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Normality mediates the effect of symmetry on facial attractiveness

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ABSTRACT

Although symmetry, averageness, and sexual dimorphism are usually considered important to facial attractiveness, there are mixed findings regarding whether and how symmetry influences facial attractiveness. The present study introduced "facial normality" to explain the inconsistency of previous research. We hypothesized that symmetry only increased facial attractiveness when it improved facial normality. We manipulated symmetry and normality simultaneously on sixteen Chinese male faces and asked participants to rate the perceived symmetry, perceived normality, and facial attractiveness. The results demonstrated an interactive effect of symmetry and normality on facial attractiveness. The structural equation model results showed two paths from symmetry to facial attractiveness: (1) Symmetry reduced facial attractiveness by decreasing perceived normality; (2) Symmetry increased facial attractiveness by increasing the perceived symmetry and then improving perceived normality. In other words, perceived normality acted as a mediator between symmetry and facial attractiveness. The present study provides a solution to the different effects of symmetry on facial attractiveness in previous studies and suggests that future studies on symmetry and facial attractiveness should consider the mediating role of normality.

1. Introduction

Faces play an important role in human lives, and our communication relies on the information extracted from faces. Especially, facial attractiveness influences our interpersonal behavior in many ways, such as moral judgment (Wilson & Eckel, 2006), hiring decision (Luxen & Van de Vijver, 2006), and mate preference (Gangestad et al., 1994). What factors affect our perceived attractiveness of a face have received growing research attention over the past decades.

For a long time, symmetry, averageness, and sexual dimorphism have been regarded as three main factors for facial attractiveness (see Little et al., 2011; Rhodes, 2006; Thornhill & Gangestad, 1999 for reviews). However, previous research on how symmetry affects facial attractiveness has not reached a consistent conclusion. Many researchers found that symmetric faces were more attractive than asymmetric ones (e.g., Grammar & Thornhill, 1994; Little et al., 2008; Perrett et al., 1999; Rhodes et al., 1998; Rhodes et al., 2001). Furthermore, a recent study with dynamic faces showed whether dynamic faces are more attractive than static ones depends on whether these dynamic faces increase facial symmetry (Hughes & Aung, 2018). Some researchers found that slight asymmetry had no significant effect on perceived facial attractiveness (e.g., Farrera et al., 2015; Kowner, 1996; Zaidel & Hessamian, 2010). A meta-analysis of 13 references (Weeden & Sabini, 2005) showed that symmetry had little effect on male facial attractiveness and had no effect on female facial attractiveness. The facial symmetry even reduced facial attractiveness (e.g., Mentus & Marković, 2016; Swaddle & Cuthill, 1995; Zaidel & Deblieck, 2007).

Here, we put forward a new viewpoint on symmetry's effect on facial attractiveness: symmetry affects facial attractiveness through facial normality. Although facial normality has been used in the research of facial attractiveness (e.g., Rhodes et al., 2003; Short & Mondloch, 2013; Zhou et al., 2016), no research has directly investigated their relationship, and facial normality has not been clearly defined. Valentine (1991) described a norm-based face space model that faces were encoded as vectors from a population norm. Here, we define facial normality as the degree to which a face deviates from the norm face in the norm-based face space model. The perception of facial normality varies depending on age (Short & Mondloch, 2013), race (Zhou et al., 2016), and visual adaptation (e.g., Rhodes et al., 2003, see Webster & MacLeod, 2011 for a review). Wang et al. (2017) established a discriminative threshold of "deformity perception" across facial subunits and suggested facial features such as eyes, nose, chin, and position had a normal range of variability, specific to age, gender, and race. The normal ranges of variability vary from individual to individual, depending on gender

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(Kwak et al., 2015), etc. (see Wang et al., 2017 for a review). Therefore, we defined facial normality specifically as the degree to which a face deviates from the norm face, which could be defined as the norms of facial features (e.g., eyes, nose, mouth) and facial configuration (e.g., the distance between eyes, the positions of nose, mouth) and was established by the average of the faces with different age, gender, and race we met. If the facial features and the facial configurations of a face are within the normal range, it could be regarded as a normal face. In contrast, when a face is distorted to the extent beyond the normal range, it is perceived as abnormal. The more the face deviates from the norm-based face space model, the more abnormal it is (Short & Mondloch, 2013; Zhou et al., 2016).

