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Attraction independent of detection suggests special mechanisms for symmetry preferences in human face perception

Anthony C. Little[1,*] and Benedict C. Jones[2]

[1]School of Biological Sciences, University of Liverpool, PO Box 147, Liverpool L69 3BX, UK
[2]School of Psychology, University of Aberdeen, William Guild Building, King's College, Aberdeen AB24 2UB, UK

Symmetrical human faces are attractive and it has been proposed that humans have a specialized mechanism for detecting symmetry in faces and that sensitivity to symmetry determines symmetry preferences. Here, we show that symmetry preferences are influenced by inversion, whereas symmetry detection is not and that within individuals the ability to detect facial symmetry is not related to preferences for facial symmetry. Taken together, these findings suggest that symmetry preferences are indeed driven by a mechanism that is independent of conscious detection. A specialized mechanism for symmetry preference independent of detection may be the result of specific pressures faced by human ancestors to select high-quality mates and could support a modular view of mate choice. Unconscious mechanisms determining face preferences may explain why the reasons behind attraction are often difficult to articulate and demonstrate that detection alone cannot explain symmetry preferences.

Keywords: symmetry; preference; detection; bias; face perception; evolution

1. INTRODUCTION

Although we can say whether a face is attractive or unattractive, it is extremely difficult to articulate the specific features that determine this attraction. Many studies of face preferences have focused on attraction to symmetry (for a review of these studies, see Thornhill & Gangestad 1999; Gangestad & Simpson 2000). Symmetry is found attractive by many animals (see review by Møller & Thornhill 1998) and studies of naturally occurring human facial asymmetries have shown that symmetry assessed by facialmetric and perceptual measures is positively correlated with attractiveness judgements (Grammer & Thornhill 1994; Scheib *et al.* 1999; Penton-Voak *et al.* 2001). Consistent with preferences for naturally occurring symmetry in real faces, computer graphic studies (Rhodes *et al.* 1998, 2001; Perrett *et al.* 1999; Little *et al.* 2001) have shown preferences for faces that had been manipulated to increase symmetry. Cross-cultural agreement (Rhodes *et al.* 2001), and even cross-species agreement (Waitt & Little 2006), on the attractiveness of symmetry may indicate a biological basis for symmetry preference. While symmetry is considered an attractive trait, individuals may not necessarily consciously look for it. Indeed, in a study manipulating only symmetry in faces, individuals preferred symmetry, but none reported seeing symmetry as the manipulation made (Perrett *et al.* 1999).

There are two main theories that have been put forward to explain human preferences for symmetry. One explanation for the preference for symmetric faces comes from a postulated link to an evolutionary adaptation to identify high-quality mates (Thornhill & Gangestad 1999; Little & Jones 2003, for review). The symmetry of human faces has been linked to potential heritable fitness, since symmetry is a useful measure of the ability of an organism to cope with developmental stress, both genetic and environmental. In other words, symmetry may act as an indicator of both phenotypic and genotypic quality (e.g. the ability to resist disease; Møller 1997; Møller & Thornhill 1998 for reviews).

A second explanation for a preference for symmetrical faces is that symmetrical stimuli are more easily processed by the visual system. This can be referred as the perceptual bias view, as it proposes that symmetry preferences arise from biases based on the properties of perceptual systems (e.g. Little & Jones 2003, for brief review). Preferences for symmetry have been observed for stimuli not related to mate choice, such as everyday objects (Rensch 1963) and decorative art (Gombrich 1984). 'Simple' perceptual bias views posit that symmetry is preferred via simple stimulus properties such as redundancy of information in symmetric stimuli or that symmetric stimuli match the human visual system's own bilaterally symmetric organization (Mach 1897; Attneave 1955; Herbert & Humphrey 1996).

A more complicated perceptual bias view for symmetry preference comes from cognitive theories about prototype formation. From this view, symmetry is attractive because when asymmetries in stimuli are randomly distributed, the average stimuli are very symmetric. We therefore find symmetry attractiveness in faces and other stimuli as it represents something closer to our internal prototypes for these stimuli and may be attractive, since it is perceived as familiar (see Jansson *et al.* 2002; Little & Jones 2003, for reviews). In this way, symmetry preferences may arise as a by-product of experience of asymmetric stimuli, which

* Author and address for correspondence: School of Psychology, University of Stirling, Stirling FK9 4LA, UK (anthony.little@stir.ac.uk).

