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Evidence against perceptual bias views for symmetry preferences in human faces

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Symmetrical human faces are attractive. Two explanations have been proposed to account for symmetry preferences: (i) the evolutionary advantage view, which posits that symmetry advertises mate quality and (ii) the perceptual bias view, which posits that symmetry preferences are a consequence of greater ease of processing symmetrical images in the visual system. Here, we show that symmetry preferences are greater when face images are upright than when inverted. This is evidence against a simple perceptual bias view, which suggests symmetry preference should be constant across orientation about a vertical axis. We also show that symmetry is preferred even in familiar faces, a finding that is unexpected by perceptual bias views positing that symmetry is only attractive because it represents a familiar prototype of that particular class of stimuli.

Keywords: facial symmetry; preference; perceptual bias; mate choice

1. INTRODUCTION

Symmetry is found attractive by many animals (see review by Møller & Thornhill 1998). Studies of naturally occurring human facial asymmetries provide evidence that symmetrical faces are attractive, showing that measured symmetry is positively correlated with attractiveness judgements (facialmetric measures (Grammer & Thornhill 1994; Scheib *et al.* 1999; Jones *et al.* 2001) and psychophysical measures (Mealey *et al.* 1999; Penton-Voak *et al.* 2001)). Consistent with preferences for naturally occurring symmetry in real faces, four recent computer graphic studies (Rhodes *et al.* 1998, 2001*b*; Perrett *et al.* 1999; Little *et al.* 2001; but see Swaddle & Cuthill 1995) have shown preferences for faces manipulated to increase symmetry. Cross-cultural agreement on the attractiveness of symmetry (Rhodes *et al.* 2001*b*) may indicate a biological basis for symmetry preference, something universal in humans than transcends culture. The nature of this biological bias for symmetry remains in dispute, however. Two main theories have been put forward to explain universal human preferences for symmetry.

2. THE EVOLUTIONARY ADVANTAGE VIEW

One explanation for the preference for symmetrical faces comes from a postulated link to an evolutionary adaptation to identify high-quality mates (see Thornhill & Gangestad (1999) for review). Symmetry in human faces has been linked to potential heritable fitness ('good-genes') because symmetry is a useful measure of the ability of an organism to cope with developmental stress (both genetic and environmental). As the optimal developmental outcome of most characters is symmetry, deviation from perfect symmetry can be considered a reflection of challenges to development. Only high-quality individuals can maintain symmetrical development under environmental and genetic stress and therefore symmetry can serve as an indicator of phenotypic quality as well as genotypic quality (e.g. the ability to resist disease: see Møller (1997) and Møller & Thornhill (1998) for reviews). This logic would lead to a preference for high symmetry mates as evolution will have favoured individuals who had preferences for high-quality mates over low-quality mates. Indeed, morphological symmetry appears to be related to reproductive success in many species, including humans (Gangestad & Thornhill 1997*a*; Møller & Thornhill 1998). For example, more symmetrical human males have more sexual partners than less symmetrical men (Thornhill & Gangestad 1994) and symmetrical males are also more likely to be chosen as extra-pair partners (Gangestad & Thornhill 1997*b*). Thus the link between symmetry and attractiveness may reflect that preferences for symmetrical individuals may be potentially adaptive.

3. THE PERCEPTUAL BIAS VIEW

A second explanation for a preference for symmetrical faces is that all symmetrical stimuli are more easily processed by the visual system (e.g. Enquist & Arak 1994; Enquist & Johnstone 1997; Enquist & Ghirlanda 1998). This is often referred to as the perceptual bias view. Attneave (1955) demonstrated that humans more easily reproduce symmetrical figures than asymmetric figures and suggested that this was because they possess more redundant information. Another explanation for the preference for bilateral symmetry is that it depends on the human visual system's own bilateral structure. In this framework, human vision is particularly sensitive to bilateral symmetry as ocular musculature is also bilaterally symmetrical (Mach 1897), or because processing of the left and right visual field in different hemispheres allowing point-by-point matching eases symmetry detection (Herbert & Humphrey 1996). Certainly preferences for symmetry have been observed for stimuli not related to mate choice such as everyday objects (Rensch 1963) and decorative art (Gombrich 1984).