We hypothesized that facial normality might affect facial attractiveness so that it can be used to reconcile the inconsistency of prior studies on the effect of symmetry on facial attractiveness. This hypothesis was based on the following three points. First, many studies implied a possible relation between facial normality and facial attractiveness. People are more accurate in judging the normality of own-race faces and more consistent in judging the attractiveness of own-race faces than other-race faces (Zhou et al., 2016). Also, stretched faces, compared with the original faces, were less attractive (Halit et al., 2000), and the extent of stretch influenced facial normality (Rhodes et al., 2003). After exposure to a face with such stretched facial configuration for a few minutes, this kind of distorted face would look more normal (Jones et al., 2008; Rhodes et al., 2003; Webster & MacLin, 1999) and more attractive than before (Cooper & Maurer, 2008; Jones et al., 2008; Rhodes et al., 2003). These results implied that people changed their perception of facial normality based on their experience and then adjusted their facial attractiveness perception to match these renormalized faces. Therefore, there may be some correlation between facial normality and facial attractiveness in that the more normal the face looks, the more attractive it can be.

Second, the null correlation between the ratings of symmetry and the facial attractiveness of real human faces (e.g., Farrera et al., 2015; Van Dongen, 2014) might be due to the fact that slight asymmetry of real human faces does not affect facial normality. Biological research points out that human faces exist fluctuating asymmetry, stress-induced deviations from perfect symmetry (e.g., Graham & Ozener, 2016; Møller & Swaddle, 1997; Parsons, 1990). Therefore, perfect symmetry may not be a prerequisite for a normal face. In this case, a more symmetric face is not necessarily more normal and not necessarily more attractive.

Third, research on the effect of symmetry on facial attractiveness adopted different methods to manipulate facial symmetry, leading to the differences in normality, resulting in inconsistent results. These methods included mirror symmetry (chimeras), a mixture of chimeras and original faces (blends), and remapping original faces (remaps) (e.g., Perrett et al., 1999; see Rhodes, 2006 for a review). Among them, remapped faces are the most normal, while chimeras are the most abnormal.

For example, Zaidel and Deblieck (2007) created symmetric faces (chimeras) by reflecting each hemiface of an original face through the vertical midline of the face and found that participants rated those symmetric faces as less attractive than the original faces. So did Mentus and Marković (2016). The result might be due to mirror-symmetric faces usually deviating from normality. Because of the existence of fluctuating asymmetry, the vertical midline of a face is not necessarily the midline of its nose or eyes, which makes these chimeras abnormal in their configuration or features, such as having too wide (or too narrow) eye spacing or nose.

In another way, Rhodes et al. (1998) blended the original faces and their mirror-reversed images to create symmetric faces and found the attractiveness of the symmetric faces was higher than the original faces. A recent study (Bertamini et al., 2019) also replicated this result using faces with the same manipulation. It is possible that this blending eliminated some abnormal elements that previously existed in the original or mirror-reversed faces. To examine whether different manipulations lead to conflicting results, Rhodes (2006) conducted a meta-analysis. The results showed that the use of blends made symmetric faces more attractive, while the use of chimeras did not. An exception is Swaddle and Cuthill (1995). They used blends but found less attractive for symmetric faces than original ones, probably because they did not control expression and remove blemishes of faces (Rhodes, 2006).

Besides, some studies using remapped symmetric faces as stimuli found symmetric faces were more attractive than original faces (e.g., Little et al., 2008; Perrett et al., 1999). Researchers first marked the predefined feature points position and then remapped these marked points to make them left-right symmetric. We conjectured that this technique would not destroy the normality of faces and even made these symmetric versions more normal by eliminating some original faces' extreme asymmetric configuration or features. In sum, although all these manipulations could adjust the original faces into perfectly symmetric ones, they also affected the facial normality to varying degrees. Therefore, normality, rather than symmetry, might be the key to facial attractiveness.