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are symmetric on average (Enquist & Arak 1994; Enquist & Johnstone 1997; Enquist & Ghirlanda 1998).

Evolutionary theorists have long posited special brain mechanisms that are focused on particular adaptive problems (Cosmides & Tooby 1994; Pinker 1997). Mate choice is a complicated problem faced by our ancestors and assessment of different aspects of quality in a partner may involve specialized mechanisms. Fodor (1983) famously described the human brain as modular and has also argued that there is no continuity from perception to cognition, i.e. low-level visual processes do not interact with higher cognitive processes. While not wanting to add to the modularity debate here, these ideas, however, are relevant as it has been suggested that humans have a special mechanism for symmetry preference, which is focused on mate choice (Little & Jones 2003). Little & Jones (2003) show that while symmetry is preferred in upright faces, it is preferred less in inverted faces. Inversion disrupts the perception of faces, particularly configural processing, to the extent that inverted faces are processed in a manner more similar to other objects, i.e. less like faces (Murray *et al.* 2000). As bilateral symmetry remains constant in inverted images, this is evidence against a simple perceptual bias view, but not a more complicated view as described earlier. Little and Jones also show that symmetry is preferred in familiar faces when the familiar version is the asymmetric version, suggesting that symmetry is not preferred solely via an association with familiarity. Further, it has been shown that attraction to symmetry occurs for real faces controlling rated distinctiveness (Rhodes *et al.* 1999), suggesting attraction to symmetry is independent of prototypicality. Together, these studies are problematic for perceptual bias views, which posit that symmetry is attractive because symmetrical faces are closer to prototypes and that symmetry preferences are linked to familiarity with symmetric prototypes. Other studies have presented evidence that human symmetry preferences are focused on mate-choice relevant factors. 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 that preferences for symmetry are strongest in opposite-sex faces.

Findings that symmetry is preferred in mate-choice relevant stimuli are indeed suggestive that there may be special mechanisms involved in human symmetry preferences. Following Fodor (1983), it is possible that if symmetry preference is 'modular', then preference may not influence higher cognitive functions. Certainly, the fact that symmetry can be preferred and yet judges have not perceived symmetry manipulation is explicitly (Perrett *et al.* 1999) consistent with the symmetry preferences reflecting an unconscious response.

In other areas, there are distinctions in brain mechanisms involved in processing and preference. For example in food reward, there are distinct pathways concerning 'wanting' and 'liking' (Berridge 1996; Berridge & Robinson 2003). In emotional processing, there are both cortical and subcortical routes in fear processing (LeDoux 1998) and in face judgements, neuroimaging studies have revealed that conscious social judgement recruits different neural responses to passive viewing, suggesting a dissociation between automatic and intentional processing (Winston *et al.* 2002). Furthermore, in the taste domain patient data suggest that preference can be found without recognition of flavour (Adolphs *et al.* 2005). Classic work on the mere repeated exposure effect (Zajonc 1968, 1980), whereby simple exposure to stimuli increases feelings of liking, has demonstrated that preferences can arise for stimuli presented subliminally and without conscious recognition (Zajonc 1980), and so indicates that preferences are also separable from recognition memory.

2. RATIONALE

The present study examined the link between preference for symmetry and the ability to detect symmetry in human faces. Detection here refers to perceptual ability to discriminate symmetry from asymmetry and is conscious, but not necessarily dependent on memory, as it requires judges to determine a difference after being given a definition of symmetry. Symmetry is preferred in upright faces and less so in inverted faces and we tested to see if this effect holds for detection. If preference and detection are based on similar mechanisms, then we may expect the effect to hold for both (though see §6), while if detection is less affected by inversion, it would be evident that symmetry preference is governed by a specialized mechanism. We also examined the relationship between an individual's ability to detect symmetry and their preferences on the same rationale. If preference were not related to detection, then this would be evidence for different specialized mechanisms at work.