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A more complicated perceptual bias view for symmetry preference comes from cognitive theories about prototype formation. For each class of stimuli it is possible that the visual system develops an internal prototype. Such a prototype is made up of an average of the characteristics of all the different stimuli of that type that have been seen. When novel stimuli are encountered they are compared against this prototype and similarity to the prototype is positively related to how familiar and attractive we find the new stimuli (see, for example, Halberstadt & Rhodes 2000; Rhodes *et al.* 2001*c*). From this view, symmetry is attractive, because when asymmetries in stimuli are randomly distributed the average stimuli are very symmetrical. We therefore find symmetry attractive in faces and other stimuli as it represents something closer to our internal prototypes for these stimuli. Certainly faces with average configurations are found to be more attractive than less average faces (e.g. Langlois & Roggman 1990; Little & Hancock 2002). Evidence for the possibility of prototype-based perceptual bias comes from a recent study by Jansson *et al.* (2002) who trained hens to recognize two asymmetrical mirror stimuli and then measured their responses to a novel symmetrical stimulus that was the average of the two images. The hens responded more strongly to the symmetrical stimuli than other hens that were not exposed to these stimuli. Such results indicate that perceptual experience can produce symmetry preferences without any link between symmetry and genetic or phenotypic quality.

4. RATIONALE FOR THE CURRENT STUDY

Symmetry is preferred in upright faces but no studies have examined symmetry preferences in inverted faces. Inverting a face maintains its vertical plane of symmetry (where bilateral symmetry is easiest to perceive symmetry (e.g. Rock 1974)) and so according to the simple perceptual bias view should not affect symmetry preference. However, if preference for symmetry is an adaptation to mate choice we might expect lower preferences for symmetry in inverted faces as inversion does disrupt the perception of faces to the extent that inverted faces are processed in a manner more similar to other objects (e.g. Murray *et al.* 2000). In other words, upright faces are an example of mate choice-*relevant* stimuli in which we expect symmetry preferences from both theoretical positions. By contrast, inverted faces are mate choice-*irrelevant* stimuli where a perceptual bias view suggests preferences for symmetry equivalent to that for upright faces whereas an evolutionary advantage view suggests lower preferences than for upright faces.

A prediction of the perceptual bias view based on prototype formation is that, for unfamiliar stimuli, stimuli most closely resembling the prototype would be most attractive. This would result in choosing the symmetrical version of most stimuli as the most attractive, if asymmetries are random, as on average the prototype image will tend to be symmetrical. For familiar stimuli, however, this may not be the case. Familiar stimuli should be preferred over symmetric stimuli as perceptual experience is for the familiar asymmetric version. Thus, from this version of the perceptual bias view we would expect no preference for symmetry in familiar stimuli whereas the evolutionary advantage view predicts no difference in symmetry preferences between novel and familiar faces.

Figure 1. (*a*) Original and (*b*) symmetrical versions of male and female faces.

To test these predictions we examine men and women's preferences for symmetry in opposite-sex upright and inverted faces (study 1) and in familiar faces (study 2).

5. METHODS

(a) *Study 1*

(i) *Participants*

Seventy-eight women and 41 men (mean age: 23.1, s.d.: 9.5) participated in study 1. The experiment was administered over the Internet and participants were recruited by email from a participant-pool list asking if the person would like to participate in an experiment. Participants could follow a link from the email to the start of the experiment.

(ii) *Stimuli*

Twenty-eight previously used (Perrett *et al.* 1999; Jones *et al.* 2001; Little *et al.* 2001) stimulus pairs were presented in this study (14 male and 14 female Caucasian individuals between 20 and 30 years of age). Each pair was made up of one original and one symmetrical image. All images were manipulated to match the position of the left and right eyes. To generate the symmetrical images, original images were morphed so that the position of the features on either side of the face was symmetrical. Images maintained original textural cues and were symmetric in shape alone (see Perrett *et al.* (1999) for technical details). The faces were unfamiliar to the participants. An example of an original and symmetrical face can be seen in figure 1.