The present study aims to explore the interactive effect of symmetry and normality on facial attractiveness. We used mirror symmetry manipulation to create symmetric and asymmetric faces and used stretching normality manipulation to create normal and abnormal faces. In this way, we manipulated original faces into four types of faces (see Fig. 1): symmetric-normal, symmetric-abnormal, asymmetric-normal, and asymmetric-abnormal faces. Participants were asked to rate all the faces' facial attractiveness on a nine-point Likert scale (1 = very unattractive, 9 = very attractive). These faces' perceived normality and perceived symmetry were also rated on nine-point Likert scales (1 = very abnormal/asymmetric, 9 = very normal/symmetric) as the manipulation check of normality and symmetry. Since we used mirrored symmetry, we expect to replicate Zaidel and Deblieck (2007) that original asymmetric faces are more attractive than symmetric ones for normal faces, while we would not observe this effect for abnormal faces. That is, we expect to observe an interaction between facial symmetry and normality. What's more, we predict that normal faces are more attractive than abnormal ones. We also adopted a structural equation modeling (SEM) approach to investigate the mediating effects of perceived symmetry and perceived normality on the relationship between the symmetry/normality manipulation and facial attractiveness. We predict that (1) symmetry and normality have effects on facial attractiveness, (2) perceived symmetry mediates the effect of symmetry

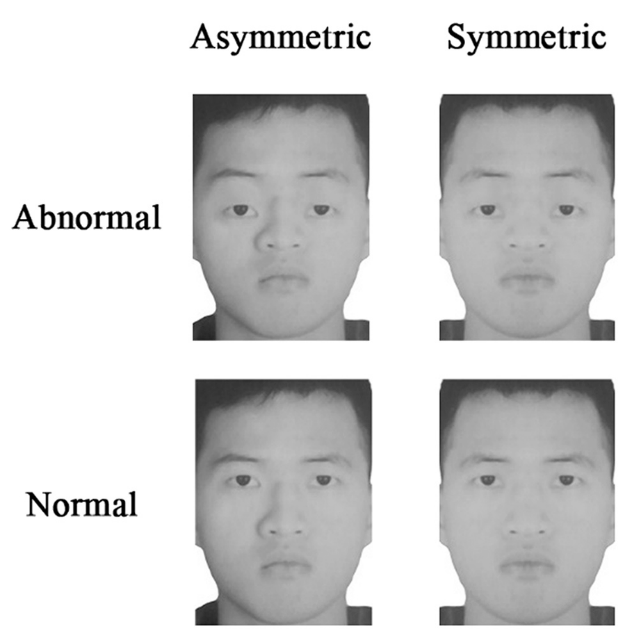

Fig. 1. Examples of stimuli in four conditions. Those demonstrated faces were not used as stimuli in the experiment.

on facial attractiveness; perceived normality mediates the effect of normality on facial attractiveness; (3) importantly, perceived normality mediates the effect of perceived symmetry on facial attractiveness.

2. Methods

2.1. Participants

Twenty-four participants (18–23 years old, $M = 20.00$, $SD = 1.77$, 12 males and 12 females) at Sun Yat-sen University participated in the study for payment. All of them had normal or corrected-to-normal vision. Informed consent was obtained from all participants before the experiment.

2.2. Materials

Sixteen gray-scale pictures (210 × 294 pixels) of Chinese male faces with neutral expressions were used as original stimuli in the present study. Our pilot study showed that they had medium facial attractiveness ($M = 5.05$, $SD = 0.30$) measured on a nine-point Likert scale (1 = unattractive, 9 = attractive), which did not significantly differ from 5 ($t(15) = 0.588$, $p = .565$). We used Adobe Photoshop to generate each picture into four faces (see Fig. 1): symmetric-normal, symmetric-abnormal, asymmetric-normal, and asymmetric-abnormal faces. The symmetric-normal faces were mirror symmetric. Their unnatural curves and shadows were re-morphed to be natural. The symmetric-abnormal faces were based on the symmetric-normal faces, and the positions of eyes were moved down by about 10% of the distance from eyebrow to chin to make these faces abnormal. "Normality" faces in previous research (Short & Mondloch, 2013; Zhou et al., 2016) were manipulated by expanding and compressing facial features at three distortion levels (−30%, −20%, −10%, 10%, 20%, 30%). Here we chose to compress 10% of the position of the eyes. Some of the asymmetric-normal faces adopted the original faces that were already asymmetric. Other asymmetric-normal faces are based on the relatively symmetric original faces, and we slightly adjusted their shape, mouth, or eyes to make them asymmetric but normal. The asymmetric-abnormal faces were based on the asymmetric-normal faces, and their eyes were moved down to the same position as the symmetric-abnormal faces. Thus, a total of 64 face images were created as stimuli.

