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Domagoj Švegar*

What does facial symmetry reveal about health and personality?

Abstract: Over the last two decades, facial symmetry has been intensively researched. The present article aims to summarize empirical research concerning relations between facial symmetry and health and facial symmetry and personality. A systematic review of the literature shows that facial symmetry is one of the most influential visual markers of attractiveness and health, important for mate selection, while asymmetry can be considered a consequence of an individual's inability to resist environmental and genetic stressors during development of the organism. However, in spite of evidence suggesting that preferences for facial symmetry are deeply rooted in our evolutionary history, a strong connection between facial symmetry and health is demonstrated only in studies measuring perceived health, while there is only scarce evidence corroborating the link between symmetry and actual health. The interconnections between facial symmetry and personality have not yet been extensively researched. Less than a dozen studies have addressed that issue and they have reached different conclusions. Some evidence suggests that facial symmetry signals personality attributes that indicate good psychological health, while other findings imply that pro-social personality traits negatively correlate with facial symmetry.

Key words: facial symmetry, health, personality, attractiveness, meta-analysis

Introduction

The human perceptual system is especially sensitive to facial asymmetries (Anderson & Gleddie, 2013). While symmetry in human faces has been suggested to be a cue to heritable fitness benefits, fluctuating asymmetry, which is defined as a small random departure from symmetry in traits that are bilaterally symmetrical at the population level, reflects maladaptation (Thornhill & Gangestad, 1999). One group of theories considers asymmetry to be a consequence of an individual's inability to resist environmental stressors (such as poor habitat quality, inadequate nutrient intake, toxins or parasitism) and genetic stressors (for example mutations or hybridization) during development of the organism (Gangestad & Simpson, 2000; Little et al., 2008; Özener & Fink, 2010; Waitt & Little, 2006). Organisms which manage to resist and maintain symmetric development in spite of such stressors are considered as superior quality individuals. Thus, those individuals who preferentially select more symmetric mates are expected to gain direct benefits by reducing

pathogen transmission to themselves from infected individuals or indirect benefits by providing offspring with heritable resistance to pathogens (Waitt & Little, 2006). Other theories consider facial symmetry in the context of biological recognition system (Waitt & Little, 2006). According to such a viewpoint (e.g. Enquist & Arak, 1994), symmetry preferences did not evolve because they relate to a signaler's quality, but as a consequence of perceptual biases in our biological recognition systems (Waitt & Little, 2006). In line with this idea, generalization over the range of stimuli leads to a preference for symmetry (Enquist & Johnstone, 1997). Since individual features and images are often not symmetrical, generalizing over the range of variations allows an individual to respond to similar stimuli in a consistent manner, and one consequence of such a process is that average symmetrical traits are preferred over traits showing asymmetry (Waitt & Little, 2006). Such recognition system theories and theories that associate facial symmetry to mate quality are not mutually exclusive.

* Department of Psychology, Faculty of Humanities and Social Sciences, University of Rijeka

Correspondence address: Filozofski fakultet u Rijeci, Sveučilišna avenija 4, 51000 Rijeka, Croatia. Email: dsvegar@gmail.com

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Facial symmetry and attractiveness

Facial symmetry is an important visual aspect of facial attractiveness (e.g. Anderson & Gleddie, 2013; Quist, Watkins, Smith, Little, DeBruine & Jones, 2012; Rhodes & Simmons, 2007). In a recent study, Quist et al. (2012) investigated symmetry preferences using symmetrized and relatively asymmetric original photographs of faces and found that women generally prefer symmetric men and label them as more attractive than asymmetric ones. Facial symmetry is found attractive even in non-human primates (Waitt & Little, 2006) and human children (Vingilis-Jaremko & Maurer, 2013). When adult rhesus macaques are presented with computer-manipulated images of symmetrical and asymmetrical versions of opposite-sexed conspecific faces, significant preferences for symmetry are found (Waitt & Little, 2006). Similarly, in a study conducted on human children, Vingilis-Jaremko & Maurer (2013) discovered that the impact of symmetry on attractiveness ratings emerges after the age of 5 years, and matures after the age of 9 years. Facial attractiveness ratings are similar across gender, sexual orientation and age, and although different societies do not place exactly the same value on all physical characteristics, there is an appreciable agreement in facial attractiveness assessments between various cultures and ethnic groups, even in studies including groups that do not have contact with Western standards of beauty (Rhodes, Zebrowitz, Clark, Kalick, Hightower & McKay, 2001; Thornhill & Gangestad, 1999). Attractiveness can thus be considered to be a visual marker of good genes and health (Jones, Little, Penton-Voak, Tiddeman, Burt & Perrett, 2001), which seems to have evolved because of mate preference for healthy fertile mates (Symons, 1979). It is precisely symmetry that is one of the most important traits related to mate selection in many animals (Perrett, Burt, Penton-Voak, Lee, Rowland & Edwards, 1999; Thornhill & Gangestad, 1999). Therefore, it seems that human preferences for facial symmetry are deeply rooted in our evolutionary history (Waitt & Little, 2006).

