisation takes place in early visual processing.

Several studies investigating Own Race Bias have found that other race faces receive more attention in the early stages of visual attention, while attention to own race faces is delayed to later stages of processing (Bean et al., 2012; Donders, Correll, & Wittenbrink, 2008; Richeson & Trawalter, 2008; Trawalter, Todd, Baird, & Richeson, 2008) possibly due to other race faces (especially Black faces) being perceived to be more threatening.

Similar conclusions were drawn by Study 1 findings in this thesis regarding Own Gender Bias. In Study 1, the male face was found to capture attention; this was the case for both male and female observers. Furthermore, one of the eye movement measures indicated that it was in fact the male observers' attention which was captured by the male face. Hence, it seems that it is not just the other face gender that captures attention, but specifically the male face. The ability of a stimulus to capture attention independent of the task at hand has been described as a "circuit breaker" of voluntary attention, which makes sure that any stimuli with potential significance is processed (Corbetta & Shulman, 2002). Physically, males are stronger than females, and more physically aggressive (Björkqvist, 1994); hence in terms of survival value, it is beneficial to notice a potential threat from a possible aggressive male in their environment. It has been argued that humans are tribal in nature (Ward, 1959) and their own group is a key in their lives that they consider other groups as potentially threatening (Dunbar, 1988). One consequence of this mind-set is that one might perceive threat by out-group members in situations where threat is actually non-existent (Haselton & Buss, 2003). In addition, considering that males are physically stronger and more aggressive than females, both males and females might be equipped with a heightened ability to process not only angry faces which pose threat (Hansen & Hansen, 1994), faces of cheaters (Mealey, Daood, & Krage, 1996), but also male faces in general given their potential for aggression. This threat hypothesis for attentional capture by male faces has also recently been suggested by Cattaneo et al.(2014), who directly found the male face to capture attention in a line bisection task.

It has been suggested by Levin's work (Feature Selection Model) that race is processed quite early before any identity specific information. Racial category seems to be processed automatically (Ito & Urland, 2003). Similarly, Sporer (In-group/Out-group Model), suggested that in-group faces are processed automatically in a configural manner. In line with Levin's work and Rodin's (1987) cognitive disregard hypothesis CIM argues that some feature or cue from the face stimuli (common to all out-group faces) triggers the categorisation process. This automatic categorisation leads to shallow processing as a consequence of no real benefits likely to be forthcoming from further interaction (considering that out-group members have low social utility (Malpass, 1990). The advantage of Sporer's model is that he also applies the model to gender and age categories. In addition, Sporer emphasises perceiver's motivation. Motivation is central to the latest theory, CIM (Hugenberg et al., 2013) which has been extended to explaining other group biases, such as gender. CIM postulates that perceivers are able to shift their attention from categorical specific features to identity diagnostic information provided that they are sufficiently motivated. While this theory has several advantages it does not take into account that Own Gender Bias seems to be predominantly absent in male observers. As mentioned above social cognitive theories suggest that social category, and in particular race, is perceived automatically as a result the other race faces are categorised as other race - rather than individuated, hence resulting in poorer recognition. Similarly, gender is said to be perceived spontaneously. As mentioned previously, it was the male face (other-gender face, considering that Own Gender Bias is asymmetrical) that captured attention in Study 1; similarly other race faces have been found to capture attention. Parallels can thus be drawn between the poor recognition of other race faces (when compared to own race faces) and the poor recognition of male faces (when compared to female faces). The male face, similarly to the other-race face maybe categorised at the expense of being individuated, hence resulting in poorer recognition. It should be noted though that the above claims are only speculations, which might be examined further by future research.

It can confidently be concluded that the male face captured attention even when faces were irrelevant to the task at hand. Study 1 in this thesis is at advantage when compared to previous studies in the literature as extensive piloting of the stimuli was carried out, prior testing of the face stimuli made sure that the face stimuli was not gender ambiguous, only those faces which had 100% agreement on gender categorisation were used, furthermore several variables such as age, attractiveness, distinctiveness, masculinity/femininity were controlled. Furthermore, the attentional capture by the male face could not be attributed to the low level characteristics of the face stimuli, or the difference in contrast/luminance between the male and the female faces, as the attentional capture effect was absent when faces were inverted in Study 1b. Hence, it is strongly suggested that piloted stimuli should be used in future studies.