2.3. Procedure

The experiment was programmed and run via E-prime 2.0 software with a 23-in. monitor of 1920 × 1080 pixels. Participants' tasks were to rate each face on facial attractiveness, normality (i.e., perceived normality), and symmetry (i.e., perceived symmetry) separately in three blocks. The facial attractiveness rating was always in the first block. The order of the other two blocks was counterbalanced across the participants.

In each block, 64 faces were randomly displayed one at a time. In each trial, a white fixation point was first presented at the screen center against the black background for 500 ms. And then, a face stimulus was presented at the center of the screen with a nine-point Likert scale (1 = very unattractive/abnormal/asymmetric, 9 = very attractive/normal/symmetric) below it until response.

3. Results

3.1. ANOVA results

We conducted a 2 × 2 repeated measure MANOVA with symmetry and normality as within-subject factors, and facial attractiveness, perceived normality, and perceived symmetry as dependent variables, with the participant as the independent observation unit (see Fig. 2). (see Supplementary data for the results with the face picture as the independent observation unit).

3.1.1. Manipulation check of normality

As shown in Fig. 2A, there was a significant main effect of normality on perceived normality ($F(1,23) = 118.859$, $p < .001$, $\eta_p^2 = 0.838$). Normal faces ($M = 6.517$, $SD = 1.374$) were perceived as more normal than abnormal faces ($M = 2.786$, $SD = 1.464$). The effect of symmetry ($F(1,23) = 3.475$, $p = .075$, $\eta_p^2 = 0.131$) and its interaction with normality ($F(1,23) = 0.103$, $p = .751$, $\eta_p^2 = 0.004$) on perceived normality did not reach significance.

3.1.2. Manipulation check of symmetry

As shown in Fig. 2B, there was a significant main effect of symmetry ($F(1,23) = 143.522$, $p < .001$, $\eta_p^2 = 0.862$) on perceived symmetry. Symmetric faces ($M = 7.777$, $SD = 0.717$) were more symmetric than asymmetric faces ($M = 4.624$, $SD = 1.208$). Interestingly, the main effect of normality ($F(1,23) = 22.681$, $p < .001$, $\eta_p^2 = 0.497$) and its interaction with symmetry also reached significance ($F(1,23) = 25.089$, $p < .001$, $\eta_p^2 = 0.522$). Normal faces ($M = 6.496$, $SD = 0.916$) were rated more symmetric than abnormal faces ($M = 5.905$, $SD = 0.699$). This was only observed in the asymmetry condition ($p < .001$, Cohen's $d = 1.13$), not in the symmetry condition ($p = .135$, Cohen's $d = 0.32$). These results showed a partial success manipulation of symmetry. Symmetric faces were more symmetric than asymmetric faces, but the symmetry manipulation could not be disentangled from the normality manipulation.

3.1.3. Effect of symmetry and normality on facial attractiveness

There were significant main effects of symmetry ($F(1,23) = 12.423$, $p < .01$, $\eta_p^2 = 0.351$) and normality ($F(1,23) = 72.009$, $p < .001$, $\eta_p^2 = 0.758$) on perceived facial attractiveness, see Fig. 2C. Asymmetric faces ($M = 3.344$, $SD = 1.051$) were perceived more attractive than symmetric faces ($M = 3.082$, $SD = 1.109$). Normal faces ($M = 4.254$, $SD = 1.115$) were more attractive than abnormal faces ($M = 2.173$, $SD = 1.323$).