The good gene sexual selection theory presumes that animals and humans prefer mates who possess indicators of good health that might be passed on to their mutual offspring (Gangestad & Simpson, 2000). According to this view, individuals with a preference for symmetrical faces leave behind more offspring than others, and thus preferences for symmetry have increased in a population (Little, 2014). If the good gene theory is valid and mate preferences have evolved to favor healthy individuals due to direct and indirect benefits, then attractiveness judgments should reflect judgments of health (Grammer & Thornhill, 1994; Jones et al., 2001). Furthermore, if symmetry is one of the most important traits related to mate selection, symmetric individuals should be perceived as more attractive and healthy.

Findings of various studies are in accordance with this suggestion. Among the first authors who demonstrated that facial symmetry has a positive influence on facial attractiveness and health ratings were Grammer and

Thornhill (1994). They generated computer images of male and female faces and of composites of faces for each sex, differing in symmetry and averageness. When these images were presented to participants, whose task was to rate attractiveness, dominance, sexiness and health of each of the faces on a Likert-type scale, it was clearly found that facial symmetry is perceived as a sign of attractiveness and also as a signal of health. A correlation between facial symmetry and perceived attractiveness was also observed in various later studies by Baudouin and Tiberghien (2004), Fink, Neave, Manning and Grammer (2006), Hume and Montgomerie (2001), Jones et al. (2001), Jones, Little, Burt and Perrett (2004), Komori, Kawamura and Ishihara (2009), Little, Apicella and Marlowe (2007), Mealey, Bridgestock and Townsend (1999), Perrett et al. (1999), Rhodes et al. (2007); Rhodes, Proffitt, Grady and Sumich (1998), Rhodes, Sumich and Byatt (1999) and Rhodes, Yoshikawa, Clark, Lee, McKay and Akamatsu (2001).

Although some authors have not found a positive correlation between facial symmetry and attractiveness (Kowner, 1996; Langlois, Roggman & Musselman, 1994; Noor & Evans, 2003; Samuels, Butterworth, Roberts, Graupner, & Hole, 2013; Scheib, Gangestad & Thornhill, 1999; Swaddle & Cuthill, 1995; Zaidel, Aarde & Baig, 2005; Zaidel & Cohen, 2005), when all the studies concerning the relation between facial symmetry and health are considered, there is enough evidence to conclude that individuals with symmetric faces are perceived as attractive (Little, 2014; Rhodes, 2006). A positive correlation between facial symmetry and attractiveness was not observed only in those studies that used digitally manipulated faces as stimuli because of certain methodological imperfection. In such studies, symmetric faces were created by cutting original faces through the vertical midline and reflecting each hemiface in order to create two perfectly symmetric chimeras. Faces created in such a manner often display certain structural abnormalities, such as atypical eye spacing or unnatural nose wideness, that make them less average and consequently less attractive because averageness is strongly associated with attractiveness (Little, 2014; Rhodes, 2006).