While early visual processing of social categories might provide an indication of how the out-group members are perceived, it does not provide any explanations or provide any evidence that the in-group faces are individuated. Hence, Study 2 was set out to examine whether same gender faces hold attention, and giving a suggestion for further individuation; however the usual finding that faces hold attention was not replicated. As a result, Study 3 aimed to extend Rehnman et al's findings and examine whether the change in observers' categorisation alters perceptual information used at encoding. Considering that in Study 3, the usual Female Own Gender Bias was not found, as well as the surprising finding that male observers demonstrated better recognition for androgynous faces labelled faces than those labelled male or female, Chapter 4 concluded that future studies examining gender differences in face recognition should take into account observers sexuality. These conclusions were made considering previous findings (Steffens, Landmann & Mecklenbrauker, 2013) which suggested that sexuality modulated the Male Own Gender Bias. Overall, Study 3 found the usual female advantage in face recognition, a finding which was not replicated in Study 4. These inconsistencies will be discussed in a separate section below, questioning the existence of Own Gender Bias in face recognition. Overall, findings from Study 3 directly contradict Rehnman et al study, which argues that perceptual expertise does not play a role in Own Gender Bias. The findings suggest that to some extent social categorisation influences how and which facial features are encoded, and these differences are modulated by observer gender. In addition, it is speculated that male and female observers might be using the same face features for different purposes. In line with the social cognitive models, it is argued that male observers seem to be paying attention to female gender categorical cues (eyebrows), and might be using these features to confirm gender category, rather than individuate one female face from the other, which results in poorer recognition accuracy. Female observers do not pay attention to the eyebrow region for female/male faces; this is paid attention to in the faces condition only, where gender is not specified, hence it was argued that this region might be used for individuation purposes (distinguishing a male face from a female face, considering the huge difference between males and females in this region). This strategy might result in an overall female advantage, as the eyebrow region only had a detrimental effect in the encoding of androgynous faces labelled female. Speculations were made that the nose region might prove beneficial to male observers when encoding faces, considering that it provides an overview of the face and maybe supports male observers in processing faces holistically. It has been argued that a greater number of fixations with a shorter duration are indicative of more efficient processing of the area viewed (Colombo, Mitchell, Coldren, & Freeseman, 1991), hence the longer fixations times on the eye and mouth region were interpreted as an indication of shallow processing of faces in male observers. In addition considering the above, the CIM model to some extent is able to explain the findings from Study 3. CIM argues that categorisation would “draw attention to race-diagnostic facial characteristics and away from identity-diagnostic facial characteristics” (Hugenberg, Wilson, See and Young, 2013, p. 9). The results of Study 3 especially in relation with male participants paying more attention to the eyebrow region in only the female condition are in line with this prediction. In addition, this categorical cue was also related to lower recognition scores, and this was again relevant only in the female condition. This is also in line with the CIM model, which indicates that attention to categorical cues results in poorer recognition memory. What is interesting is the finding that female observers did not demonstrate this pattern for the female condition. It seems to be the case that male observers seem to be distracted and pay attention to features which might not be informative in differentiating female faces. It must be noted though that considering that the faces were the same across the three conditions, and the fact that female obsevers paid attention to the eyebrow region in the faces condition, it cannot be concluded that eyebrows are non-informative. It is speculated that attention to the eyebrows possibly accompanied with the longer fixations on the mouth area might result in poorer recognition in male participants. It should be noted at this point that even though CIM might seem a reasonable model to explain Own Gender Bias, as discussed below it fails to explain the asymmetrical nature of Own Gender Bias, i.e. a male own gender is only rarely found.

6.4 Motivation in Own Gender Bias

CIM seems to argue that Own Gender Bias mechanisms are not associated with perceptual expertise as most individuals have similar levels of experience in individuating males and females. CIM postulates that motivation plays a crucial role in this bias. Motivation has taken a major role in the CIM model, such that it has been suggested that the application of perceptual expertise in encoding of faces is modulated by motivation to use such expertise to encode faces.

The role of perceptual expertise was also questioned on Tafili's (2008, 2009) findings, where the usual female Own Gender Bias was reversed into a Male Own Gender Bias in the presence of a male oriented overarching social category, this was found across two different studies using football and politics as overarching social categories. In addition, a gender neutral social category led to no Own Gender Bias being found.

