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Short article

Are attractive facial characteristics peculiar to the sex of a face?

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Preferences for faces are thought to be the result of either general adaptations for mate selection, and thus influenced by sexual dimorphism, or mechanisms of general information processing and thus nonspecific to faces. If mate choice determines face preference then it should follow that the sex of a face should affect attractiveness judgements. To test this idea we used image morphing to generate three versions of face images: original, opposite sex, and antiface. First we established that the sex of the face was identifiable in our images. We then collected attractiveness ratings for the three face types. We found that attractiveness ratings to the original faces were correlated with, and did not differ significantly between, ratings to the opposite-sex faces. However, ratings for either the original or opposite face types were not correlated with and were significantly lower than ratings to the antifaces. Our findings failed to support the idea that attractiveness is related to sexual dimorphism in faces alone but suggest instead that other more generic factors influence preferences for all faces.

Keywords: Face perception; Attractiveness; Sex dimorphism; Face space.

Contrary to the aphorism that "beauty lies in the eye of the beholder", a growing corpus of research indicates that attractiveness preferences for faces may be universal, rather than being determined by arbitrary socio-cultural standards of beauty. Our understanding of what mediates these universal preferences is, however, relatively poor. In general, two alternative models are proposed to account for the development of preferences for facial characteristics: Preferences are either derived from adaptations to selection pressures for mate selection or are the consequence of the way in which information is processed to allow for efficient and robust cognition (see Rhodes, 2006, for a review).

On the one hand, sexual selection pressures favour the development of features that are an outward indicator of a healthy genotype, thus enabling an individual to select a mate who will provide offspring with the best possible advantage for survival (e.g., see Barrett, Dunbar, & Lycett, 2002). If face preferences are adaptations for

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mate selection then the factors that determine the attractiveness of a face should be peculiar to the sex of the face. Indeed, features that connote sexual dimorphism should be particularly attractive in each of the sexes. For example, testosterone-dependent secondary characteristics such as facial hair and jaw size in a male face may indicate genetic health (Møller & Alatalo, 1999) and status and thus signal mate potential, but these same features may not signal mate potential in a female face. In contrast, highly feminine characteristics thought to indicate youth and fertility, such as high cheekbones and a small chin, are preferred in female faces (e.g., Perrett, May, & Yoshikawa, 1994), and exaggeration of these features increases the perceived attractiveness of female faces (Perrett et al., 1998; Perrett et al., 1994; Rhodes, Chan, Zebrowitz, & Simmons, 2003). However, to the best of our knowledge, no study has examined whether preferences for these features are peculiar to the sex of the face.

An alternative proposal is that attractiveness preferences may be a reflection or a "by-product" of general perceptual or cognitive mechanisms for processing information. As such, general characteristics such as averageness or symmetry are often found to influence attractiveness judgements of faces (e.g., Langlois & Roggman, 1990; O'Toole, Price, Vetter, Bartlett, & Blanz, 1999; Perrett et al., 1994; Rhodes, Roberts, & Simmons, 1999; Scheib, Gangestad, & Thornhill, 1999). However, it is debatable whether these attributes reflect the set of features that are important for determining health and reflect, again, adaptations for mate selection (see Rhodes, 2006) or whether they reflect general information processing underlying memory representations. If the latter, then averageness or symmetry should not be specific determinants of preferences in faces only but should underlie our preferences for any type of stimuli. Indeed a growing body of evidence supports the idea that factors that affect attractiveness in faces, such as averageness, generalize to other classes of stimuli such as birds, watches, or random dot patterns (Halberstadt & Rhodes, 2000, 2003; Winkielman, Halberstadt, Fazendeiro, & Catty, 2006) suggesting that facial attractiveness preferences may indeed be influenced by general information-processing mechanisms.

A recent neuroimaging study on the role of sexual orientation on attractiveness in faces revealed that differential activation in the orbitofrontal cortex signalled a preference for faces associated with the sexual orientation of the participant (Kranz & Ishai, 2006). This finding is interesting, especially since there were no behavioural differences in attractiveness judgements across participants and faces. Thus, although judgements of attractiveness in unfamiliar faces may be initially derived from general principles, separate, reward-related processing may determine whether or not the face is one that could be a potential mate.