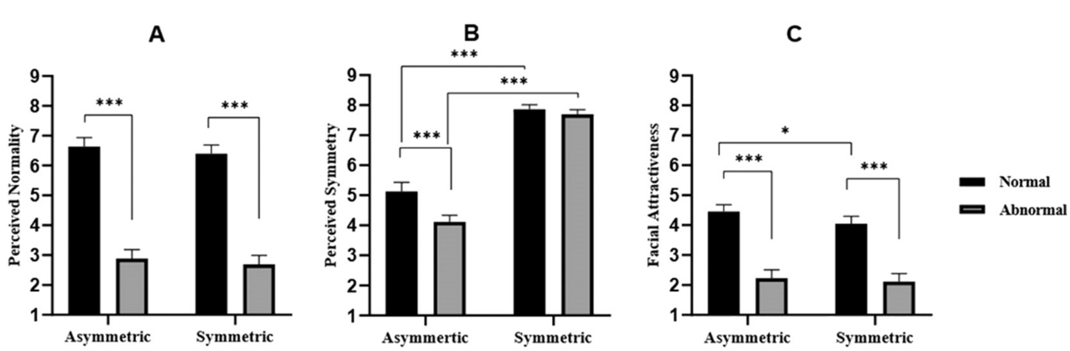

Fig. 2. Perceived normality (A), perceived symmetry (B), and facial attractiveness (C) as functions of symmetry and normality. Error bars indicate standard error. *$p < .05$, **$p < .01$, ***$p < .001$.

Expectedly, the interaction of normality and symmetry was significant ($F(1,23) = 5.410$, $p < .05$, $\eta_p^2 = 0.190$). Bonferroni post hoc comparison showed that, when faces were in the normal condition, asymmetric faces were more attractive than symmetric faces ($p < .01$, Cohen's $d = 0.69$). In contrast, in the abnormal condition, there was no significant difference between asymmetric and symmetric faces ($p = .103$, Cohen's $d = 0.35$).

3.2. SEM results

The results of MANOVA showed that both symmetry and normality influenced perceived symmetry. Thus, to further explore the interactive mechanism of normality and symmetry on facial attractiveness, based on our hypothesis, we investigated the pathways from symmetry and normality to facial attractiveness using SEM.

A path analysis was conducted by Mplus 7.0. According to our hypothesis, both symmetry and normality affect facial attractiveness. Thus, we treated symmetry (asymmetric = −1, symmetric = 1), normality (abnormal = −1, normal = 1), and their interaction as predictors, with facial attractiveness as a dependent variable. Based on the presumptive model, perceived symmetry mediates the effect of symmetry on facial attractiveness; perceived normality mediates the effect of normality on facial attractiveness; perceived normality mediates the effect of perceived symmetry on facial attractiveness. Therefore, both perceived symmetry and perceived normality were added as mediators. We treated the manipulations of faces (i.e., normality, symmetry, and their interaction) and participants' ratings as nested within individuals.

The path analysis results were presented in Tables 1 and 2, and the final model was established and presented in Fig. 3. We found a significant total effect ($\beta = 0.646$, $p < .001$) from normality to facial attractiveness. Normality positively predicted facial attractiveness via perceived normality ($\beta = 0.395$, $p < .001$), as well as via first perceived symmetry and then perceived normality ($\beta = 0.019$, $p = .042$). However, normality did not predict facial attractiveness via merely perceived symmetry ($\beta = 0.015$, $p = .574$). Symmetry did not predict facial attractiveness via merely perceived symmetry as well ($\beta = 0.080$, $p = .578$), but negatively predicted facial attractiveness via perceived normality ($\beta = -0.123$, $p = .001$) and positively predicted facial attractiveness via first perceived symmetry and then perceived normality ($\beta = 0.099$, $p = .011$). The total effect from symmetry to facial attractiveness was significantly negative ($\beta = -0.081$, $p < .001$). Besides, a total effect from the interaction of normality and symmetry to facial attractiveness was found ($\beta = -0.046$, $p = .022$). The interaction negatively predicted facial attractiveness via perceived symmetry and then perceived normality ($\beta = -0.013$, $p = .029$). When via only perceived symmetry ($\beta = -0.011$, $p = .570$) or only perceived normality ($\beta = 0.011$, $p = .295$), no significant effect was found. We did not find any significant direct effect from symmetry ($\beta = -0.138$, $p = .361$), normality ($\beta = 0.217$, $p = .108$), or their interaction ($\beta = -0.033$, $p = .316$) to facial attractiveness. Thus, the critical result showed that both symmetry and normality predicted facial attractiveness via perceived normality, or via first perceived symmetry and then perceived normality, but not via perceived symmetry.

Table 1
Path analysis model results.