As a result, Study 4 in the present thesis examined the role of motivation from an evolutionary perspective considering that gender as a social category is related to mating and mate guarding. Study 4 took into consideration Steffens et al. (2013) findings where male observers' sexual orientation was found to modulate male Own Gender Bias. Homosexual males were found to demonstrate a better memory for male faces, while heterosexuals outperformed homosexuals on female faces. Surprisingly heterosexual females were not found to demonstrate the same opposite gender bias as males demonstrated. A female Own Gender Bias was demonstrated for both homosexual and heterosexual females. The authors argued that mate guarding could be a possible explanation for female observers' behaviour.

Study 4 re-examined Own Gender Bias taking into consideration certain personality motivators which could potentially influence Own Gender Bias. Firstly, no Own Gender Bias was found, the usual female advantage in face recognition was absent. The female faces were found to be recognized better than male faces and this was the case for both female and male observers. Jealousy, Intrasexual Competition and Sociosexual orientation were not found to be related to face recognition, nor did they modulate Own Gender Bias. It is surprising that the usual female advantage was not demonstrated; nevertheless these findings are useful in several ways, especially in relation to the predictions made by CIM. CIM seem to mention that Own Group Biases are dependent on whether their category, in this case gender category has been made "motivationally relevant" (Hugenberg, Wilson, See, and Young, 2013). In none of the studies examining Own Gender Bias in the literature has gender category been primed, hence this model needs to clarify especially in relation to Own Gender Bias how motivation is related. As noted in the next few paragraphs there is a preference for the female face since infancy, such a relationship is not available for 'mere' group bias which is created in lab situations.

CIM does not seem to take account of the finding that the female interest in faces has been demonstrated for infants and children. Findings from developmental studies have revealed that infants show a preference for female faces rather than male faces (Leinbach & Fagot, 1993). Furthermore, when compared to boys, girls pay more attention to a female face (Connellan, Baron-Cohen, Wheelwright, Batki, & Ahluwalia, 2000). It was suggested that this might be due to the fact that the majority of infants are reared by females, and this could lead to greater familiarity with female faces. Also, infants show a spontaneous preference for their mother's face to unfamiliar female faces, even when hair cues are removed (Bartrip, Morton, & de Schonen, 2001), demonstrating that they can discriminate and generalise their expertise with the female primary caregivers to other female faces more generally. Quinn, Yahr, Kuhn, Slater, and Pascalis (2002) found that this female preference was reversed on the occasions where the primary caregiver was a male. It must be mentioned though that we need to be conscious in interpreting these findings due to the small sample size (N = 6). However, further evidence provided by Quinn et al. (2002) suggests that infants with female primary care givers are indeed more expert at processing female faces relative to male faces. In this study, the habituation technique was used, where infants are habituated (familiarised) with either male or female faces. Later, the infants were tested for preference with a novel versus a familiar face. Both the novel and the familiar faces were of the same gender. They revealed that no differential preference was found for the group that was familiarized with male faces, suggesting that the infants were considering male faces as one type of stimuli without differentiating between them. However, for the female face familiarized group, a preference for the novel female faces was shown, indicating that the female faces are represented as individual exemplars, hence showing more expertise in processing the female faces. It has been suggested by the recent meta-analysis (Herlitz & Loven, 2013) that this extensive experience with female faces might be further reinforced for female observers, who have more close relationships with other females. A recent study (Sommer et al. 2013) which found a general advantage for female observers in face perception and face memory showed that this female superiority was partially explained by the intensity of social involvement. Wolff et al. (2013) also measuring quantity and quality of contact did not find any correlations between memory and contact, even though females demonstrated a great quality of contact than males. It must be noted however, that both these studies used different types of measures as well as different types of analysis. Sommer et al. examined social involvement vs things oriented activities (activities which do not involve people), while Wolff concentrated on actual times (hours per week). Contact studies examining Own Race Bias have shown that contact measures have proven problematic, hence targeting groups such as teachers and perhaps students who attended an all-boys or all-girls school might be beneficial in terms of avoiding the problems associated with contact quantity/quality measures. Examining the role of contact on Own Age Bias, Harrison and Hole (2009) compared trainee teachers (who have greater experience with children) and control groups, the usual Own Age Bias was found for the control group, while no Own Age Bias was found for trainee teachers (in fact a children bias trend was demonstrated for the teachers). A similar approach in examining the role of contact could also be taken when investigating Own Gender Bias.