In a recent study investigating female facial attractiveness, a principal component analysis of face shape found components of facial attractiveness to be independent of sexual dimorphism (Valenzano, Mennucci, Tartarelli, & Cellerino, 2006). The question we address here is whether or not features that characterize sexual dimorphism determine the attractiveness of a face when identity is held constant. If so, then attractiveness judgements should be specific to the sex of the face and should not necessarily generalize across the sexes. On the other hand, attractive features may be largely independent of the sex of the face but may be, instead, related more to general information-processing mechanisms. If that is the case, then judgements of attractiveness should not be determined by the sex of the face alone but more by other general factors such as its typicality (or averageness) and symmetry.

Previously, models of face perception have been proposed to account for the effect of face typicality on perception and attractiveness. One such model, the so-called "face-space" model (Valentine, 1991; O'Toole et al., 1999) proposes that the distance of the face to the average, or prototype, face in face-space affected how well the face would be recognized or considered attractive. For example, Valentine argued that typical faces are represented in memory closer to the average (i.e., the prototype) and have a greater number of near neighbours than do distinctive faces; thus they are more easily confusable and less recognizable. Indeed, many studies have shown that memory for faces previously rated as being typical is worse than memory for distinctive faces (see e.g., Newell, Chiroro, & Valentine, 1999). On the other hand, since distance from the average face reflects how representative the face is of faces in general then more typical faces would be preferred since they are better examples of faces than less typical or distinctive faces (see Langlois & Roggman, 1990). Thus, the face-space model predicts that distance from the average face is a reliable indicator of attractiveness in faces (see O'Toole et al., 1999).

Although it is generally assumed that a single prototype face lies at the origin of a multidimensional face-space, recent studies investigating the perception of the sex of a face (O'Toole et al., 1998) and the relationship between face distinctiveness and sex (Baudouin & Gallay, 2006) suggest that the structure of face-space may alter substantially to accommodate visually derived semantic subsets of faces (i.e., male and female faces). As such, instead of faces clustering around a single prototype, two sex-based clusters emerge so that the face-space close to the average male or female face is densely populated, with relatively few faces clustering around the overall average face. The sex prototype, rather than the overall average prototype, then becomes the reference point against which face judgements are made, for instance, when determining the distinctiveness of a male or female face (e.g., Baudouin & Gallay). However, as would be expected in such a face-space, the sexual characteristics of a face would covary with its identity, so that it is difficult to ascertain whether sexual dimorphism or particular configural arrangements of features underpin attractiveness preferences.

In this study we were interested in manipulating sex information independently of identity information in face images. In a previous study investigating the effect of manipulating faces through the origin of face-space (i.e., the average face, Blanz, O'Toole, Vetter, & Wild, 2000), it was found that sex information in a face could be manipulated independently of the identity of a face by using the general, androgynous, average of a set of faces. Therefore, we generated our face stimuli in a face-space comprising a single androgynous prototype.

Face stimuli

Images of 20 female and 20 male faces were randomly chosen from a database of over 200 face images collated at the Max Planck Institute for Biological Cybernetics, Tübingen (see Blanz & Vetter, 1999, for a more in-depth description of the generation of the face images). These face images were obtained from laser scans (Cyberware^{TM}) and comprised 3-D head models and their associated surface reflectance maps. Thus, after processing, each face was represented by approximately 7×10^4 vertices and the same number of colour values. The average age of the female faces was 27 years and 2 months, and the average age of the male faces was 28 years and 5 months. The faces in all images were still images shown in full-face presentation, without background details, and were rendered as colour images. All the faces were altered to remove secondary sex cues (e.g., hair, beards, make-up, and jewellery). In all studies, the images were presented at a resolution of 72 dots per inch (dpi) on a computer screen.

Face images were defined by physical characteristics, resulting in a multidimensional face space in which similarity between the faces was determined by their vector direction and distance from each other in this space. Using custom-built software to generate morphed images within the face space (Blanz & Vetter, 1999) we created two different versions of each original face stimulus, yielding three face sets: the original face images, "opposite-sex face image" derivatives, and "anti-face image" derivatives. See Figure 1 for examples of these images.

The original images were unmanipulated images from the database. Opposite-sex images were created by morphing the original images through the "average" face (i.e., the average dimensions of 100 male and 100 female faces, which results in an androgynous prototype) and taking a vector equal in direction and distance from this average across to the opposite sex. Importantly, this morph did not traverse the "average" face in the identity dimension, where all physical characteristics would change. Images were manipulated only in the sex dimension so that only physical characteristics related to the sex of the face changed. In other words, we essentially created the "sister" or "brother" of the original face by changing the sex but not the overall identity of the face.