(a) *Study 1 methods*

(i) *Participants*

In study 1, 37 women and 19 men (mean age = 23.2, s.d. = 4.6) participated. The experiment was performed over the Internet and participants were recruited via an electronic poster system from a participant-pool list asking if the person would like to participate in an experiment. Participants could follow a link to the start of the experiment.

(ii) *Stimuli*

Thirty previously used (Perrett *et al.* 1999; Jones *et al.* 2001; Little *et al.* 2001; Little & Jones 2003) stimulus pairs were presented in this study (15 male and 15 female Caucasian individuals between 20 and 30 years). Each pair was made up of one original and one symmetric image. All the images were manipulated to match the position of the left and the right eyes. To generate the symmetric images, original images were morphed so that the position of the features on either side of the face was symmetrical. The images maintained original textural cues and were symmetric in shape alone (see Perrett *et al.* (1999) for technical details). An example of an original and a 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 pair was seen twice, once upright and once inverted, in a random order. The images were presented side by side on screen with the instructions: 'Which face is the most attractive?' and 'Please click the

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

face which you feel is most attractive'. Clicking on a box below the faces moved onto the next of the 15 image pairs. Image order and side of presentation were randomized. After attractiveness ratings, the same faces were presented again in the same manner, with participants this time being asked to choose the face they thought to be the most symmetric. A definition of symmetry, 'both sides (left and right halves) of symmetric faces look the same', was provided just prior to detection rating. Participants were also asked their age and sex, which they typed into a box on the screen. Attractiveness judgements were always made prior to detection, as once told the images differed in symmetry, preferences may be driven by this knowledge. Half of the participants saw male faces and half of the participants saw female faces (28 in each group).

3. STUDY 1 RESULTS

(a) *Preferences*

A repeated-measures ANOVA with 'orientation' (upright versus inverted) as a within-participant variable and 'sex of face' (male versus female) and 'sex of rater' (male versus female) as between-participant variables revealed a significant effect of orientation ($F_{1,52}=10.6$, $p=0.002$), no interaction between orientation and sex of face ($F_{1,52}=1.4$, $p=0.24$), orientation by sex of rater ($F_{1,52}=0.2$, $p=0.66$) and no significant three-way interaction ($F_{1,52}=0.\ 03$, $p=0.58$). There was no overall effect of sex of rater ($F_{1,52}=0.44$, $p=0.51$) or sex of face ($F_{1,52}=2.85$, $p=0.10$) and no interaction between these variables ($F_{1,52}=0.40$, $p=0.53$). Mean values and standard errors can be seen in figure 2.

A one-sample *t*-test against chance (50%) revealed a significant symmetry preference in upright male (mean preference = 62%, $t_{27}=5.4$, $p<0.001$) and female (mean preference = 56%, $t_{27}=3.4$, $p=0.002$) faces, but not in inverted male (mean preference = 54%, $t_{27}=1.1$, $p=0.24$) or female faces (mean preference = 51%, $t_{27}=0.56$, $p=0.58$).

(b) *Detection*

A repeated-measures ANOVA with orientation (upright versus inverted) a within-participant variable and sex of face (male versus female) and sex of rater (male versus female) as a between-participant variable revealed no significant effect of orientation ($F_{1,52}=0.39$, $p=0.54$), no interaction between orientation and sex of face ($F_{1,52}=0.3$, $p=0.87$), orientation by sex of rater ($F_{1,52}=0.02$, $p=0.09$) and no significant three-way interaction ($F_{1,52}=0.13$, $p=0.72$). There was a significant overall effect of sex of rater ($F_{1,52}=9.22$, $p=0.004$) but not sex of face ($F_{1,52}=0.14$, $p=0.71$) and no interaction between these variables ($F_{1,52}=1.1$, $p=0.30$). The significant effect of sex reflected that women detected a greater proportion of symmetric faces than men (males 62% and females 71%). Mean values and standard errors can be seen in figure 2.