As mentioned above a few studies have taken into account contact measurements, although to some extent findings from social psychology on gender differences in group interactions have not been taken into account. Findings from such studies seem to suggest that males and females interact with same gendered and opposite gendered members in different ways. In terms of spatial behaviour when interacting with same and opposite gender members, female-female pairs are the closest (in terms of distance from each other), followed by male-female and male-male interactions. Females are approached closer by others (males and females), while males, in particular unknown males are approached at a greater distance (Argyle, 1994). In social situations females have also been found to look (gaze) more than males, in particular females have been found to look more at other females. In addition, both males and females look less at males (Argyle, 1994). Explanations for these gender differences have been offered ranging from physiological and innate factors, especially in relation females' increased interest in faces; socialization; gender norms and female oppression (Argyle, 1994). The origins of these gender differences are beyond this thesis, however these differences in social communication might have an effect in the way that male and female observers process male and female faces, considering that gender differences have been found on gazing behaviour. These gender differences in gaze behaviour during social interaction could provide vital information of the quantity and quality of attention that is paid to male and female faces. It is recommended that future research examines these gender differences in real world situations or even in a brief social interaction with a confederate in a lab context, after the participants has taken part in the face recognition test. It is also recommended that the participants' eye movements are recorded in these social situations as well as lab face recognition experiments, which might provide a clearer picture of the attentional processes.

6.5 General methodological issues and future directions

There are limitations to this research that might constrict the degree to which the findings can be generalised. First however, it should be noted that the studies in this thesis are at advantage compared to most of studies on Own Group Bias. In the present thesis extra care was taken to pilot all the face stimuli used in this thesis, the face stimuli were carefully matched on age, attractiveness and distinctiveness, as well as masculinity and femininity. It was made sure that only those faces which had 100% agreement were used in the first two studies in this thesis. For the third study carefully piloted face stimuli were used to ensure the androgynousness of the face stimuli used. In fact a series of 3 pilots were used, where each pilot had a considerably good number of participants (50 % female and 50 % male). For the last study similar procedures were used including careful piloting in all the previously mentioned variables. Previous research especially on own group biases in face recognition seems to have neglected the importance of the face stimuli, hence this could be a point that future research should be taking into account. Nevertheless the present study used the same photographs in both learning and recognition stages in both Study 3 and Study 4. Bruce (1982) suggests using different stimuli at learning and at test to ensure that participants are being test for their face recognition abilities and not their ability to recognize photographs. It should be noted however that this was not physically possible to carry out in relation with Study 3 due to the nature of stimuli (i.e. the stimuli was created via morphing). All of the studies on Own Gender Bias and most of the studies on the other group biases do not take this into consideration. It is strongly recommended that future research keeps this in mind; however it should also be noted that using different photographs at learning and recognition would result in increasing task difficulty, considering that the faces presented are unfamiliar. This is perhaps a future point that might be interesting for CIM to include on their account of Own Group Bias. Own Race Bias might show consistency as the task itself is extremely difficult (due to the lack of perceptual expertise), while the inconsistency of the Own Gender Bias might be a result of the difficulty of the task rather than solely motivational factors. If the task itself is easy, then males might perform at the same level as females (hence the emergence of a

Female Own Gender Bias might not be apparent). Hence, it would be interesting for future research on Own Gender Bias, and future studies examining Own Group Biases to examine the role of task difficulty in the emergence of these biases.

Study 1 concluded that male faces capture attention when the face stimuli are irrelevant to the task at hand. It would be interesting for future research to assess the presence of this effect further, especially in relation with the threat explanation. An examination on how threatening the faces are perceived would be useful. This could be an additional task carried out after the visual search, where the faces are rated on threat perception by the same participants. Another option would be to prime participants with a threatening situation and examine for potential face gender differences in attentional capture.

The findings of Study 2 call into question whether faces hold attention. As discussed previously, if faces hold attention it should not matter whether their attention holding abilities are being compared with another category which has a wide range of exemplars. Study 2 also used a wide range of face stimuli, consisting of 16 exemplars, which was consistent with the object exemplars; hence the number of exemplars for each category was the same. This is a finding that the literature should be aware of. Despite the interesting findings it should be noted here that only female participants were recruited, due to asymmetry of Own Gender Bias. In fact, many studies examining Own Race Bias seem to recruit only white participants, possibly due to difficulty of recruiting other races. It is good practice however to include both genders even though Own Gender Bias is asymmetrical; hence studies 3 and 4 in this thesis included both male and female participants. This is a procedure that all future research which examines own gender/race/age bias should follow, as the interaction between the participants' social grouping and the social grouping of the target face demonstrates whether a bias is present.

