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Effects of symmetry and familiarity on the attractiveness of human faces

Tatjana Mentus[1] & Slobodan Marković[2]

[1]*Faculty of Special Education and Rehabilitation, University of Belgrade, Serbia*
[2]*Laboratory of Experimental Psychology, University of Belgrade, Serbia*

The effects of both symmetry (perceptual factor) and familiarity (cognitive factor) on facial attractiveness were investigated. From the photographs of original slightly asymmetric faces, symmetric left-left (LL) and right-right (RR) versions were generated. Familiarity was induced in the learning block using the repetitive presentation of original faces. In the test block participants rated the attractiveness of original, previously seen (familiar) faces, original, not previously seen faces, and both LL and RR versions of all faces. The analysis of variance showed main effects of symmetry. Post hoc tests revealed that asymmetric original faces were rated as more attractive than both LL and RR symmetric versions. Familiarity doesn't have a significant main effect, but the symmetry-familiarity interaction was obtained. Additional post hoc tests indicated that facial attractiveness is positively associated with natural slight asymmetry rather than with perfect symmetry. Also, unfamiliar LL symmetric versions were rated as more attractive than familiar LL versions, whereas familiar RR versions were rated as more attractive than RR unfamiliar faces. These results suggested that symmetry (perceptual factor) and familiarity (cognitive or memorial factor) play differential roles in facial attractiveness, and indicate a relatively stronger effect of the perceptual compared to the cognitive factor.

Keywords: symmetry, familiarity, facial attractiveness

The present study is concerned with the effects of two factors on facial attractiveness: symmetry (perceptual factor) and familiarity (cognitive or memorial factor). Numerous studies have shown that people generally prefer symmetric and familiar (or prototypical, or average) stimuli, including faces and other objects (cf. Berlyne, 1974; Halberstadt & Rhodes, 2000; Langolis & Roggman, 1990; Martindale & Moore, 1988; Rhodes & Tremewan, 1996).

Corresponding author: mentus@fasper.bg.ac.rs

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Symmetry

Many studies found the strong effect of symmetry on facial attractiveness (e.g. Cronin, 1992; Little, 2014; Little & Jones, 2003; Little, Jones, & DeBruine, 2011; Møller, 1995; Penton-Voak et al., 2001; Perrett et al., 1999; Rhodes, Proffitt, Grady, & Sumich, 1998; Swaddle, 1999; Thornhill & Møller, 1997). Standard explanation of this effect comes from Evolutionary psychology which stresses the adaptive function of facial symmetry preference: symmetry is attractive because it is an honest signal of genetic quality and general health (Thornhill & Møller, 1997; Bukinham, et al., 2006; Cronin, 1992; Møller, 1995; Swaddle, 1999; Thornhill & Møller, 1997). On the other side, some studies suggested that perfect symmetry is not a crucial factor of facial attractiveness: participants prefer naturally asymmetric original faces compared to their artificially symmetrized versions (Chen, German, & Zaidel, 1997; Knowner, 1996; Zaidel, Chen, & German, 1995; Zaidel & Cohen, 2005; Zaidel & Deblieck, 2007). Interestingly, in their study, Komori and associates found that symmetry affected the attractiveness of male faces, but not of female ones (Komori, Kawamura, & Ishihara, 2009).

The two techniques are most frequently used for facial symmetrization. The first one is based on computer-generated left-left (LL) and right-right (RR) images or "chimerical stimuli" (Chen et al., 1997; Knowner, 1996; Langlois & Roggman, 1990; Swaddle & Cuthill, 1995; Zaidel et al., 1995). Using this technique Zaidel and Deblieck (Zaidel & Deblieck, 2007) found that symmetrized faces were judged as less attractive than original ones. Interestingly, some authors found that LL chimerical versions were more attractive than the original ones (Burt & Perrett, 1997; Gilbert & Bakan, 1973; Rhodes, 1985; Luh, Redl, & Levy, 1994). This finding was explained by the dominance of the right brain hemisphere in face processing: the left half of the image (i.e. right half of the observed face) is largely projected onto the dominant right brain hemisphere and, consequently, it is experienced as more similar to the whole face (or, as a better representative of the whole face) than the right half (cf. Burt & Perrett, 1997; Gilbert & Bakan, 1973). However, some other studies did not obtain this left half bias (Chen et al., 1997; Knowner, 1996; Zaidel et al., 1995; Zaidel & Deblieck, 2007).