A one-sample *t*-test against chance (50%) revealed significant symmetry detection in upright male (mean detection = 69%, $t_{27}=5.9$, $p<0.001$) and female (mean detection = 69%, $t_{27}=8.4$, $p<0.001$) as well as in inverted male (mean detection = 67%, $t_{27}=5.8$, $p<0.001$) and female faces (mean detection = 68%, $t_{27}=6.3$, $p<0.001$).

(c) *Preference and detection*

To test for an interaction, a repeated-measures ANOVA was conducted with rating task (detection versus preferences) and orientation (upright versus inverted) as within-participant variables and with sex of face and sex of rater as

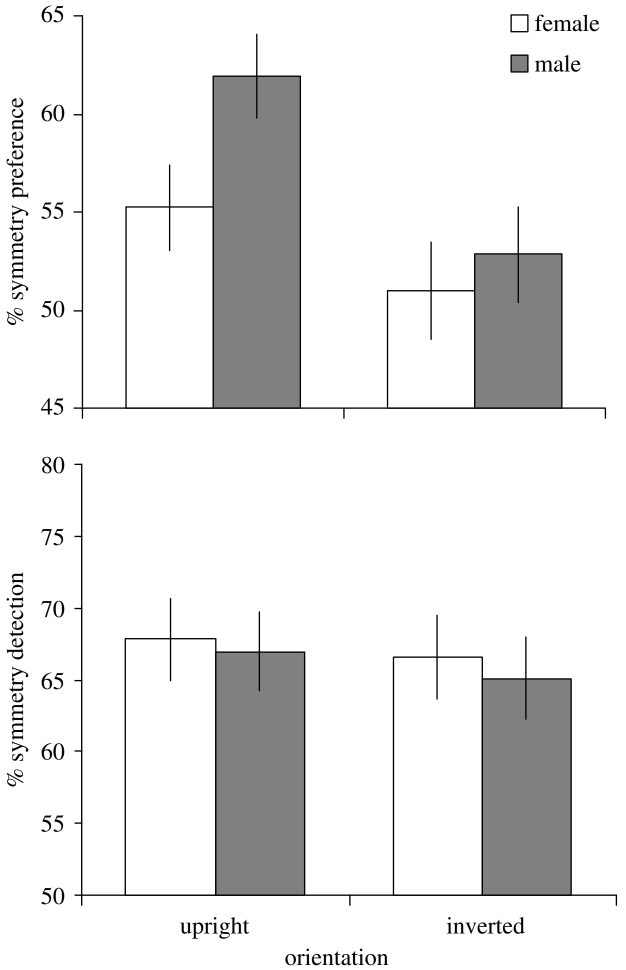

Figure 2. Preference and detection for symmetry in faces from study 1 (collapsing across sex of face, between-participants) according to sex of rater (male and female) and orientation (upright and inverted).

