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RESEARCH

Assessing the Roles of Symmetry, Prototypicality, and Sexual Dimorphism of face Shape in Health Perceptions

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Abstract

Health perceptions are thought to play an important role in human mate preferences. Although many studies have investigated potential relationships between health ratings of faces and facial symmetry, prototypicality, and sexual dimorphism, findings have been mixed across studies. Consequently, we tested for potential relationships between health ratings of faces and the symmetry, prototypicality, and sexual dimorphism of those faces' shapes. When these three shape characteristics were considered in separate regression models, we observed significant positive relationships between health ratings and both shape symmetry and prototypicality. By contrast, health ratings and sexual dimorphism were not significantly correlated in these analyses. However, in analyses in which symmetry, prototypicality, and sexual dimorphism were entered simultaneously as predictors in a single model, prototypicality, but not symmetry, was significantly correlated with health ratings. Moreover, sexual dimorphism predicted health ratings of female, but not male, faces in these analyses. Collectively, these results suggest that the relationship between symmetry and health ratings is, at least partly, driven by the effect of prototypicality on health perceptions and highlight the importance of considering multiple aspects of face shape when investigating factors that predict perceived health.

Keywords Facial attractiveness · Perceived health · Symmetry · Prototypicality · Sexual dimorphism

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Introduction

Many researchers have hypothesized that facial-attractiveness judgments reflect evolved behaviors that function, at least in part, to identify healthy potential mates (Rhodes, 2006; Thornhill & Gangestad, 1999; Little et al., 2011). Although evidence that individuals with more attractive faces are actually healthier is mixed (for a recent review see Jones et al., 2021a), facial-attractiveness judgments of faces and health ratings (i.e., perceptual ratings of how healthy a person appears to be) are highly correlated and health perceptions are thought to play an important role in human mate preferences (Rhodes, 2006; Thornhill & Gangestad, 1999; Little et al., 2011). Indeed, Rhodes et al. (2007) demonstrated that health perceptions contribute to the attractiveness of putative health cues in faces (see also Jones et al., 2001). Consequently, there is now a relatively large literature investigating the shape characteristics in faces that predict health ratings (e.g., Boothroyd et al., 2013; Fink et al., 2006; Grammar & Thornhill, 1994; Gray & Boothroyd, 2012; Jones et al., 2001; Penton-Voak et al., 2001; Rhodes et al., 2001, 2003, 2007). Although explicit perceptions may not necessarily guide behaviour in other species, it is well established that explicit perceptions influence behaviour in modern humans (e.g., third-party ratings of the trustworthiness of face images influence trusting behaviour in economic games, Van't Wout & Sanfey, 2008).

Because symmetry, prototypicality, and sexual dimorphism are theorized to function as cues of physical condition in many species, much of the research on predictors of health perceptions of faces has investigated the role these specific characteristics might play in health perceptions. Indeed, several studies have reported that faces perceived to be healthier have more symmetric (Fink et al., 2006; Grammar & Thornhill, 1994; Jones et al., 2001; Penton-Voak et al., 2001; Rhodes et al., 2001, 2007) or more prototypical (Grammar & Thornhill, 1994; Jones, 2018; Rhodes et al., 2001, 2007) shapes. Other studies have reported that more masculine male faces (Boothroyd et al., 2013; Rhodes et al., 2003) and more feminine female faces (Gray & Boothroyd, 2012; Jones, 2018; Rhodes et al., 2003) are perceived to be healthier. However, there are several potential problems with this literature on the possible roles of symmetry, prototypicality, and sexual dimorphism in health ratings of faces.