Morphing is the second technique for generating faces. Using a computer softer the photographs of different faces are combined (superposed one over another) creating a unique average face. Many studies have shown that morphed (averaged) faces were more attractive than single individual faces which are averaged (Grammer & Thornhill, 1994; Mealey, Bridgstock, & Townsend, 1999; Rhodes et al., 1998). However, it is not clear whether the morphed faces are attractive because they are average or symmetric (i.e. morphed faces are artificially more symmetric than the original ones). In addition, some findings suggested that the most beautiful faces (e.g. faces of the models) are more attractive than average faces (Alley & Cunningham, 1991). Similarly, asymmetries play a positive role in memorizing and recognizing faces (Brady, Campbell, & Flaherty, 2005; Brédart, 2003).

Familiarity

Many studies investigated the role of familiarity in face perception and facial attractiveness. Young, Hellawell and Hay (1987) demonstrated that familiar and unfamiliar faces are differently mentally representated, indicating that spatial configurations play a greater role in the representation of familiar than unfamiliar faces. In addition, some studies found that the internal facial characteristics were more important for familiar face recognition, while external characteristics were more important for the recognition of unfamiliar faces (Diamond & Carey, 1986; Vereš–Injac & Persike, 2009). Also, Bruce, Valentin and Baddely (1987) indicated that the observation angle has a different effect on familiar and unfamiliar faces. A 3/4 view increased the recognition speed only where the faces were unfamiliar, whereas frontal and profile views were not discriminative: the recognition of both familiar and unfamiliar faces was faster in the frontal view and slower in the profile view. Troje and Kersten (1999) reported the similar effect in the recognition of one's own face: participants were slower in naming their own faces shown in profile. Finally, Mohr, Landgrebe and Schweinberger (2002) found the stronger interhemispheric cooperation in familiar face processing: simultaneous bilateral presentation increased the recognition speed only for familiar, but not for unfamiliar faces.

Studies of the familiarity effect on facial attractiveness indicated that more familiar faces are more attractive than unfamiliar ones. Some studies suggested that even a mere exposure of stimuli induced positive affective responses (the so-called "mere-exposure effect"; Bornstein, 1989; Harrison, 1977; Zajonc, 1968; see also Mita, Dermer, & Knight, 1977). Winkielman and Cacioppo (2001) found that celebrity faces were judged as more attractive than unfamiliar faces. They explained this finding by using the Processing fluency theory: fluently (fast and easily) processed stimuli, such as familiar faces, induce a positive effect and, therefore they were judged as more attractive. Rhodes, Hadgestadt and Brajkovich (2001) found that a positive effect of previously seen faces can be generalized to their averaged composites: repetitive exposure of individual faces increased the liking ratings of their composites, although the composites (morphs, average faces) were not seen previously.

Symmetry – Familiarity

Halberstadt and associates contrasted the effects of symmetry and familiarity on facial attractiveness (Halberstadt, Pecher, Zeelenberg, Ip Wai, & Winkielman, 2013). They used the morphs generated from the faces of famous persons in two distant countries (The Netherlands and New Zealand). The participants from these countries rated the attractiveness of the morphs as well as the attractiveness of the individual faces. When participants rated the faces from the other country, the typical averaging effect was obtained: morphs (i.e. more symmetric faces) were rated as more attractive than the individual faces. On the other hand, when participants judged the faces from their own country,

familiarity prevailed: the individual faces of celebrities (naturally asymmetric in a certain scale) were rated as more attractive than the morphs (artificially symmetrized). The authors suggest that in this context familiarity plays a more important role in face attractiveness than symmetry.