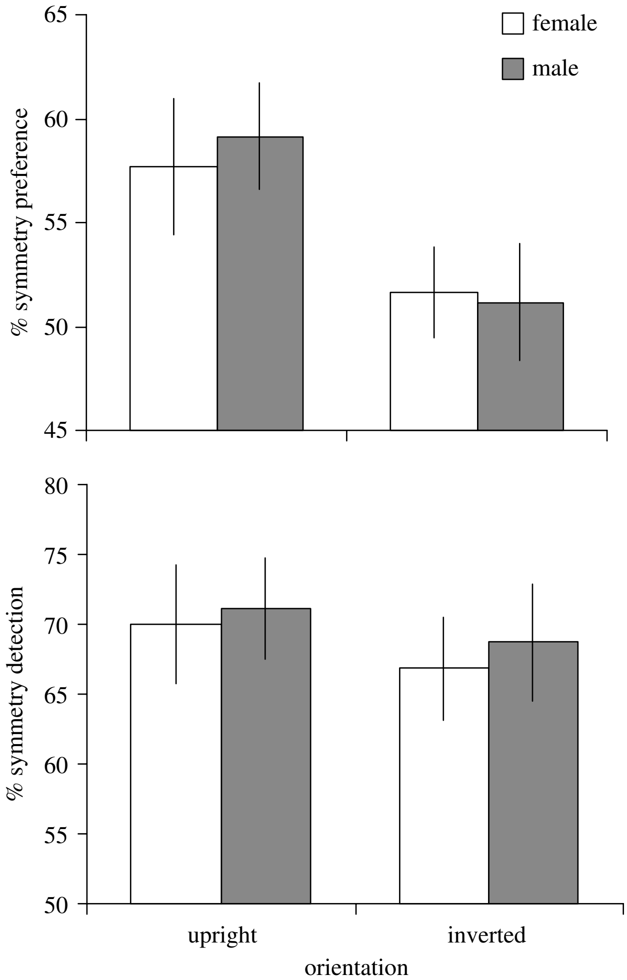

Figure 3. Preference and detection for symmetry in faces from study 2 (collapsing across sex of face, between-participants) according to sex of rater (male and female) and orientation (upright and inverted).

between-participant variables. This revealed a marginally significant interaction between rating task and orientation ($F_{1,52}=3.6$, $p=0.064$; other effects not reported).

(d) *Individuals*

Pearson product moment correlations revealed no significant relationship between symmetry preference and symmetry detection for both upright ($r_{54}=0.03$, $p=0.80$) and inverted ($r_{54}=-0.14$, $p=0.32$) faces. There was a significant positive relationship between detection of symmetry in upright and inverted faces ($r_{54}=0.32$, $p=0.018$), but no significant relationship for preference between upright and inverted faces ($r_{54}=0.19$, $p=0.17$).

(e) *Stimuli*

For individual stimuli, there was no significant correlation between how well symmetry was detected and how much symmetry was preferred for inverted faces ($r_{28}=0.04$, $p=0.84$) or upright faces ($r_{28}=-0.30$, $p=0.11$).

4. STUDY 2 METHODS

(a) *Participants*

In study 2, 24 individuals (13 women and 11 men, mean age = 27.7, s.d. = 7.2) participated. Participants were recruited in the same way as study 1.

(b) *Stimuli*

The same images from study 1 were used here.

(c) *Procedure*

The procedure of presentation was identical to that of study 1 except that participants rated both male and female faces for a total of 30 face pairs (15 males and 15 females) seen in the preference trials and 30 face pairs in the detection trials.

5. STUDY 2 RESULTS

(a) *Preferences*

A repeated-measures ANOVA with orientation (upright versus inverted) and sex of face (male versus female) as within-participant variables, and sex of rater (male versus female) as a between-participant variable revealed a significant effect of orientation ($F_{1,22}=5.4$, $p=0.030$), no significant effect of sex of face ($F_{1,22}=0.04$, $p=0.85$) no interaction between orientation and sex of face ($F_{1,22}=0.22$, $p=0.67$), orientation by sex of rater ($F_{1,22}=0.52$, $p=0.48$), sex of rater by sex of face ($F_{1,22}=0.94$, $p=0.34$) and no significant three-way interaction ($F_{1,22}=1.1$, $p=0.31$). There was no overall effect of sex of rater ($F_{1,22}=0.11$, $p=0.73$). Mean values and standard errors can be seen in figure 3.

A one-sample *t*-test against chance (50%) revealed a significant symmetry preference in upright male (mean preference=58%, $t_{23}=3.7$, $p<0.001$) and female faces (mean preference=58%, $t_{23}=2.8$, $p=0.023$), but not in inverted male (mean preference=51%, $t_{23}=0.29$, $p=0.78$) or female faces (mean preference=52%, $t_{23}=0.78$, $p=0.44$).

(b) *Detection*

A repeated-measures ANOVA with orientation (upright versus inverted) and sex of face (male versus female) as within-participant variables, and sex of rater (male versus female) as a between-participant variable revealed no significant effect of orientation ($F_{1,22}=1.3$, $p=0.27$), no significant effect of sex of face ($F_{1,22}=0.51$, $p=0.48$), no interaction between orientation and sex of face ($F_{1,22}=0.02$, $p=0.89$), orientation by sex of rater ($F_{1,22}=0.01$, $p=0.96$), sex of rater by sex of face ($F_{1,22}=1.4$, $p=0.24$) and no significant three-way interaction ($F_{1,22}=0.32$, $p=0.58$). There was no overall effect of sex of rater ($F_{1,22}=0.27$, $p=0.61$). Mean values and standard errors can be seen in figure 3.