First, although many studies have reported evidence for links between health perceptions and either facial symmetry, prototypicality, or sexual dimorphism, other studies have reported mixed evidence for these links. For example, Foo et al. (2017) reported that healthier-looking male faces were more symmetric and prototypical, but not more masculine, while healthier-looking female faces were more feminine, but not more symmetric or prototypical. Similarly, Rhodes et al. (2007) reported that healthier-looking female faces were more feminine but observed no evidence that healthier-looking male faces were more masculine (see also Alharbi et al., 2020 and Boothroyd et al., 2007). Results such as these raise the possibility that reported links between health perceptions of faces and symmetry, prototypicality, and sexual dimorphism may not necessarily be as robust as other work suggested.

Second, many studies have assessed symmetry, prototypicality, and sexual dimorphism of faces using perceptual ratings, rather than objective measures of these characteristics (i.e., employed ratings of symmetry, prototypicality, or sexual dimorphism, rather than facial-metric assessments of these characteristics, e.g., Gray & Boothroyd, 2012; Foo et al., 2017; Rhodes et al., 2003). Using perceptual ratings to assess physical characteristics of faces in this way may be somewhat problematic, since such ratings can be influenced by factors other than the physical characteristic researchers wish to assess (see, e.g., Bartlome & Lee, 2023; Dong et al., 2023; Scott et al., 2010). However, evidence that this issue necessarily has a material effect on the conclusions made from studies employing both approaches (i.e., studies that assessed face shape using both perceptual ratings and objective measures and analysed these two types of assessment separately) is somewhat mixed. For example, on one hand, Rhodes et al. (2001) found that health ratings of faces were correlated with rated symmetry, but not an objective measure of symmetry, suggesting these two approaches can produce different patterns of results. On the other hand, Boothroyd et al. (2013) found that neither rated masculinity nor an objective measure of masculinity were correlated with health ratings of male faces, suggesting these approaches can produce similar patterns of results.

Third, many studies have tested for possible links between health perceptions of faces and symmetry, prototypicality, or sexual dimorphism using face stimuli in which these physical characteristics were experimentally manipulated using computer graphics methods (e.g., Alharbi et al., 2020; Jones et al., 2001; Penton-Voak et al., 2001). However, several recent studies have reported that findings for social judgments of faces that were obtained using this method are often not observed (or, if observed, have considerably smaller effect sizes) in studies using natural face images and objective assessments of physical characteristics of faces (Dong et al., 2023; Jones & Jaeger, 2019; Jones et al., 2023; Lee et al., 2021; Leger et al., 2023; Scott et al., 2010). Given such results, many researchers have expressed concerns about the appropriateness of experimentally manipulated face images for studying social judgments of faces (Dong et al., 2023; Jones & Jaeger, 2019; Jones et al., 2023; Lee et al., 2021; Leger et al., 2023; Scott et al., 2010). Nonetheless, Boothroyd et al. (2007) reported that experimentally manipulated masculinity did not influence the perceived health of male faces and also reported that masculinity and health ratings of natural male faces were not significantly correlated. Rhodes et al. (2001) also presented evidence that facial symmetry and prototypicality have similar effects on health perceptions using these two types of method.

Fourth, studies assessing health perceptions of natural (i.e., unmanipulated) face stimuli have typically considered individual predictors, rather than entering multiple predictors simultaneously into regression models (but see Foo et al., 2017). This approach may not be ideal, however, since there is some evidence for interrelationships among symmetry, prototypicality, and sexual dimorphism. For example, several studies have reported that more masculine male and more feminine female faces tend to be more symmetric (Gangestad & Thornhill, 2003; Little et al., 2008; but see also Van Dongen et al., 2020) and other work has demonstrated that faces with more distinctive (i.e., the converse of prototypical) face shapes tend to be more asymmetric (Jones et al., 2007; Lee et al., 2016). Such results suggest that it may be useful to compare findings for health ratings and symmetry, prototypicality, and sexual dimorphism when these physical characteristics are analysed individually and when these physical characteristics are entered simultaneously as predictors of health ratings.