The purpose of the study

Previous studies do not provide a clear picture of the relative contribution of symmetry and familiarity in facial attractiveness. To summarize:

Some studies revealed the positive role of symmetry in facial attractiveness (e.g. Cronin, 1992; Little & Jones, 2003; Little et al., 2011; Møller, 1995; Swaddle, 1999; Thornhill & Møller, 1997), whereas other studies reported no effects of symmetry (Zaidel & Deblieck, 2007). In addition, the results of some studies revealed the left-right difference in chimerical facial versions: LL versions are more attractive than RR ones (Burt & Perrett, 1997; Gilbert & Bakan, 1973; Luh et al., 1994; Rhodes, 1985), whereas some studies did not find this LL advantage (Chen et al., 1997; Knowner, 1996; Zaidel et al., 1995; Zaidel & Deblieck, 2007). One of the few studies that investigated the relative contribution of symmetry and familiarity has shown the stronger positive effect of familiarity compared to symmetry (Halberstadt et al., 2013).

Having in mind the inconsistence of the existing data, we designed a study with the purpose to provide a more precise insight into the differential effect of symmetry and familiarity on facial attractiveness ratings.

We used the experimental setting, which is generally similar to that used by Halberstadt and associates (Halberstadt et al., 2013). An equal number of familiar and unfamiliar faces and their symmetrized versions were subjected to the judgment of attractiveness. However, our study has two specificities. In order to avoid the variability of the familiarity of celebrities (e.g. participants could be more or less familiar with a particular celebrity), we used the learning procedure: participants familiarized with the unfamiliar faces during the learning experimental phase. In order to avoid confound effects of symmetry vs. averageness we did not use the morphing technique. We created the stimulus set using original (asymmetric) faces and their symmetrized LL and RR versions.

Generally, we expected the greater effect of basic stimulus constraints on facial attractiveness, such as symmetry, compared to more cognitive (or memory) factors, such as familiarity. Namely, LL and RR type of increased symmetry also structurally transforms an original face inducing the artificial deformations and exaggerations, such as creating too wide or too narrow faces. This “symmetrization” can violate some internal facial proportions as well, such as distance between eyes or eyebrows. In addition, original faces fluctuate asymmetry in a normally distributed scale, and therefore they look more natural than perfectly (and artificially) symmetric faces (cf. Knowner, 1996). On the other hand, familiarity does not violate the structural facial characteristic, so its aesthetic influence can only be indirect, that is via the affective evaluation system: familiar is safe, relaxing, pleasant and, therefore, attractive.

Method

Participants

42 students from the Faculty of Philosophy, University of Belgrade participated in the present study. They were divided into two groups. Group 1: 14 participants (4 males and 10 females); Group 2: 28 participants (10 males and 18 females).

Stimuli

Achromatic (black-white) photographs of 24 faces of Serbian residents, both male (12) and female (12), were taken from a database of the Department of Psychology, University of Belgrade. They were used only after the consent of photographed people was provided. The faces were unfamiliar to the participants. All the faces were photographed in frontal orientation. Images were equal in size, shape and brightness. Images of 9 x13 inches were presented on the 17'' screen, perpendicular to the eyesight, from the distance 0.6m.

From this database, 12 images were randomly chosen for the familiarization procedure (the learning stage of the experiment), and in addition, all 24 faces were symmetrized (the test stage of the experiment). Photoshop 7, software for digitalized image processing, was used to obtain perfectly symmetrical images. Each original photograph was split along the vertical axis to the left and right half and then each of the halves was joined with its mirrored version to obtain strictly symmetric LL or RR face versions. Thus, each of original faces (OR), was conjoined with the corresponding left-left (LL) and right-right (RR) versions (24x3) creating total of 72 stimuli in the experiment. An example of the stimuli generated from one original photographed face is shown in Figure 1.

LL OR RR

Figure 1. The example of images of a female face used in this study as stimuli. The symmetric (LL and RR) pair of images is obtained by a vertical section of the original image (OR) into the left and the right half, and by joining the halves with their mirror images.

Design

The study was based on a two-factor univariate design: Symmetry (asymmetric original, OR; symmetric left-left, LL; symmetric right-right, RR) and Familiarity (familiar and unfamiliar).