Original faces were also morphed through the "average" face to create antifaces. The antiface is defined as the face comprising the opposite value of all physiognomic dimensions to the original face. For example, if the original face had large eyes, its antiface would have small eyes. Morphing through an androgynous mean in both the sex and identity dimensions changed both the sex of the face and its physical characteristics, resulting in an antiface stimulus that was difficult to associate with the original face perceptually (see e.g., Blanz et al., 2000; Leopold, O'Toole, Vetter, & Blanz, 2001, for the use of antifaces in previous studies). We included antiface stimuli mainly as a control set of faces in order to test whether any potential differences (or lack thereof) in attractiveness between the original and opposite-sex versions were not simply due to our morphing procedure. The antifaces used in this study are not reflected the same distance through

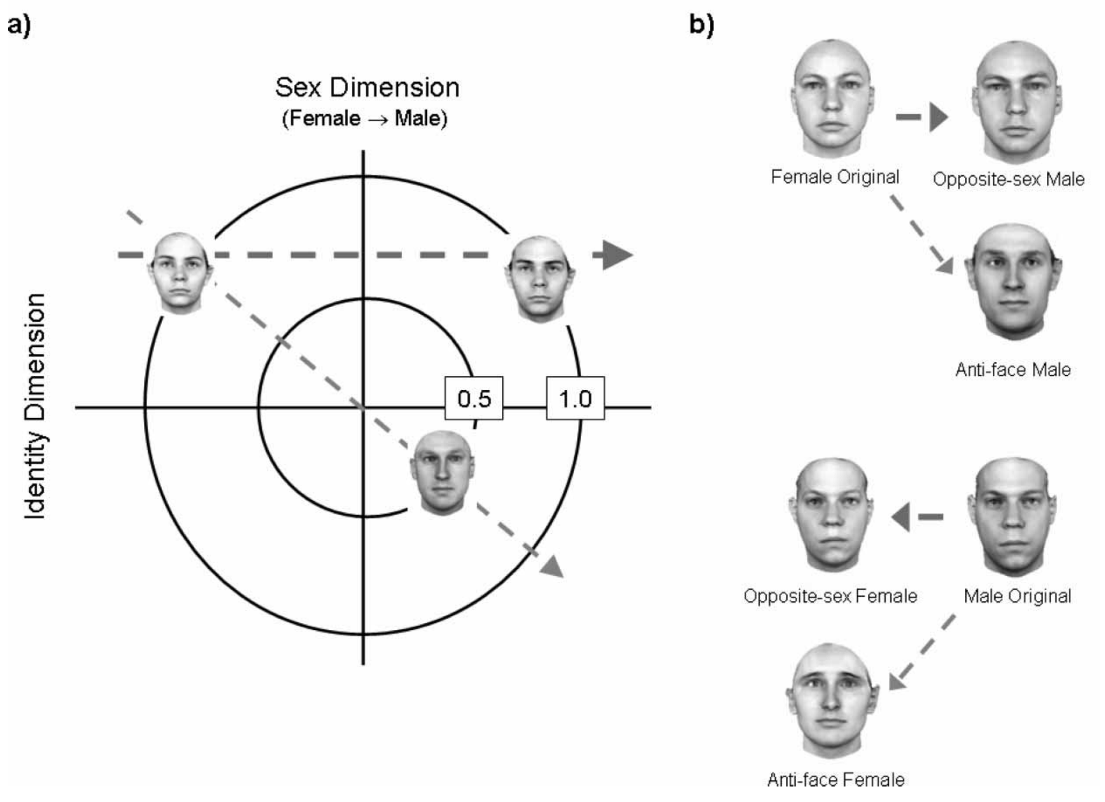

Figure 1. *Examples of the stimuli we generated within the multidimensional face space. (a) A schematic illustration of our face-space where all dimensions are collapsed onto our two experimental dimensions: sex of face (female to male horizontal axis) and face identity (vertical axis). Original and opposite-sex faces are equidistant from the average face. For technical reasons, antifaces have been reflected only halfway through the mean. (b) The upper row depicts an example of a female original face and its computer morphed opposite-sex and antiface pairs, and the lower row depicts an example of computer-morphed faces from an original male face.*

to the other side of the mean: The caricature level (which was 1 for original faces and 0 for the average) was set to −.5 for the antifaces (see also Blanz et al., 2000, for a rationale and similar procedure). The antifaces were, therefore, closer to the "average" face in this face space than either their original or opposite-sex versions (both of which were equidistant from the average face). This permitted us to assess the role of distance from the average face in judgements of attractiveness and reduce the likelihood of perturbations in the images due to the morphing process. Examples of opposite-sex and antiface faces for original male and female faces are illustrated in Figure 1.