Study 4 aimed to first examine the existence of Own Gender Bias and the usual female advantage found in face recognition, however these were both absent. In line with our results, two recent studies (Sommer et al. 2013; Weirich et al. 2011) also did not find an Own Gender Bias, however these studies demonstrated a female advantage in face recognition. It is strongly recommended that future research concentrates on examining the consistency of an Own Gender Bias as if inconsistencies are persistent then this will contribute negatively in identifying the underlying mechanisms. In other words, the robustness of Own Gender Bias needs to be assessed first before an effort is made to examine its causes. CIM suggests that motivation plays a crucial role in this bias and the role of motivation was also examined in Study 4, but the results demonstrated null results. One possible limitation of this study as mentioned previously might lie on the fact that mating and mate guarding personality factors were used as the motivating factors. It was reasoned that since sexual orientation had been demonstrated to modulate the male Own Gender Bias it would be appropriate to use mating and mate guarding personality factors as possible motivators of face recognition. These results demonstrate that more definitive conclusions and research is needed to support the role of motivation on Own Gender Bias. Future research should determine whether motivation is internal (personality variables) or external (situational factors). The results from study 4 seem to suggest that mating and mate guarding personality factors do not play a role on face recognition. It is speculated that this could be the result of two possible outcomes. First, it was ensured that all the face stimuli were average in attractiveness (this was carried out intentionally as attractive faces are recognized better) however in the context of Study 4, there might have not been any real situational motivation for participants to see the faces as potential mating partners or as a threat. Secondly, this idea of contextual motivation was not present in study 4; perhaps future research could investigate this type of motivation.

6.6 Conclusions

The primary aim of this thesis was to examine the underlying mechanisms of Own Gender Bias. The first three studies sought to investigate the role of attention on Own Gender Bias, while the last study, taking into account that no indication of Own Gender Bias was present in the first three studies, re-examined the presence of the Own Gender Bias under a possible role of motivation on this bias. This thesis relied on the extensive research carried out on Own Race Bias as well as recent research on

Own Gender Bias to guide the investigation although it is not straightforward to draw firm conclusions on how similar these biases are However the results of Study 1 in this thesis demonstrate some similarity to Own Race Bias (where the other race captures attention) as it seems to be that in Own Gender Bias the other gender, the male face that captures attention (considering that Own Gender Bias is asymmetrical). Study 3 revealed several important findings which suggest that gender social categorisation influences the perceptual characteristics that are utilised at encoding. This effect was modulated by participants' gender as well as face gender. It was speculated that male and female observers use the same features for possibly different purposes. Study 4 demonstrates that mating and mate guarding personality factors do not module face recognition or Own Gender Bias. In addition no Own Gender Bias nor a female advantage in face recognition was found in Study 4.Therefore, it is strongly advised that research on Own Gender Bias should focus on examining how robust Own Gender Bias is, as this will aid in identifying its underlying mechanisms. It should also be noted that further research is needed to support claims that motivation is crucial to Own Gender Bias and research specifically to identify the type of motivation relevant to this specific bias. In addition, it would be of interest for future research to examine the role of task difficulty in the emergence of Own Gender Bias and perhaps Own Group Biases in general.

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Appendix 1

Multidimensional Jealousy Scale

Instructions:

Please think of a person with whom you are having or have had a strong romantic/love relationship. This person is referred to a X in this questionnaire. Please rate your response to the following questions by circling the appropriate number beside each item.

Cognitive

How often do you have the following thoughts about X?	All the time						Never
I suspect that X is secretly seeing someone of the opposite sex	1	2	3	4	5	6	7
I am worried that some member of the opposite sex may be chasing after X	1	2	3	4	5	6	7
I suspect that X may be attracted to someone else	1	2	3	4	5	6	7
I suspect that X may be physically intimate with another member of the opposite sex behind my back	1	2	3	4	5	6	7
I think that some members of the opposite sex may be romantically interested in X	1	2	3	4	5	6	7
I am worried that someone of the opposite sex is trying to seduce X	1	2	3	4	5	6	7
I think that X is secretly developing an intimate relationship with someone of the opposite sex	1	2	3	4	5	6	7
I suspect that X is crazy about members of the opposite sex	1	2	3	4	5	6	7