Procedure

The experiment was conducted in two stages: (1) the learning (familiarization) stage, and (2) the test stage, for testing the effects of familiarity and symmetry on the facial attractiveness judgments.

The learning stage

12 faces were randomly chosen from the set of 24 original faces. Faces from this subset were copied 12 times each, making the database of 144 (12 x 12) faces in total. Participants, thus, had been exposed to the 144 images. Images were presented in random order. Through the repetitive exposure, these 12 original versions of faces were learned (i.e. each image had been presented 12 times). The participants were asked to judge the gender of the face presented in the image, and to press a corresponding button on the keyboard: "Please, answer whether the face presented on the screen is male or female. If the face is male, press button A on the keyboard, and if it is female then press button L".

The test stage

The basic stimulus set consisted of 12 familiar faces (i.e. faces presented in the learning stage) and 12 unfamiliar (new) faces. Three versions of 24 faces were generated (OR, LL and RR). All stimuli, 72 in total, were presented on the computer monitor in a random order. The participants were asked to rate the attractiveness on the 5-point scale (ranging from 1– least attractive to 5– most attractive).

The same procedure was administrated to both groups of participants. Images used in the learning and test stage were alternated across the groups. In other words, images that were used in the learning stage in Group 1, in Group 2 were presented as new (unfamiliar) faces, and vice versa.

Results

Mean attractiveness ratings are shown in Figure 1. The analysis of variance revealed the significant main effect of Symmetry, $F(2,80)=101,85$, $p<.001$. Sidak post-hoc tests indicated that OR faces were rated as significantly more attractive than the LL ($p<.001$) and RR ones ($p<.001$). No main effect of Familiarity was obtained, whereas the interaction Symmetry x Familiarly was significant, $F(2,80)=8,29$, $p<.001$. Sidak post-hoc tests indicated that LL unfamiliar faces were rated significantly more attractive than RR unfamiliar faces ($p<.001$) and RR familiar faces were rated as more attractive than LL familiar faces ($p<.001$). In addition LL unfamiliar faces were rated as more attractive than LL familiar faces ($p<.001$) and RR familiar faces were rated as more attractive than unfamiliar ones ($p<.001$).

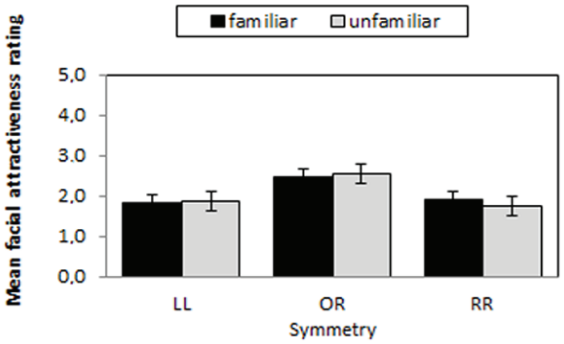

Figure 2. Mean rates of attractiveness of familiar and unfamiliar faces in three versions (asymmetric original, OR and two symmetric versions, left-left, LL, and right-right, RR).

Discussion

In the present study the effects of symmetry and familiarity on facial attractiveness ratings were investigated. The effect of familiarity was not obtained, but both the symmetry and familiarity/symmetry interaction was significant. The finding that symmetry is a stronger objective constraint of facial attractiveness than familiarity, is in line with our expectation, but is not consistent with the Halberstadt and associates' finding that familiarity prevails symmetry (Halberstadt et al., 2013). However, our results are not completely comparable with the Halberstadt and associates' findings, because the familiarity variable is differently defined in these two studies. In the Halberstadt and associates' study (2013) familiarity-unfamiliarity was defined as belongingness of the faces and their morphs to the participants' own nation (familiarity) or the other ("distant") nation (unfamiliarity). However, this "familiarity" was not based on the real previous experience with concrete faces (particularly not with the morphs!). It was rather based on a general impression that the own-nation faces (and the morphs made of them, as well) look more familiar than the other-nation faces. On the other hand, in our study familiarity was defined more strictly, as a result of the learning process: after repetitive exposure, faces are memorized and become familiar. Further studies should investigate the effects of different forms of familiarity on facial attractiveness more thoroughly. We can only speculate that this difference comes from the difference in affective charge of two forms of familiarity: belongingness to the own-nation is more affectively charged than the repetitive exposure. Unfortunately, the lack of related studies in this area prevents us to evaluate this hypothesis.