Prestudies

We were concerned that, due to the removal of secondary sex cues (e.g., hair, beards, etc.), that the sex of the face may not have been easily determined. With that in mind we investigated whether participants could identify the sex of a face in two short prestudies.

In the first study, 16 participants performed a categorization task in which they had to identify whether a face stimulus was male or female, when both sex and identity varied across stimuli. The original male and female face stimuli were presented serially in a randomized order and remained on screen until a sex-categorization response was made. The mean accuracy rates for identifying female and male faces were 68.13% ($SD = 21.52\%$) and 99.69% ($SD = 1.25\%$), respectively. We adopted a criterion correct response level of 70% for male and female classifications. A sign test indicated that participants had little difficulty correctly classifying male faces as male, performing significantly above the criterion level ($z = 3.75$, $p < .001$). A Wilcoxon matched-pairs test indicated that participants appeared to have greater difficulty classifying female faces ($z = -3.52$, $p < .001$); however, a second sign test showed that performance for female face images did not differ significantly from the set criterion level ($z = 0.25$, $p = .8$). Thus the findings of this study indicated that participants could reliably classify the sex of the original face images, despite the removal of secondary cues to sex, albeit with greater difficulty for female face images.

Therefore, in a second prestudy we used a two-alternative forced choice (2AFC) paradigm to determine more clearly whether participants were able to discriminate between the male and female face images when identity was manipulated or held constant. Faces were presented in pairs: Original female face images were paired with their opposite-sex morphs, their antifaces, or another original male image. The task for a second set of 16 participants was to identify whether the female image was on the left or the right in each face pair presented on a computer screen by pressing the appropriate response key. The percentage correct scores across conditions were 99% (23.3%), 91.7% (21.9), and 94.1% (22.3%) for opposite-sex, antiface, and other male pairings, respectively (standard deviations in parentheses). Sign tests indicated that the scores in all conditions were significantly greater than the criterion level of 70% adopted in the first study (all $z = 3.75$, $p < .001$).

We conducted a one-way, repeated measures analysis of variance (ANOVA) on the percentage correct scores across the three face pairs (opposite-sex, antiface, original face pairings) which revealed a main effect of face pair, $F(2, 30) = 17.453$; $p < .001$. Bonferroni pairwise comparisons were drawn to establish the source of the effect: The mean percentage of correct responses in identifying the female face from the opposite-sex face was significantly higher than performance to the other face pairings (both $p < .001$). Thus, participants were very accurate at identifying the female target face when the "identity" information of both faces was the same, and only the sex information had changed.

This finding was expected since the opposite-sex image is derived from a symmetrical translation through face-space; therefore, the female image differed from its paired image only by information relating to the sex of the face, which, on this dimension, it was exactly opposite. In contrast, the other image pairs differed on both the sex and identity dimensions. which may have introduced some uncertainty in the response resulting in slightly more errors in performance. For example, since antifaces lie closer to the mean, the female and antiface images of the face pair are not equidistant from the "average-sex" face. Similarly, random original male images may not be the same distance from the average-sex face than the original female in the pair. Thus, the decision is not simply male/female; if paired images fall close together in face-space, then it would be expected that discrimination between the two would become more difficult.

Irrespective of the relative difficulty in identifying the female face from its antiface or an original male face, we were nevertheless assured that the sex of the face was identifiable from our images, since performance was relatively high in all our prestudies. Moreover, as participants could reliably distinguish between male and female images, we could be confident that participants were aware of the sex differences between images, thus allowing us to collect valid attractiveness ratings in the following experiment.

MAIN EXPERIMENT

We used the same face sets here as those in the prestudies and collected attractiveness ratings for each of the faces. If attractiveness is related to sexual dimorphism in faces (i.e., more masculine features such as a strong jaw or prominent brow are seen as attractive in male faces whereas more youthful features such as relatively large eyes are considered more attractive in female faces) then we expected that attractiveness ratings to the same facial identity but different sex would not be correlated, nor would they necessarily be considered equally attractive. On the other hand, if facial attractiveness is related to the distance from the average face, then we expected attractiveness ratings to be highest to the antifaces and equal for the original and opposite-sex faces.