	β	b	SE	p-value
Perceived symmetry				
Symmetry	**0.820**	**1.576**	**0.036**	**<.001**
Normality	**0.154**	**0.296**	**0.037**	**<.001**
Symmetry × Normality	**−0.111**	**−0.212**	**0.025**	**<.001**
Perceived normality				
Symmetry	**−0.236**	**−0.556**	**0.087**	**.007**
Normality	**0.757**	**1.782**	**0.053**	**<.001**
Symmetry × Normality	0.020	0.048	0.020	.316
Perceived symmetry	**0.232**	**0.284**	**0.106**	**.029**
Facial attractiveness				
Perceived symmetry	0.098	0.082	0.176	.577
Perceived normality	**0.522**	**0.357**	**0.114**	**<.001**
Symmetry	−0.138	−0.222	0.151	.361
Normality	0.217	0.350	0.135	.108
Symmetry × Normality	−0.033	−0.052	0.032	.316
Intercepts				
Facial attractiveness	0.647	1.042	0.553	.242
Perceived symmetry	**1.228**	**2.890**	**0.376**	**.001**
Perceived normality	**3.227**	**6.201**	**0.294**	**<.001**

Note. β = standardized coefficient, b = unstandardized coefficient, SE = standard error for standardized coefficients. Significant results were in bold.

Table 2
Indirect effects for the path analysis model.

Model pathways	Estimated	SE	p-Value
Sym → Perceived Sym → Facial Att	0.080	0.145	.578
Sym → Perceived Nor → Facial Att	**−0.123**	**0.038**	**.001**
Sym → Perceived Sym → Perceived Nor → Facial Att	**0.099**	**0.039**	**.011**
Nor → Perceived Sym → Facial Att	0.015	0.027	.574
Nor → Perceived Nor → Facial Att	**0.395**	**0.095**	**<.001**
Nor → Perceived Sym → Perceived Nor → Facial Att	**0.019**	**0.009**	**.042**
Inter → Perceived Sym → Facial Att	−0.011	0.019	.570
Inter → Perceived Nor → Facial Att	0.011	0.010	.295
Inter → Perceived Sym → Perceived Nor → Facial Att	**−0.013**	**0.006**	**.029**

Note. The parameters shown in the chart are standardized. SE = standard error. Sym = Symmetry, Nor = Normality, Inter = Symmetry × Normality, Att = Attractiveness. Significant results were in bold.

4. Discussion

In the present study, we manipulated faces' symmetry and normality to investigate their interactive effect on facial attractiveness. We treated perceived symmetry and perceived normality as mediators to investigate their possible mediation effect in the effect of symmetry and normality on facial attractiveness. First, MANOVA results showed that asymmetric faces were perceived as more attractive than symmetric faces. Interestingly, this effect was only observed on normal faces. The SEM results also showed a negative total effect of symmetry on facial attractiveness but no direct effect. Two indirect paths indicated that perceived normality acted as a mediator between symmetry and attractiveness: (1) symmetry positively predicted facial attractiveness via first perceived symmetry and then perceived normality; (2) symmetry negatively predicted facial attractiveness via perceived normality. Second, MANOVA results showed normal faces were more attractive than abnormal faces, and SEM results showed that normality was positively associated with facial attractiveness in terms of total effect rather than the direct effect. Similarly, normality positively predicted facial attractiveness via first perceived symmetry and then perceived normality, as well as via perceived normality. In a word, perceived normality existed as a complete mediator between symmetry and facial attractiveness and between normality and facial attractiveness.

Our findings provide a further understanding of previous research's inconsistent results on how symmetry influences facial attractiveness. The present study adopted mirror-symmetry manipulation and found asymmetric faces were perceived more attractive than symmetric faces, consistent with other studies with mirror-symmetry manipulation (e.g., Mentus & Marković, 2016; Zaidel & Deblieck, 2007), inconsistent with the studies that used blending-symmetry manipulation (e.g., Bertamini et al., 2019; Rhodes et al., 1998) or remapping-symmetry manipulation (e.g., Little et al., 2008; Perrett et al., 1999). Rhodes and Jeffery (2006) indeed showed that blending-symmetric faces, compared with original faces, are more attractive, while the mirror-symmetric faces are less attractive. However, why different manipulations of symmetry lead to inconsistent results had not been addressed to date. Our findings provide