(iii) *Procedure*

Participants were presented with two images of the same individual, an original and a symmetrically remapped version. Each image was seen twice, once upright and once inverted. Participants rated all of the faces with instructions to rate for a long-term relationship. The images were presented side by side on screen with the instructions: 'which face is the most attractive?' and 'please click the face which you feel is most attractive'. Clicking on a box below the faces moved onto the next of the 28 image pairs. Image order and side of presentation were ran-

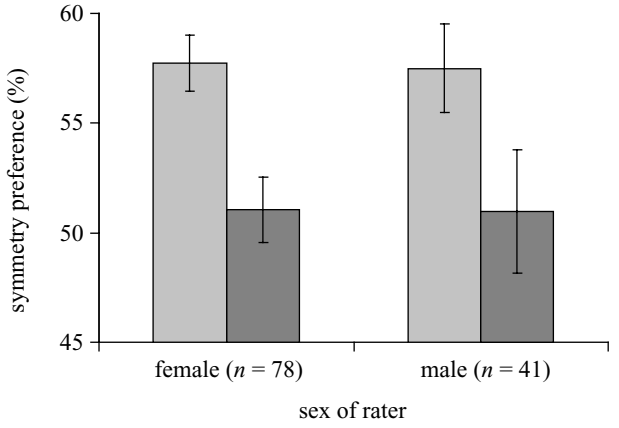

Figure 2. Preference for symmetry in opposite-sex faces according to sex of the rater (male and female) and orientation (upright (light grey bars) and inverted (dark grey bars)) expressed as a percentage of the number of times the symmetrical version of a face was chosen over the original version.

domized. Participants were also asked their age, which they typed into a box on screen.

(b) *Study 2*

(i) *Participants*

Fifteen individuals (nine women and six men, mean age: 26.7, s.d.: 2.7) participated in study 2. Participants were unpaid volunteers and were selected on the basis of all knowing each other socially.

(ii) *Stimuli*

The 15 participants all had their photograph taken in a neutral expression and under standard lighting conditions. All images were manipulated to match the position of the left and right eyes. The images were made in a different manner to study 1. Images were made symmetrical in both texture and shape to produce the symmetrical version of the face. Each image was then warped back into its original shape to create the original version of the face. Thus both images possessed symmetrical textural cues and differed in symmetrical shape alone. This methodology is similar to that employed by Rhodes *et al.* (2001*a*, study 1a). Note that the only difference between original and symmetrical versions using both methodologies is the symmetrical shape information.

(iii) *Procedure*

The procedure of presentation was identical to that of study one except that participants rated all of the faces with instructions to rate for attractiveness and not long-term partner attractiveness and that there were 30 image pairs. As well as the 14 familiar face pairs, participants were also shown their own face in symmetrical and original versions.

6. RESULTS

(a) *Study 1*

A repeated-measures ANOVA with 'orientation' (upright versus inverted) as a within-participant variable and 'sex' (male versus female) as a between-participant variable revealed a significant effect of 'orientation' ($F_{1,117} = 15.6$, $p < 0.001$), no interaction between 'orientation' and 'sex' ($F_{1,117} = 0.01$, $p = 0.93$) and no overall effect of 'sex' ($F_{1,117} = 0.01$, $p = 0.96$). Means and standard errors can be seen in figure 2.

A one-sample *t*-test against chance (50%) revealed a significant symmetry preference in upright opposite-sex faces across males and females (mean preference of 58%, $t_{118} = 7.1$, $p < 0.001$) but not in inverted opposite-sex faces (mean preference of 51%, $t_{118} = 0.75$, $p = 0.45$).

(b) *Study 2*

The number of times the symmetrical version was chosen over the original version for the 14 familiar face pairs (excluding own face) was calculated for each participant. A one-sample *t*-test against chance (50%) revealed a significant preference for the symmetrical versions of the faces (mean per cent of symmetrical faces chosen was 69%, $t_{14} = 5.4$, $p < 0.001$).