Method

Participants
A total of 30 undergraduate students (24 female and 6 male) from the School of Psychology, Trinity College Dublin, Ireland, participated in this study for research credits. The research methodology of this study and both prestudies was approved by the School of Psychology Ethics Committee, and all participants provided written informed consent before taking part. All reported normal, or corrected-to-normal, vision. None of the participants taking part in this experiment took part in either of the prestudies.

Apparatus
The experiment was designed and run on a G3 Macintosh with a 21″ colour monitor. Stimuli were presented as single face images using PsyScope (Cohen, MacWhinney, Flatt, & Provost, 1993) software, and all were shown from the full-face viewpoint. Participants sat approximately 57 cm away from the screen, with each face image subtending 9 degrees visual angle. Participants rated the stimuli from 1 ("not attractive") to 7 ("highly attractive") using the computer keyboard.

Design
The experiment comprised two blocks of face trials with 60 same-sex stimuli in each (e.g., original females, male-to-female opposite-sex faces, and male-to-female antiface faces were presented in the same block). Prior to each block, participants were informed of the sex of the faces about to be presented. The order of stimuli was randomized within blocks, and the order of blocks was counterbalanced across participants. Stimuli remained on the screen until attractiveness judgements were made.

Procedure
Participants were tested individually and were instructed to rate each face stimulus for attractiveness on a scale from 1 (indicating "not attractive") to 7 (indicating "very attractive"). They were encouraged to respond using the full scale.

Results and discussion

The mean rating scores across each of the conditions is shown in Figure 2. As an independent

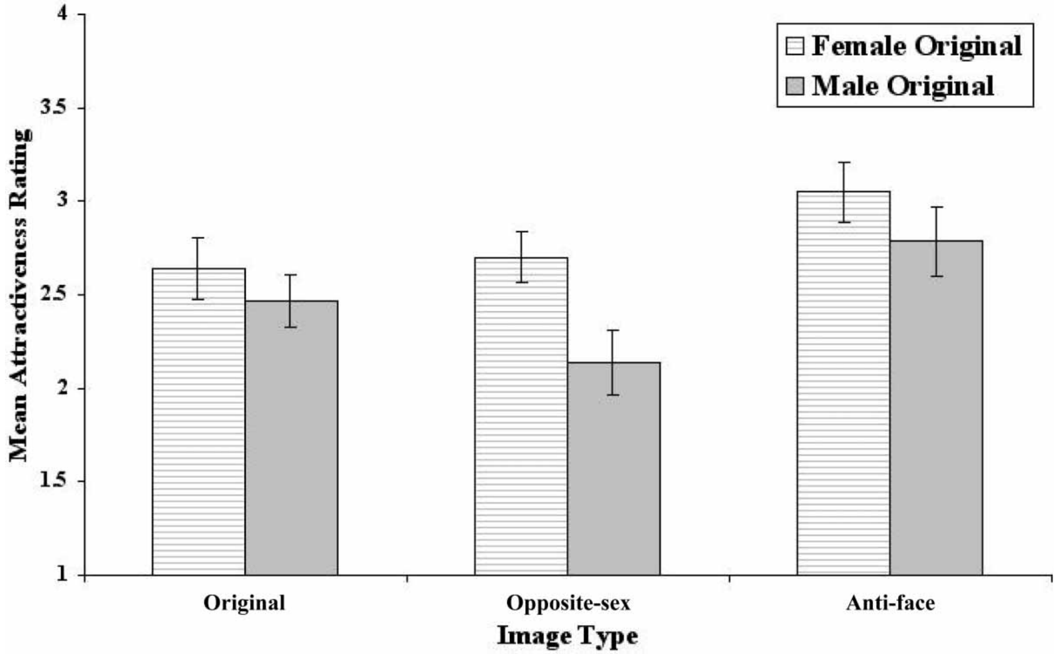

Figure 2. *Mean attractiveness ratings for each of the face types (original, opposite-sex, and antiface) according to the sex of the original face. Error bars represent* ± 1 *standard error of the mean.*

t test revealed no difference between attractiveness ratings of male and female participants, $t(28) = 0.09$, $p = ns$, the sex of the participant was not included as a variable in subsequent analyses. Interrater reliability was calculated using Kendall's coefficient of concordance. We found a moderate degree of interrater reliability across participants ($W = 0.4$, $\chi^2 = 1{,}244.73$, $p < .001$). We then conducted Pearson correlations on the attractiveness ratings across the original faces and each of the opposite-sex and antiface types. For the original female faces, we found a positive correlation between ratings to these faces and ratings to the opposite-sex face ($r = .68$, $p < .001$) but not the antiface stimuli ($r = .05$, *ns*). Similarly for the original male faces, we found a positive correlation between ratings to these original faces and to the opposite-sex faces ($r = .76$, $p < .001$) but not between the original and antifaces ($r = -.02$, *ns*).