A one-sample *t*-test against chance (50%) revealed significant symmetry detection in upright male (mean detection=71%, $t_{23}=5.9$, $p<0.001$) and female (mean detection=70%, $t_{23}=4.8$, $p<0.001$) faces as well as inverted male (mean detection=69%, $t_{23}=4.6$, $p<0.001$) and female faces (mean detection=67%, $t_{23}=4.7$, $p<0.001$).

(c) *Preference and detection*

To test for an interaction, a repeated-measures ANOVA was conducted with face sex (male versus female), rating task (detection versus preferences) and orientation (upright versus inverted) as within-participant variables and with sex of rater as a between-participant variable. This revealed a significant interaction between rating task and orientation ($F_{1,22}=5.6$, $p=0.027$; other effects not reported).

(d) *Individuals*

For individual judges, Pearson product moment correlations revealed no significant relationship between symmetry preference and symmetry detection for both upright ($r_{22}=-0.15$, $p=0.47$) and inverted ($r_{22}=-0.19$, $p=0.38$) faces. There was a significant positive relationship between detection of symmetry in upright and inverted faces ($r_{22}=0.76$, $p<0.001$), but no significant relationship for preference between upright and inverted faces ($r_{22}=0.02$, $p=0.92$).

(e) *Stimuli*

For individual stimuli, there was a significant correlation between how well symmetry was detected and how much symmetry was preferred for inverted faces ($r_{28}=0.38$, $p=0.037$) and a marginally significant correlation for upright faces ($r_{28}=0.33$, $p=0.076$).

6. DISCUSSION

The present study demonstrates that preferences for symmetry in human faces appear dissociable from detection. Inversion of faces lowered preference for facial symmetry, but had a smaller impact on judge's ability to detect facial symmetry implying different mechanisms for symmetry preference and detection. More importantly, when examining individual scores, a person's preference for symmetry was not correlated with their ability to detect it. While at the stimulus level, we might expect preference and detection to be linked, since increasing perceptual differences between two stimuli can impact on both preference and detection (though our results are equivocal on this issue), this in no way implies that preference and detection are mediated by the same neural mechanism within an individual. Our results suggest the opposite, that different brain mechanisms are involved in symmetry preference and detection. While we have phrased our results in terms of attraction to or preference for symmetry, we note that our data may equally reflect participants avoiding or disliking asymmetry as we use a force choice paradigm.

Here, across two studies, we replicate an effect of facial inversion on symmetry preference, whereby preferences for symmetry are lower in inverted compared to upright faces (Little & Jones 2003). However, for detection, inversion appears to be less detrimental, and individuals have similar abilities to detect symmetry in inverted and upright faces. Given face inversion generally disrupts face processing (Yin 1969); this is somewhat surprising, but suggests that conscious detection of symmetry is determined by processes, which are different to those governing preferences. Some authors have argued that inversion decreases discrimination in some facial regions, but that this impairment lessens with increasing viewing time (Barton *et al.* 2001). Given that our study allowed unlimited time for both preference and discrimination, this further adds to the notion that preferences for upright faces are governed by a special mechanism. Our results contrast with one study showing that inversion does disrupt detection of symmetry (Rhodes *et al.* 2005), but we note that even if there is some disruption in detection, the effects of inversion on preference are significantly greater.

We also show that within individuals, the ability to detect symmetry was unrelated to preferences for symmetry, providing further evidence that preference and detection appear to arise out of different perceptual mechanisms. It is noteworthy that three of the four correlations we performed between preference and detection for individual raters were negative in slope and those with the strongest symmetry preferences appear to detect it only, as well as those with the weakest, demonstrating that detection does not lead to preference or vice versa. We did find significant correlations between the ability to detect symmetry in inverted and upright faces, suggesting that symmetry detection occurs via similar processes for both types of stimuli, and no correlation was found between preferences for symmetry in inverted and upright faces, again highlighting that symmetry preference in upright faces is special. We also note that scores are higher for detection than preference. If preference were solely dependent on detection, we would expect that both the tasks would produce identical scores. At the very least, there must be something involved in detection that is different from preference to produce scores which are not identical.