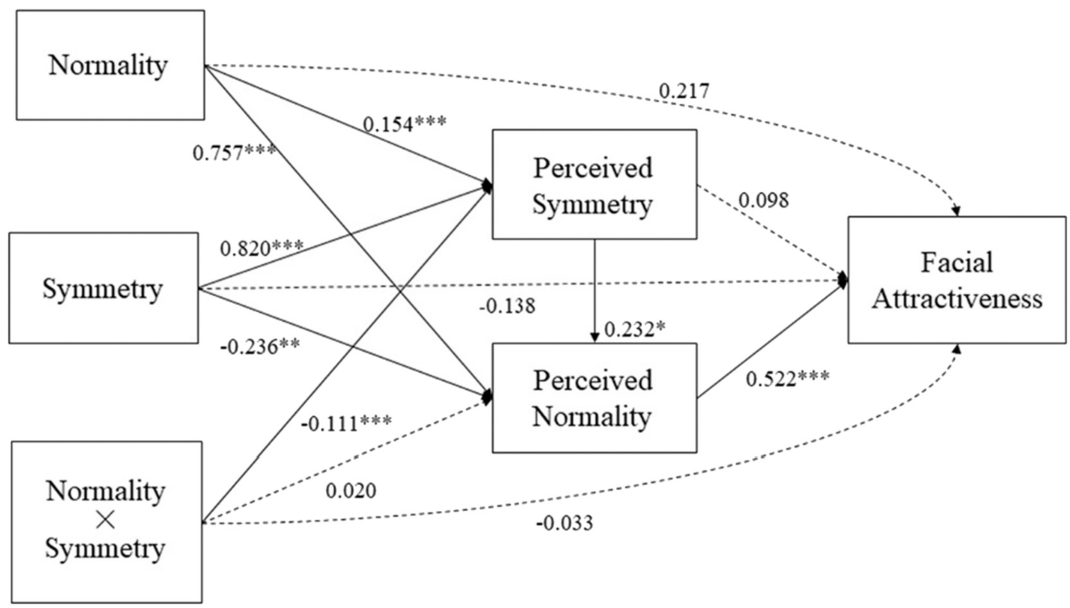

Fig. 3. Path analysis model with standardized coefficients. Nonsignificant paths are marked by dotted lines. R^2 for dependent variables: 0.536 for facial attractiveness, 0.647 for perceived normality, 0.709 for perceived symmetry. * $p < .05$, ** $p < .01$, *** $p < .001$.

a possible solution by introducing the effect of normality.

First, we found two paths with opposite effects from symmetry to facial attractiveness. We suggest that the symmetry manipulation in previous research (e.g., Bertamini et al., 2019; Little et al., 2008; Mentus & Marković, 2016; Perrett et al., 1999; Rhodes et al., 1998; Zaidel & Deblieck, 2007) influenced these two paths with varying degrees, so they obtained inconsistent results. On the one hand, symmetry had a negative effect on facial attractiveness via perceived normality. Absolute symmetry (induced by mirror symmetry) (Mentus & Marković, 2016; Zaidel & Deblieck, 2007) makes faces more symmetric, but it strongly destroys their normal configuration or normal features and then reduces the perceived normality of these faces. In this way, it makes faces less attractive. On the other hand, symmetry influenced perceived symmetry positively, and then perceived symmetry increased perceived normality, resulting in higher facial attractiveness. Flexible symmetry (induced by blends, remap, and morph) (Bertamini et al., 2019; Little et al., 2008; Perrett et al., 1999; Rhodes et al., 1998) makes faces more normal and then increases facial attractiveness.

Second, we emphasized the important role of normality in the effect of symmetry on facial attractiveness. We found an indirect effect of symmetry and normality interaction on attractiveness via perceived symmetry and perceived normality. The negative coefficient of the interaction between symmetry and normality on perceived symmetry indicated that normality would weaken the positive effect of symmetry on perceived symmetry, which sequentially reduced perceived normality and attractiveness. This result was consistent with the MANOVA results. That was, for normal faces, compared with abnormal faces, symmetry had a smaller positive effect on facial attractiveness via perceived symmetry and perceived normality. A possible reason for the attenuated effect of normality on the perceived symmetry is that most of the faces (i.e., normal faces) in our daily lives exist fluctuating asymmetry, stress-induced deviations from perfect symmetry (Graham & Ozener, 2016; Møller & Swaddle, 1997; Parsons, 1990). Therefore, we may ignore the fluctuating asymmetry of normal faces more than that in abnormal faces when perceiving facial attractiveness.