In general, as can be seen in Figure 2, participants tended not to rate the face images as highly attractive. The rating scores were analysed using a 2×3 factorial, repeated measures ANOVA, with sex of original face (male or female) and type of face (original, opposite-sex, antiface) as factors. There was a main effect of the sex of the original face, $F(1, 29) = 20.58$; $p < .001$, indicating that ratings to the faces from the original female face were higher than those to the original male face. We also found a main effect of face type, $F(2, 58) = 13.52$; $p < .001$. The interaction between these main factors failed to reach significance, $F(2, 58) = 2.61$; $p = .087$.

A post hoc analysis was conducted on the main effect of face type to isolate the sources of variance within the data. A Scheffé test found no significant difference between ratings given to the original and opposite-sex face types. However, ratings for antifaces were found to be significantly higher than those to either the opposite-sex or original face types (both *p*s $< .002$). Thus the main effect for face type was found to occur in the anticipated direction: Original faces and their opposite-sex derivatives were rated equally attractive, but antifaces were rated as more attractive than either.

Since the two-way interaction between the sex of the face and the face type was marginally significant we decided to conduct a post hoc analysis to reveal any potential source of the interaction. We found that ratings to both the original female face and its opposite-sex counterpart were significantly lower than ratings to the female antiface images (Scheffé test, $p < .05$), and there was no difference between the ratings to the original and opposite-sex face images. For the male faces, the ratings to the original face images and opposite-sex face images were also lower than those to the antiface images (using the Scheffé test, the differences in ratings between the original and antiface images was significant, $p < .05$, and marginally significant between the opposite-sex and antiface images, $p < .07$). However, unlike the ratings to the female faces, we found that the ratings to the original male face images were significantly higher than those to the opposite-sex face images ($p < .05$). Given that overall the attractiveness ratings to the images derived from the male faces were low, a reduction in the ratings to opposite-sex faces may have been due to the retention of some less attractive features that may be more exaggerated in a female face. However, given that the two-way interaction was not significant and that male faces were generally less attractive than female faces, it remains to be seen whether a change in the sex of the face image further reduces the attractiveness of that face when the original was not rated as highly attractive.

Given that the classification accuracy of original female images was found to be low in Prestudy 1 ($\sim$70%) it could be argued that it is questionable whether attractiveness remains stable when the sex of the image is manipulated if a number of the original female faces are perceived as male. Therefore, we also decided to analyse a subset of our data to check that our findings held for more easily identifiable female faces. We identified 11 original female images that were each reliably classified as being female (mean accuracy >70%, with an average of 82.9% accuracy across these 11 images) and ran a repeated measures ANOVA on the attractiveness ratings for these original images (mean rating of 2.52) and their corresponding opposite sex (mean rating of 2.53) and antiface (mean rating of 3.2) images. There was a main effect of face type, $F(2, 20) = 7.52$; $p < .004$. Post hoc paired t tests revealed no significant difference between original and opposite sex ratings, $t(10) = -0.11$; $p = .9$. However, attractiveness ratings for both original and opposite-sex images differed significantly from ratings of antiface images: respectively, $t(10) = -2.84, -2.80$; both ps $= .02$. Together these analyses demonstrate that the main effect for face type is also found to occur in the anticipated direction for more feminine faces: As with the larger data set, original female faces and their opposite-sex derivatives were rated equally attractive, but antifaces were rated as more attractive than either.