In light of the above, we tested for possible relationships between health ratings of male and female face images and symmetry, prototypicality, and sexual dimorphism. Rather than assessing these physical characteristics via perceptual ratings, we used established image-analysis methods (Holzleitner et al., 2019) to objectively measure symmetry, distinctiveness (the converse of prototypicality), and sexual dimorphism of shape information in natural (i.e., unmanipulated) face images.

Methods

Stimuli Fifty male and 50 female face images were taken from an open-access face-image database (DeBruine & Jones, 2022). Male and female face images depicted young adult white men (mean age = 24.2 years, SD = 3.99 years) and young adult white women (mean age = 24.3 years, SD = 4.01 years), respectively. Images had been standardised on pupil position and clothing masked prior to rating. The individuals photographed posed with neutral expressions, front-on to the camera, and with direct gaze. Images are publicly available at https://osf.io/a3947/.

Health ratings Health ratings were also taken from the same open-access face-image database (DeBruine & Jones, 2022). Two hundred men and 200 women (mean age = 25.15 years, SD = 5.62 years) were randomly allocated to rate either the 50 male face images or the 50 female face images for health using a 1 (much less healthy than average) to 7 (much more healthy than average) scale. Trial order was fully randomised. Ratings were collected using the Experimentum data-collection platform (DeBruine et al., 2020). Inter-rater agreement for health ratings was high for both male and female faces (both Cronbach's alphas > 0.90).

Sexual Dimorphism of Face Shape

Sexual dimorphism of face shape was objectively measured for each of the 50 male and 50 female face images using the facefuns package (Holzleitner & DeBruine, 2021) in R (R Core Team, 2021), which implements shape analysis of images that have been delineated with standard landmarks. This method has been used in many previous studies to assess sexual dimorphism of face shape (e.g., Cai et al., 2019; Dong et al., 2023; Holzleitner et al., 2019; Leger et al., 2023; Komori et al., 2011). Shape components were first derived from Principal Component Analysis (PCA) of 132 Procrustes-aligned landmark points (see Holzleitner et al., 2019 for a diagram showing these facial landmarks) on each of the 50 male and 50 female face images. Delineation (placement of face landmarks) was done by Lisa DeBruine. Previous work has shown that measures of face shape derived from manually placed and automatically generated image landmarks are highly correlated (Jones et al., 2021b). Scores representing sexual dimorphism of face shape were then calculated from each photograph using a vector analysis method (e.g., Cai et al., 2019; Dong et al., 2023; Holzleitner et al., 2019; Leger et al., 2023; Komori et al., 2011). This method uses the shape principal components to locate each face on a female-male continuum. The female-male continuum was defined by calculating the average shape information of the 50 female faces and the average shape information of the 50 male faces. Sexual dimorphism scores were then derived by projecting each image onto this female-male vector. Higher scores indicated more masculine face shapes. No scores were more than three standard deviations from the mean (i.e., there were no extreme values). The templates (i.e., landmark points) used to calculate these shape scores (and also distinctiveness and asymmetry shape scores) are publicly available (DeBruine & Jones, 2022).

Distinctiveness of Face Shape

Distinctiveness scores were also calculated from each photograph using the facefuns package (Holzleitner & DeBruine, 2021) in R (R Core Team, 2021). This technique has been used to measure face-shape distinctiveness in many previous studies (e.g., Cai et al., 2019; Holzleitner et al., 2019; Leger et al., 2023). This method uses the shape principal components described in the previous section of our methods to measure the distance each face lies from the mathematical average shape for the sample of faces of the same sex. That is, the average shape values for the same-sex sample were calculated and, for each image, the Euclidean distance from the average was derived. Higher scores indicate that the face lies a further distance away from the average (i.e., had a more distinctive shape). We measured distinctiveness scores for male and female faces separately, in light of evidence that faces are primarily processed relative to sex-specific prototypes (e.g., Little et al., 2005; Rhodes et al., 2011). No scores were more than three standard deviations from the mean (i.e., there were no extreme values).