Emotional

How would you emotionally react to the following situations?	Very Pleased						Very Upset
X comments to you on how great looking a particular member of the opposite sex is	1	2	3	4	5	6	7
X shows a great deal of interest or excitement in talking to someone of the opposite sex	1	2	3	4	5	6	7
X smiles in a very friendly manner to someone of the opposite sex	1	2	3	4	5	6	7
A member of the opposite sex is trying to get close to X all the time	1	2	3	4	5	6	7
X is flirting with someone of the opposite sex	1	2	3	4	5	6	7
Someone of the opposite sex is dating X	1	2	3	4	5	6	7
X hugs and kisses someone of the opposite sex	1	2	3	4	5	6	7
X works very closely with a member of the opposite sex (in school or office)	1	2	3	4	5	6	7

Behavioural

How often do you engage in the following behaviours?	Never						All the time
I look through X's drawers, handbag, or pockets	1	2	3	4	5	6	7
I call X unexpectedly, just to see if s/he is there	1	2	3	4	5	6	7
I question X about previous or present romantic relationships	1	2	3	4	5	6	7
I say something nasty about someone of the opposite sex if X shows an interest in that person	1	2	3	4	5	6	7
I question X about his/her telephone calls	1	2	3	4	5	6	7
I question X about his/her whereabouts	1	2	3	4	5	6	7
I join in whenever I see X talking to a member of the opposite sex	1	2	3	4	5	6	7
I pay X a surprise visit just to see who is with him/her	1	2	3	4	5	6	7

Scale for Intrasexual Competition

[Version for men]

Please indicate how much of the following statements apply to you. Circle the number that corresponds to the answer of your choice

How often do you engage in the following behaviours?	Not at all applicable				Completely applicable		
I can't stand it when I meet another man who is more attractive than I am	1	2	3	4	5	6	7
When I go out, I can't stand it when women pay more attention to a friend of mine than to me	1	2	3	4	5	6	7
I tend to look for negative characteristics in attractive men	1	2	3	4	5	6	7
When I'm at a party, I enjoy it when women pay more attention to me than to other men	1	2	3	4	5	6	7
I wouldn't hire a very attractive man as a colleague	1	2	3	4	5	6	7
I just don't like very ambiguous men	1	2	3	4	5	6	7
I tend to look for negative characteristics in men who are very successful	1	2	3	4	5	6	7
I wouldn't hire a highly competent man as a colleague	1	2	3	4	5	6	7
I like to be funnier and more quick-witted than other men	1	2	3	4	5	6	7
I want to be just a little better than other men	1	2	3	4	5	6	7
I always want to beat other men	1	2	3	4	5	6	7
I don't like seeing other men with a nicer house or nicer car than mine	1	2	3	4	5	6	7

Scale for Intrasexual Competition

[Version for women]

Please indicate how much of the following statements apply to you. Circle the number that corresponds to the answer of your choice

How often do you engage in the following behaviours?	Not at all applicable Completely applicable						
I can't stand it when I meet another woman who is more attractive than I am	1	2	3	4	5	6	7
When I go out, I can't stand it when men pay more attention to a friend of mine than to me	1	2	3	4	5	6	7
I tend to look for negative characteristics in attractive women	1	2	3	4	5	6	7
When I'm at a party, I enjoy it when men pay more attention to me than to other women	1	2	3	4	5	6	7
I wouldn't hire a very attractive woman as a colleague	1	2	3	4	5	6	7
I just don't like very ambiguous women	1	2	3	4	5	6	7
I tend to look for negative characteristics in women who are very successful	1	2	3	4	5	6	7
I wouldn't hire a highly competent woman as a colleague	1	2	3	4	5	6	7
I like to be funnier and more quick-witted than other women	1	2	3	4	5	6	7
I want to be just a little better than other women	1	2	3	4	5	6	7
I always want to beat other women	1	2	3	4	5	6	7
I don't like seeing other women with a nicer house or nicer car than mine	1	2	3	4	5	6	7

The revised Sociosexual Orientation Inventory (SOI-R)

Please respond honestly to the following questions:

1. With how many different partners have you had sex within the past 12 months?

□	□	□	□	□	□	□	□	□
0	1	2	3	4	5-6	7-9	10-19	20 or more

2. With how many different partners have you had sexual intercourse on *one and only one* occasion?

□	□	□	□	□	□	□	□	□
0	1	2	3	4	5-6	7-9	10-19	20 or more

3. With how many different partners have you had sexual intercourse without having an interest in a long-term committed relationship with this person?