The effect of symmetrization on facial attractiveness was negative, as we expected: original asymmetric faces were rated as more attractive than both LL and RR symmetric versions. Namely, we supposed that LL and RR symmetrization would reduce the attractiveness, because it reduces the natural

look of the faces (cf. Knowner, 1996; see also, Little, 2014). In fact, this form of symmetrization confounds with artificiality. However, the opposite is not completely true: while normally or slightly fluctuating asymmetry can be attractive, extremely asymmetric faces (e.g. distorted or mutilated faces) certainly will not be experienced as beautiful and attractive, but rather as grotesque and repulsive.

Theoretically most intriguing findings are associated with the familiarity/symmetry interaction. Analysis indicated that, for unfamiliar faces, LL versions were rated as more attractive than RR ones. This result is consistent with previous studies in which the left bias was interpreted using a model of cortical lateralization: the left half of the observed face (i.e. right half the photographed person's face) is mostly projected onto the dominant right hemisphere, which is specialized for face processing (cf. Burt & Perrett, 1997; Gilbert & Bakan, 1973). However, for familiar faces the preferences for the two versions were inverted: RR versions were rated as more attractive than LL ones. This result cannot be explained by solely using a lateralization of face processing.

Interaction also reveals the opposite effect of familiarity on two symmetric versions of the faces: for LL versions unfamiliar faces were rated as more attractive than familiar ones, whereas for RR versions familiar faces were rated as more attractive than unfamiliar ones. Although the additional studies are needed to properly understand the nature of this interaction, we can propose some tentative directions for future researches. According to the Processing fluency theory aesthetic preference (including the facial attractiveness as well), is a consequence of fluent (fast and easy) information processing (cf. Winkielman & Cacioppo, 2001). This theory predicts that both symmetry and familiarity should increase the processing fluency (or processing economy), but our results show that the effects of the two features were neither expected nor simply additive (symmetry + familiarity). Artificially symmetrized (i.e. perfectly structured) natural objects, such as the LL and RR facial chimeras, look unusual and artificial, and therefore, they are more demanding for processing than natural slightly asymmetric faces. In other words, the role of symmetry in processing fluency and attractiveness should be redefined and specified differently for natural and artificial stimuli: symmetry perhaps increases the fluency of artificial stimuli processing, but it decreases the fluency of the natural ones. In addition, having in mind that LL versions of symmetrized faces look more natural or more similar to the original asymmetric faces than the RR versions (cf. Burt & Perrett, 1997; Gilbert & Bakan, 1973), one can speculate that familiarity interferes negatively with LL and positively with RR versions. Namely, LL versions generated from the familiar faces decrease the fluency because the dominant right hemisphere confounds the previously seen and memorized faces with their LL versions. On the other hand, the non-dominant left hemisphere is not confused with the RR version created from the familiar original faces. Nevertheless, all these hypothetical explanations should be thoroughly and fully evaluated in the future studies.

The present study suggests that the roles of symmetry and familiarity in the facial attractiveness ratings are not simple and nor clear. First, it is difficult, if not impossible, to separate symmetry from other stimulus characteristics. Like in the morphing technique, where the symmetry is confounded with averageness, LL and RR symmetrization is confounded with the violation of specific facial proportions and features. In other words, it is not quite clear whether the reduced attractiveness of symmetrized faces comes from the lower preference for symmetry itself or it is only a negative aesthetic effect of artificiality. We argued that the more plausible hypothesis is natural/artificial look, but in order to evaluate it, future studies should be done. In addition, a whole research project would be necessary to investigate specific roles and the interactive effect of different stimulus constraints (symmetry, artificiality, facial proportions etc.) and cognitive factors (different forms of learning effects, mere exposure, the familiarity of friends' faces, faces of celebrities etc.).

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