Asymmetry of Face Shape

Asymmetry scores were also calculated from each photograph using the facefuns package (Holzleitner & DeBruine, 2021) in R (R Core Team, 2021). This technique has been used to measure face-shape asymmetry in many previous studies (e.g., Cai et al., 2019; Holzleitner et al., 2019). For each image, the landmark template was mirrored, and shape asymmetry measured as the Euclidean distance between original and mirrored templates. Higher scores indicate that the face has greater asymmetry. One extreme value (i.e., one score more than three standard deviations from the mean) was adjusted (i.e., winsorized) to be three standard deviations from the mean prior to further analyses.

Analyses

All statistical analyses were carried out using R (R Core Team, 2021), with the packages lme4 (Bates et al., 2015), lmerTest 3.1-3 (Kuznetsova et al., 2017), jtools 2.2.3 (Long, 2022), and robustHD 0.7.3 (Alfons, 2022). Data processing and display used kableExtra 1.3.4 (Zhu, 2021) and tidyverse 1.3.1 (Wickham, 2021). All data, full outputs, and analysis code are publicly available on the Open Science Framework (https://osf.io/vrmxd/).

We first tested for correlations among the three measures of face shape (asymmetry, distinctiveness, and sexual dimorphism). Next, we analysed health ratings in three linear mixed effects models, each model testing for an effect of an individual face-shape parameter (distinctiveness, asymmetry, or sexual dimorphism). In each of these models, health ratings served as the dependent variable. The models included main effects of face-shape scores (distinctiveness, asymmetry, or sexual dimorphism, depending on the model), rater sex (effect coded so that −0.5 corresponded to male raters and 0.5 corresponded to female raters), and face sex (effect coded so that −0.5 corresponded to male faces and 0.5 corresponded to female faces) as predictors, as well as all possible two- and three-way interactions. The models also included by-rater and by-stimulus random intercepts, by-rater random slopes for face-shape scores (face sex varied between raters), and by-stimulus random slopes for rater sex. Face shape scores were standardised prior to analyses by converting them to z scores (separately for each face sex). Higher face-shape scores for both male and female faces indicate more distinctive, asymmetric, or masculine shapes, respectively. Finally, we analysed health ratings in a fourth linear mixed effects model that was identical to the three previous ones, except that all three face-shape parameters (distinctiveness, asymmetry, sexual dimorphism), as well as the interactions involving them, were included as predictors in a single model.

Results

Intercorrelations among Sexual Dimorphism, Distinctiveness, and Asymmetry Scores

Sexual dimorphism scores were not significantly correlated with distinctiveness scores ($r = .04$, $N = 100$, $p = .70$) or asymmetry scores ($r = -.08$, $N = 100$, $p = .44$). Distinctiveness and asymmetry scores were significantly positively correlated ($r = .41$, $N = 100$, $p < .001$). This same pattern of results was seen for both male and female faces when they were analysed separately. For female faces, distinctiveness and asymmetry scores were significantly positively correlated ($r = .39$, $N = 50$, $p = .005$) and sexual dimorphism scores were not significantly correlated with distinctiveness scores ($r = -.07$, $N = 50$, $p = .63$) or asymmetry scores ($r = -.15$, $N = 50$, $p = .31$). Similarly, for male faces, distinctiveness and asymmetry scores were significantly positively correlated ($r = .43$, $N = 50$, $p = .002$) and sexual dimorphism scores were not significantly correlated with distinctiveness scores ($r = .15$, $N = 50$, $p = .31$) or asymmetry scores ($r = -.01$, $N = 50$, $p = .95$).

Linear Mixed Effects Model Testing for Possible Effects of Distinctiveness

This analysis revealed a significant negative effect of distinctiveness on health ratings that was not qualified by any significant higher order interactions. Full results of this analysis are summarised in Table 1.