□	□	□	□	□	□	□	□	□
0	1	2	3	4	5-6	7-9	10-19	20 or more

4. Sex without love is OK.

1 □ 2 □ 3 □ 4 □ 5 □ 6 □ 7 □ 8 □ 9 □

Strongly disagree — Strongly agree

5. I can imagine myself being comfortable and enjoying "casual" sex with different partners.

1 □ 2 □ 3 □ 4 □ 5 □ 6 □ 7 □ 8 □ 9 □

Strongly disagree — Strongly agree

6. I do *not* want to have sex with a person until I am sure that we will have a long-term, serious relationship.

1 □ 2 □ 3 □ 4 □ 5 □ 6 □ 7 □ 8 □ 9 □

Strongly disagree — Strongly agree

7. How often do you have fantasies about having sex with someone you are *not* in a committed romantic relationship with?

    □ 1 – never

    □ 2 – very seldom

    □ 3 – about once every two or three months

    □ 4 – about once a month

    □ 5 – about once every two weeks

    □ 6 – about once a week

    □ 7 – several times per week

    □ 8 – nearly every day

    □ 9 – at least once a day

8. How often do you experience sexual arousal when you are in contact with someone you are *not* in a committed romantic relationship with?

    □ 1 – never

    □ 2 – very seldom

    □ 3 – about once every two or three months

    □ 4 – about once a month

    □ 5 – about once every two weeks

    □ 6 – about once a week

    □ 7 – several times per week

    □ 8 – nearly every day

    □ 9 – at least once a day

9. In everyday life, how often do you have spontaneous fantasies about having sex with someone you have just met?

   □ 1 – never

   □ 2 – very seldom

   □ 3 – about once every two or three months

   □ 4 – about once a month

   □ 5 – about once every two weeks

   □ 6 – about once a week

   □ 7 – several times per week

   □ 8 – nearly every day

   □ 9 – at least once a day

The Marlowe-Crowne Social Desirability Scale

Listed below are a number of statements concerning personal attitudes and traits. Read each item and decide whether the statement is true (T) or false (F) as it pertains to you personally.

1. Before voting I thoroughly investigate the qualifications of all the candidates. T F

2. I never hesitate to go out of my way to help someone in trouble. T F

3. It is sometimes hard for me to go on with my work if I am not encouraged. T F

4. I have never intensely disliked anyone. T F

5. On occasion I have had doubts about my ability to succeed in life. T F

6. I sometimes feel resentful when I don't get my way. T F

7. I am always careful about my manner of dress. T F

8. My table manners at home are as good as when I eat out in a restaurant. T F

9. If I could get into a movie without paying and be sure I was not seen I would probably do it. T F

10. On a few occasions, I have given up doing something because I thought too little of my ability. T F

11. I like to gossip at times. T F

12. There have been times when I felt like rebelling against people in authority even though I knew they were right. T F

13. No matter who I'm talking to, I'm always a good listener. T F

14. I can remember "playing sick" to get out of something. T F

15. There have been occasions when I took advantage of someone. T F

16. I'm always willing to admit it when I make a mistake. T F

17. I always try to practice what I preach. T F

18. I don't find it particularly difficult to get along with loud mouthed, obnoxious people. T F

19. I sometimes try to get even rather than forgive and forget. T F

20. When I don't know something I don't at all mind admitting it. T F

21. I am always courteous, even to people who are disagreeable. T F

22. At times I have really insisted on having things my own way. T F

23. There have been occasions when I felt like smashing things. T F

24. I would never think of letting someone else be punished for my wrongdoings. T F

25. I never resent being asked to return a favour. T F

26. I have never been irked when people expressed ideas very different from my own. T F

27. I never make a long trip without checking the safety of my car. T F

28. There have been times when I was quite jealous of the good fortune of others. T F

29. I have almost never felt the urge to tell someone off. T F

30. I am sometimes irritated by people who ask favours of me. T F

31. I have never felt that I was punished without cause. T F

32. I sometimes think when people have a misfortune they only got what they deserved. T F

33. I have never deliberately said something that hurt someone's feelings. T F