For symmetrical versus original face preferences for each participant's own face a significant preference for the symmetrical version was again seen (11 out of 15 participants picked the symmetrical version: $\chi^2 = 5.4$, d.f. = 1, $p = 0.020$).

7. DISCUSSION

Study 1 demonstrates that in both men and women there is a greater preference for symmetry in upright opposite-sex faces than there is in inverted faces. A lower preference for symmetry in inverted faces is inconsistent with the prediction made by the perceptual bias view that symmetry preferences for faces should remain constant across orientation, as it is the simple symmetry of the image, not any particular relevance to mate-choice, which is preferred. Our findings are more consistent with the evolutionary advantage view of symmetry preference, which predicts viewers should be more sensitive to symmetry when judging the attractiveness of mate-choice relevant stimuli (e.g. upright faces) than when judging the attractiveness of mate-choice irrelevant stimuli (e.g. inverted faces).

Potentially, a lower preference for symmetry in inverted faces is consistent with a prototype formation theory of perceptual bias for symmetry. Upright faces are familiar stimuli and so can be compared to a symmetrical-prototype but inverted faces are not often encountered and so no 'inverted face-prototype' has been formed to which other inverted faces can be compared. 'Average faces', images made up of multiple faces, have been found as attractive in several studies (e.g. Langlois & Roggman 1990; Little & Hancock 2002), and one explanation for this attractiveness is that highly average faces are close to each individual's internal 'face prototype' and so are familiar (Rhodes *et al.* 2001*c*). Familiarity has been found to increase feelings of attractiveness (e.g. mere exposure (Zajonc 1968; Bornstein 1989)). In study 2, however, we found symmetry preferences in familiar faces (and also the participant's own face) even though a perceptual bias view linking familiarity to attractiveness would predict that the familiar original faces would be chosen over the symmetrical version. Thus, study 2 demonstrated that although familiarity may account for some of the preference for symmetry in human faces it might not explain all of this preference.

Other studies have presented evidence that is inconsistent with a perceptual bias view. For example, Jones *et al.* (2001) have shown that the attractiveness–symmetry relationships may be mediated by perceived health and Little *et al.* (2001) and Penton-Voak *et al.* (2001), using different methodologies, have shown opposite-sex face sensitivity in symmetry preference. Little *et al.* (2001) have also demonstrated that symmetry preference differs according to self-rated attractiveness in women. It is worth noting that although these studies provide data more in line with an evolutionary advantage view than a perceptual bias view, the current studies are the first, to our knowledge, to directly assess competing, specific hypothesis put forward by these two views.

The current study provides no evidence for a general preference for symmetry independent of stimuli. That is, no preference for symmetry was found in the inverted faces. Previous findings showing preferences for symmetry in non-mate-choice relevant stimuli (Rensch 1963; Gombrich 1984) would suggest that we should have found a symmetry preference in inverted faces. It is possible, however, that with less subtle symmetry changes or more stimuli we would show preferences for symmetry in inverted faces but that the preference for symmetry in upright faces would still be significantly greater. Thus, we feel that there is reason to believe perceptual bias for symmetry preference may exist, as evidenced by preference for symmetry in non-mate-choice relevant stimuli. On top of perceptual biases, however, other mechanisms may be in operation that may make humans particularly attentive to symmetry in mate-choice relevant stimuli. Where others have postulated that preferences for symmetrical faces may be based on generalization of mechanisms that create general symmetry preferences (Enquist & Arak 1994) it is possible that the reverse is true: general preferences for symmetry could be based on generalization of an adaptation to prefer symmetric faces and bodies.

Ultimately, any differences in symmetry preference based on familiarity, the judge, context or orientation are problematic for a simple perceptual bias view. Whereas perceptual bias may account for some level of symmetry preference in many stimuli, the evidence for symmetry preferences in human faces thus far suggests that, even if the evolutionary relevant view is incorrect, the perceptual bias account as it stands is insufficient to explain preferences for symmetry in human faces.

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