Table 1 Summary of results from our analysis of the effect of distinctiveness on health ratings

	Estimate	SE	t	df	*p*
Intercept	3.567	0.075	47.351	222.749	< 0.001
Distinctiveness	-0.206	0.061	-3.355	101.867	0.001
Rater sex	-0.126	0.092	-1.371	400.606	0.171
Face sex	-0.054	0.151	-0.356	222.749	0.722
Distinctiveness x rater sex	-0.006	0.022	-0.247	144.238	0.805
Distinctiveness x face sex	0.075	0.123	0.609	101.867	0.544
Rater sex x face sex	0.524	0.184	2.853	400.606	0.005
Distinctiveness x rater sex x face sex	-0.013	0.045	-0.289	144.238	0.773

Table 2 Summary of results from our analysis of the effect of asymmetry on health ratings

	Estimate	SE	t	df	*p*
Intercept	3.566	0.077	46.549	216.403	< 0.001
Asymmetry	-0.157	0.064	-2.457	101.013	0.016
Rater sex	-0.126	0.092	-1.371	400.391	0.171
Face sex	-0.052	0.153	-0.34	216.403	0.734
Asymmetry x rater sex	0.006	0.021	0.268	120.948	0.789
Asymmetry x face sex	0.029	0.127	0.224	101.013	0.823
Rater sex x face sex	0.524	0.184	2.853	400.391	0.005
Asymmetry x rater sex x face sex	-0.007	0.043	-0.175	120.948	0.861

Table 3 Summary of results from our analysis of the effect of sexual dimorphism on health ratings

	Estimate	SE	t	df	*p*
Intercept	3.567	0.077	46.304	214.404	< 0.001
Sexual dimorphism	-0.087	0.063	-1.381	100.166	0.170
Rater sex	-0.126	0.092	-1.372	399.525	0.171
Face sex	-0.054	0.154	-0.348	214.404	0.728
Sexual dimorphism x rater sex	-0.025	0.019	-1.328	93.917	0.187
Sexual dimorphism x face sex	-0.197	0.126	-1.555	100.166	0.123
Rater sex x face sex	0.524	0.184	2.855	399.525	0.005
Sexual dimorphism x rater sex x face sex	-0.03	0.038	-0.783	93.917	0.435

Linear Mixed Effects Model Testing for Possible Effects of Asymmetry

This analysis revealed a significant negative effect of asymmetry on health ratings that was not qualified by any significant higher order interactions. Full results of this analysis are summarised in Table 2.

Linear Mixed Effects Model Testing for Possible Effects of Sexual Dimorphism

The main effect of sexual dimorphism was not significant, nor were any of the interactions including sexual dimorphism. Full results of this analysis are summarised in Table 3.

Linear Mixed Effects Model Testing for Possible Effects of Distinctiveness, Asymmetry, and Sexual Dimorphism

This analysis revealed a significant negative main effect of distinctiveness on health ratings and a significant interaction between sexual dimorphism and sex of face. Full results of this analysis are summarised in Table 4.

Repeating this analysis for male and female faces separately (and with face sex removed from the model) to interpret the interaction between sexual dimorphism and sex of face showed a significant negative effect of sexual dimorphism on health ratings of female faces (estimate = -0.21, SE=0.08, t = -2.57, df=50.39, p=.013). By contrast, the corresponding effect for health ratings of male faces was not significant (estimate=0.04, SE=0.09, t=0.50, df=49.91, p=.62). Full results for these two models are given on the Open Science Framework (https://osf.io/vrmxd/).