It appears from our data, therefore, that the physical characteristics, (i.e., the configural and/or featural information) influence the perceived attractiveness of a face and not knowledge of the sex of the face. Once a change occurs to the physical attributes of the face, as in the antiface images, the judgements of attractiveness are subsequently affected. In a face-space model where the caricature level of an original face is $+1$ and that of the antiface is -1, it would be expected that their attractiveness ratings would be the same, since both faces would be equidistant from the average face (i.e., at 0). As antifaces in this study were reflected only halfway through the origin to reduce imaging distortions (see "Face stimuli"), they lay closer to the average face and consequently were more typical. Thus, antifaces were considered more attractive than the other two face types. This finding supports previous findings linking attractiveness to the averageness of a face (for a review, see Rhodes, 2006).

GENERAL DISCUSSION

We investigated whether judgements of attractiveness were affected by the sex of the face. In other words, we tested whether there was any relationship between features that are related to sexual dimorphism and face preferences. According to the evolutionary position, attractiveness preferences are based on adaptations for mate selection—that is, outward indicators of reproductive fitness such as youthfulness in females and dominance in males. As different physiognomic characteristics appear to be associated with different fitness indicators for each sex, it is thought that there should be no relationship in what makes a face attractive across the sexes. On the other hand, more cognitive or information-processing positions predict that rules of attractiveness are nonspecific, even to faces. Our results indicate that although sex information is discernible in our stimuli (prestudies), attractiveness ratings overall did not differ when the sex of the face was the only dimension that was manipulated (although there was a suggestion that ratings were reduced when the opposite-sex face was derived from an original male face but the related interaction was not significant). Moreover, antifaces were consistently rated as more attractive than their original or opposite-sex faces. Thus it appears that it is the location of the stimuli in face-space rather than the sex information in the face that underpins attractiveness judgements.

Overall, the results of our experiments are more consistent with the prototype hypothesis central to the face-space model of face processing (Valentine, 1991) than the evolutionary model based on sex-specific factors of mate selection, in that successful male–female face discrimination (prestudies) and attractiveness judgements (main experiment) appear to be a function of the proximity of the face stimuli to the average, or prototypical, face. A number of studies have reported similar results pertaining to attractiveness judgements for a range of nonface exemplars that lie close to their category prototypes (e.g., Halberstadt & Rhodes, 2000), suggesting that attractiveness preferences may be shaped by general processing mechanisms, rather than solely being adaptations for mate choice.

It is possible that sexual dimorphism may have played a subtle role in judgements of attractiveness but that these cues were dominated by other, more general features in determining attractiveness. In our face images there were no other cues to the sex of the face other than the basic physical characteristics. In other words, obvious clues to the sex of the face such as hairstyle, make-up, beards, or moustaches were not present. For instance, baldness is typically viewed to be a male trait; the removal of hair may have had the slight effect of "masculinizing" the female images in Prestudy 1, thus reducing the accuracy of their classification as female. Consequently, it still remains possible, and even likely, that efforts to enhance sexual dimorphism in faces by enhancing culturally defined secondary characteristics will also enhance attractiveness ratings. Furthermore, the reduction in attractiveness ratings to the opposite-sex faces derived from male images may have been due to any obvious cues to the sexuality of the face images and the retention of some male features. Nevertheless, in the absence of these secondary (and culturally defined) cues, sexual dimorphism does not seem to have a strong role in determining preferences in faces.

Interestingly, we found no effect of participant sex on ratings of attractiveness for male and female images, contrary to what might be expected if attractiveness preferences are adaptations for mate choice. Similar behavioural results have been reported in other studies (e.g., Aharon et al., 2001; Kranz & Ishai, 2006). However, imaging studies investigating the neural correlates of attractiveness judgements report that, although the sex of the face does not influence activation in face processing regions of cortex, sexual preference modulates face-evoked activation in the reward centres located in the orbitofrontal cortex (Kranz & Ishai, 2006). Therefore, whilst sex information in faces may not mediate attractiveness judgements based on mate potential, it may influence higher order processing of facial attractiveness based on potential reward value as a sexual partner (e.g., Kranz & Ishai, 2006). In any case, it is possible that attractiveness judgements are a consequence of general processing mechanisms that are subsequently modulated by top-down processing of sex information, based on an evaluation of potential reward value.

CONCLUSION

The "good genes hypothesis" posits that attractiveness preferences have evolved to aid the selection of healthy mates for reproduction, and thus it can be assumed that the sex information in a face plays a central role in attractiveness judgements. However, our data suggest that attractiveness preferences may be a by-product of general information-processing mechanisms whereby faces (and possibly all objects) are processed with reference to a central prototype, and preferences arise as a consequence of the location of faces in face-space in relation to that prototype, irrespective of sex information.

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