Preference and detection are probably linked at the stimulus level. For example, imagine two images that barely differ and a pair of stimuli with a large symmetry difference. It would seem obvious that detection would be easier in the latter, and in turn, a large difference could also generate stronger preferences between the two stimuli. We reiterate that this in no way implies that symmetry preference and detection are dependent on similar perceptual mechanisms. Two separate mechanisms may be at work, but both are dependent on the stimulus input. However, we find equivocal evidence for this idea. Study 1 showed no significant correlations between ease of detection and preference for each paired stimuli, while study 2 did. We also note that the positive correlations for study 2 are relatively low, implying that there is certainly no strong relationship between detection and preference even at the level of the stimulus.

Our findings add to the previous studies which have shown that dissociable mechanisms may govern processing of different aspects from the same stimulus, such as in food reward, where there are dissociable neural substrates for wanting and liking (Berridge 1996) in research on emotional processing showing that aspects of emotion can be traced along multiple neural routes (LeDoux 1998), and in research on face perception showing that conscious judgement of social traits elicits activation of brain regions not active in passive viewing (Winston *et al.* 2002). Our finding may be most akin to the patient data demonstrating that an individual can prefer particular flavours without being able to recognize them (Adolphs *et al.* 2005).

We postulate that distinctions between preference and detection are in favour of a specialized mechanism focused on mate choice. If preferences can be distinct from cognition (Zajonc 1980) and ability to discriminate between stimuli (present study), then the core of the perceptual bias view, that preferences arise as by-products of other cognitive and perceptual mechanisms, appears untenable. In other words, demonstration, that preferences are 'special' in dissociation from other abilities, appears indicative of special evolved mechanisms for preferences, while the perceptual bias view explicitly proposes that preferences are by-products of other systems, particularly detection and recognition systems (Johnstone 1994), which is not supported here. Our data do not falsify the view that symmetry is preferred due to familiarity based on exposure, but if familiarity affects only preferences and not detection, this may indeed be evidence for specialized systems governing preferences. Indeed, it is possible that this could be the specialized mechanism for symmetry preference. However, we note that symmetry preferences do not appear to be entirely dependent on familiarity (Rhodes *et al.* 1999; Little & Jones 2003) and that there are predictable individual differences in symmetry preferences (Little *et al.* 2001), which together cast doubt on this general explanation.

A relationship between symmetry preference and detection may not have been taken as evidence against views postulating specialized mechanisms focused on mate choice. Such a relationship between preference and detection may have meant that the mechanism governing preference was based on detection and hence related to it. Our data do imply that symmetry preference is different from detection and so our results have implications for studies in which judges are trained to discriminate between stimuli on the basis of symmetry. Such studies have been conducted in the past on non-human animals (Swaddle 1999; Jansson *et al.* 2002; Swaddle & Ruff 2004) and computer models (Enquist & Johnstone 1997) and have concluded that learning to discriminate asymmetric stimuli can result in preferences for a symmetric mean (Enquist & Johnstone 1997; Jansson *et al.* 2002) and that discrimination abilities are limited to detect asymmetries greater than that found in natural populations (Swaddle 1999; Swaddle & Ruff 2004). If discrimination/detection is different from preference, then such conclusions may not be valid to extrapolate to organisms performing mate-choice decisions. Much of the evidence for perceptual bias for symmetry comes from such studies. We note here that demonstrating the extent and effects of symmetry discrimination may not be informative of symmetry preference mechanisms that are focused on mate-choice relevant stimuli (Jones *et al.* 2001; Little *et al.* 2001; Little & Jones 2003). Those interested in symmetry preferences in other species should not rely solely on detection and discrimination paradigms. We restate here that where others have postulated that preferences for symmetric 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.

Our findings also give some explanation as to why humans are quickly able to judge attractiveness and yet have difficulty in expressing exactly what physical traits are attractive. If attraction is partly or even wholly determined by mechanisms that are largely unconscious, then an overall feeling of attraction may be all that reaches consciousness.

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