Discussion

We tested for possible relationships between health ratings of faces and three aspects of their face shape (symmetry, prototypicality, sexual dimorphism) in two types of regression model (when shape characteristics were tested individually in separate regression models and when all three shape characteristics were entered simultaneously as predictors in a single model). Results from models in which each shape characteristic was investigated individually suggested that healthy-looking faces had symmetric and prototypical face shapes. These results are consistent with previous studies reporting that faces perceived to be healthier have more symmetric (Fink et al., 2006; Grammar & Thornhill, 1994; Jones et al., 2001; Penton-Voak et al., 2001; Rhodes et al., 2001, 2007) or more prototypical (Grammar & Thornhill, 1994;

Table 4 Summary of results from our analysis of the effects of distinctiveness, asymmetry, and sexual dimorphism on health ratings when all three shape parameters were entered as predictors simultaneously

	Estimate	SE	t	df	*p*
Intercept	3.566	0.073	48.568	233.152	<0.001
Sexual dimorphism	-0.085	0.059	-1.43	100.252	0.156
Rater sex	-0.126	0.092	-1.371	400.116	0.171
Face sex	-0.053	0.147	-0.361	233.152	0.719
Asymmetry	-0.097	0.066	-1.476	100.543	0.143
Distinctiveness	-0.177	0.065	-2.727	101.415	0.008
Sexual dimorphism x rater sex	-0.026	0.02	-1.314	96.266	0.192
Sexual dimorphism x face sex	-0.255	0.119	-2.147	100.252	0.034
Face sex x rater sex	0.524	0.184	2.854	400.116	0.005
Rater sex x asymmetry	0.006	0.022	0.276	108.326	0.783
Face sex x asymmetry	-0.046	0.132	-0.352	100.543	0.725
Rater sex x distinctiveness	-0.009	0.023	-0.372	135.159	0.711
Face sex x distinctiveness	0.083	0.13	0.635	101.415	0.527
Sexual dimorphism x rater sex x face sex	-0.031	0.039	-0.797	96.266	0.427
Asymmetry x rater sex x face sex	-0.008	0.044	-0.182	108.326	0.856
Distinctiveness x rater sex x face sex	-0.014	0.047	-0.295	135.159	0.769

Jones, 2018; Rhodes et al., 2001, 2007) face shapes. By contrast with previous studies reporting correlations between health ratings and sexual dimorphism (Boothroyd et al., 2013; Gray & Boothroyd, 2012; Rhodes et al., 2003), results from models in which each shape characteristic was investigated individually showed no significant relationships between health ratings and sexual dimorphism.

Results when all three shape characteristics were entered simultaneously as predictors in a single model showed a different pattern of results to those described above. Here, a significant relationship between prototypicality and health ratings was also observed, but the relationship between symmetry and health ratings was not significant. These two results suggest that the association between symmetry and health ratings may be at least partly driven by the positive effect of prototypicality on health perceptions. Consistent with this interpretation, symmetry and prototypicality were positively correlated in this sample of faces (see also Lee et al., 2016). Thus, it would appear that prototypicality partially mediates the effect of symmetry on health ratings. Indeed, a mediation analysis showed that prototypicality significantly contributed to the link between symmetry and health ratings and indicated that prototypicality mediated this link by ~46% (see https://osf.io/vrmxd/ for full results of this analysis).

Results when all three shape characteristics were entered simultaneously as predictors in a single model also suggested that healthier-looking female faces have more feminine face shapes, but that healthier looking male faces do not have more masculine face shapes. Although this effect of sexual dimorphism for female faces was significant only when we controlled for effects of symmetry and averageness, a difference in the effects of sexual dimorphism for health ratings of male and female faces has been reported in some previous studies (Foo et al., 2017; Rhodes et al., 2007). That the association between femininity and health ratings of women's faces was only significant when we controlled for other aspects of face shape (prototypicality and symmetry) suggests femininity is unlikely to function as a cue to women's perceived health during social interactions (i.e., the functional significance of the observed effect of femininity is likely to be limited).