Third, the direct effect of symmetry on facial attractiveness is not significant. Likewise, previous studies indicated that the symmetry of original faces did not associate with the perceived attractiveness (e.g., Farrera et al., 2015; Van Dongen, 2014). Symmetry was not necessary for attractiveness because human faces would not be symmetric essentially (Graham & Ozener, 2016).

Taken our results together, it is only when symmetry makes a face more normal, can it increase facial attractiveness. Therefore, facial normality, rather than symmetry, is the core factor affecting attractiveness, which is often neglected in past research. We will try to explain why normality positively predicts attractiveness from the aspects of face processing, social effect, and evolutionary value.

First, facial normality benefits face processing, and processing fluency improves the perception of facial attractiveness. Rhodes and Jeffery (2006) considered norm-based coding as an effective way for face processing. Norm-based coding refers to face processing by comparing the face with the norm face (a prototype with both configuration and feature information) of a specific category, such as gender, age, and race (Short et al., 2015). Norm-based coding avoids the processing of redundant information and ensures that only relevant dimensions are used to encode faces of a given category, which enhances face recognition. In short, a more normal face is easier in visual processing and requires less consumption of cognitive resources. According to the hedonic fluency theory (Reber et al., 2004), processing fluency increased the aesthetic pleasure of the observer. Hence, the observer responded to the stimulus more positively, no matter whether this stimulus was a painting or a face. The faces that were closed to the population norms indeed were categorized faster and perceived as attractive (Trujillo et al., 2014), supporting that normal faces may cause positive and pleasant experiences due to less consumption of visual processing resources and increase the perception of attractiveness consequently.

Second, as mentioned before, normal faces are usually in line with social norms and self-experience, which may be perceived as attractive. A cross-cultural study found that people with different cultural backgrounds had different standards for attractive faces, especially females' beauty-related disciplines were more susceptible to social norms and conformity (Kim & Lee, 2018). Moreover, Potter and Corneille (2008) found that people considered a face attractive when it was similar to an ingroup prototype. Faerber et al. (2016) also found that familiar faces were more normal and more attractive when compared to unfamiliar faces. We suggest that abnormal faces are perceived as unattractive because they are too weird to meet social norms' criteria towards attractiveness.

Third, from the evolutionary psychological perspective, we guess that normal faces are healthier and reflect nice quality compared with abnormal faces, which leads people to perceive them as attractive. Rhodes et al. (2001) found that when a face was stretched to deviate from the norm, it was rated less healthy. Further, to avoid parasitic infections and promote the production of offspring, our preference for healthy individuals is highly adaptive (Thornhill & Gangestad, 1993). Healthy faces were perceived as more attractive because they represented healthy bodies and good genes (Henderson & Anglin, 2003; Rhodes et al., 2007). Thus, normality improves facial attractiveness probably because normal faces look healthier.

5. Conclusion

To sum up, the present research found the interactive effect of symmetry and normality on facial attractiveness and found perceived normality as a mediator on the effect of symmetry on facial attractiveness. That is, symmetry cannot directly affect facial attractiveness, but it works through perceived normality. Future studies on symmetry and facial attractiveness should consider the mediating role of normality. The current study has several limitations that offer directions for future research. First, other manipulations of normality and symmetry are not explored. We only used the binary form of normality and symmetry, and the grade form of symmetry and normality may provide more information about their effect on facial attractiveness. It is also interesting to compare mirror-symmetry manipulation, blending-symmetry manipulation, and remapping-symmetry manipulation in one experiment to further explore the interactive effect of normality and symmetry on facial attractiveness. Second, whether the interactive effect of normality and symmetry could be generalized to other facial trait perceptions such as trustworthiness, dominance, etc., is worth investigating. Finally, how the interaction works through the way our neural network work is also an open question.

Declaration of competing interest

We declare that we have no financial and personal relationships with other people or organizations that can inappropriately influence our work, there is no professional or other personal interest of any nature or kind in any product, service and/or company that could be construed as influencing the position presented in, or the review of, the manuscript entitled, "Normality Mediates the Effect of Symmetry on Facial Attractiveness".

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.actpsy.2021.103311.

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