Some researchers have previously reported that facial symmetry and sexual dimorphism are positively correlated and suggested that this correlation occurs because both characteristics reflect a common underlying quality (i.e., good physical health or immune function, Gangestad & Thornhill, 2003; Little et al., 2008). By contrast with these findings, facial symmetry and sexual dimorphism were not significantly correlated in our study (see also Van Dongen et al., 2020). These null results are consistent with other recent work suggesting that neither facial symmetry nor sexual dimorphism are reliably correlated with measures of physical health or immune function (e.g., Cai et al., 2019; Jones, 2018).

Although we found that prototypicality predicted health ratings in both of our models, and found some evidence for significant relationships between health ratings of faces and both symmetry and sexual dimorphism, these relationships were relatively weak (i.e., none of our models explained > 4% of the variance in health ratings, see https://osf.io/vrmxd/). In other words, despite the focus on these shape characteristics in studies of health perceptions of faces, our data suggest that these characteristics explain only a relatively small proportion of the variance in health ratings. This finding raises the question of what facial characteristics drive health perceptions. One possibility is that health perceptions are driven by skin, rather than shape, characteristics. Indeed, previous work has reported associations between health ratings and aspects of skin coloration (e.g., Jones, 2018; Henderson et al., 2016; Stephen et al., 2009). Another possibility is that health perceptions are driven by shape characteristics other than those considered in our study. For example, it is well-established that face shape contains information about individual differences in adiposity and that these cues predict health perceptions (e.g., Coetzee et al., 2009; Henderson et al., 2016). Of course, these two possible explanations are not necessarily mutually exclusive. Further work considering a wider range of shape and surface characteristics would be needed to clarify this issue.

Although we observed evidence that prototypicality and perceived health are positively correlated, our data do not speak to the reasons why this association occurs. One possibility is that the association occurs because individuals with prototypical face shapes are actually healthier than individuals with distinctive face shapes. However, empirical tests of this potential explanation have produced mixed results. Some studies have reported evidence that measures of actual health and facial prototypicality are positively correlated (e.g., Jones, 2018), while other work has reported null results for links between measures of prototypicality and actual health (e.g., Cai et al., 2019). Another possibility is that prototypical faces are generally perceived positively because of the tendency for people to ascribe negative traits to individuals with distinctive physical characteristics (the 'anomalous-is-bad' stereotype, Workman et al., 2021). Further work is needed to explore these (and other) potential explanations for the observed associations between perceived health and facial prototypicality.

A limitation of the current study is that we investigated health ratings of white faces only that were made by participants living in highly developed, western cultures. Consequently, our results may not generalise to ratings of other ethnicities and/or image sets that are more heterogeneous in terms of ethnicity, and also may not generalise to health ratings made by individuals from other types of cultures or societies. Further work is needed to explore these issues.

In conclusion, we found that prototypicality and health ratings of faces were positively and significantly correlated both when prototypicality was the only shape predictor included in our model and when it was entered simultaneously along with other shape predictors (symmetry, sexual dimorphism). By contrast, the relationship between health ratings and symmetry was only significant when no other shape characteristics were included as predictors. This pattern of results for symmetry may be particularly noteworthy, since it suggests that effects of symmetry on health ratings are, at least partly, driven by the positive effect of prototypicality on health perceptions. Additionally, relationships between sexual dimorphism and health ratings of faces were only significant when the other shape characteristics were included as predictors (and then only for female faces). Collectively, these results highlight the utility of considering multiple predictors when investigating the role shape characteristics play in health perceptions of faces.

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Author Contributions All authors designed the study. KL, VS, LMD, and BCJ carried out analyses. KL and BCJ wrote the first draft of the manuscript, which was reviewed by all authors.

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Data Availability All data, full outputs, and analysis code are publicly available on the Open Science Framework (https://osf.io/vrmxd/).

Declarations

Competing Interests The authors declare no competing interests.

Ethical Approval All procedures were approved by the Department of Psychological Sciences and Health (University of Strathclyde) Ethics Committee, all work was undertaken in accordance with the Declaration of Helsinki, and all participants provided informed consent.

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