Facial symmetry and health

Besides finding that facial symmetry positively correlates with attractiveness ratings, within the same study, Grammer and Thornhill (1994) also discovered that individuals with symmetric faces are perceived as more healthy. Their results were replicated and extended in a study by Shackelford and Larsen (1997), who investigated the relationship between facial asymmetry and health in two samples of undergraduates. While Grammer and Thornhill (1994) investigated perceived health, Shackelford and Larsen (1997) used self-reports, observer ratings, daily diary reports and psychophysiological measures in order to explore actual as well as perceived health. This was one of the first studies examining the actual physical, psychological or emotional health correlates of facial symmetry. Within the study, Shackelford and Larsen (1997)

collected participants' photographs in order to assess their facial symmetry. These photographs were also administered to independent observers, who were required to rate certain personality traits, attractiveness and health of the subjects. During a period of two months, participants had to complete daily measures of their physical, psychological and emotional health status, while their general cardiovascular fitness was objectively measured via cardiac recovery time after exercising. Data analysis showed that facial asymmetry signals psychological, emotional and physiological distress. In both of the samples, male participants with high facial asymmetry were more depressed and emotionally labile than men with low facial asymmetry, while female participants displaying greater facial asymmetry complained about more muscle soreness and cramping than facially symmetrical women. Although other connections of symmetry and health were found in only one of the samples, when all the results are considered, it can be concluded that compared to facially symmetrical participants, asymmetrical ones report more physiological, psychological and affective problems and that their photographs were rated as being less healthy (Shackelford & Larsen, 1997). These findings support the hypothesis that facial symmetry signals good genes. Furthermore, Shackelford and Larsen (1997) concluded that the relationship between facial symmetry and health is stronger for men, which is also consistent with the good gene theory as well as the parental investment theory.

Similarly as Grammer and Thornhill (1994), Shackelford and Larsen (1997) also found that individuals with symmetric faces are at the same time perceived as attractive as well as healthy. However, these results could also be explained by a halo effect of attractiveness (Penton-Voak et al., 2001). Indeed, in thorough meta-analyses, Feingold (1992) revealed that physically attractive people are perceived not only as more healthy, but also as more sociable, popular, dominant, sexually warm, intelligent, socially skilled and sexually experienced than physically unattractive people. In another meta-analytic review, Langlois, Kalakanis, Rubenstein, Larson, Hallam and Smoot (2000) showed that attractive individuals are judged and treated more positively than unattractive ones. In line with these meta-analyses, Henderson and Anglin (2003) and Kalick, Zebrowitz, Langlois and Johnson (1998) have also provided evidence to support the conclusion that healthy people are perceived as attractive. When all the results are considered, it is possible that the relation between symmetry and health observed by Grammer and Thornhill (1994) and Shackelford and Larsen (1997) is just a reflection of a strong attractiveness halo effect, whereby health as a positive trait is indiscriminately attributed to attractive individuals (Rhodes, 2006). This research question was investigated by Jones et al. (2001), who made an attempt to rule out the halo effect explanation. In the first experiment, they discovered that ratings of attractiveness as well as ratings of health positively correlate with facial symmetry. Further analysis revealed that the relationship between facial symmetry and perceived health remained unchanged when attractiveness was statistically controlled.

In a second experiment in the same study, Jones et al. (2001) manipulated facial symmetry and discovered that health ratings improve when facial symmetry is increased. Since all these results are not consistent with Penton-Voak et al.'s (2001) suggestion that the correlation between perceived health and facial symmetry is caused by an attractiveness halo effect, Jones et al. (2001) concluded that perceptual analysis of symmetry can be considered as an adaptation that facilitates discrimination between potential mates on the basis of apparent health, in line with good gene theory.

Following a similar research question as Grammer and Thornhill (1994) and Shackelford and Larsen (1997), Rhodes et al. (2001) used morphing techniques to alter the averageness and symmetry of individual faces and found that perceived health correlates positively with facial symmetry. However, in a second study, conducted on individuals whose detailed medical records were available, it was found that correlation between symmetry and health is limited only to perceived health. With an exception of a marginally significant correlation between measured facial asymmetry and health in mid-adult females, facial asymmetry was not associated with actual health scores (Rhodes et al., 2001).

Rhodes (2006) claimed that many studies reported a positive correlation between facial symmetry and perceived health, whilst only a few found any kind of evidence that corroborated that facial symmetry signals actual health (Rhodes, 2006). For example, although Shackelford and Larsen (1997) found a positive relation between facial symmetry and self-reported health symptoms, Rhodes (2006) argued that these correlations could be the consequence of a type I statistical error because more than 1000 correlations were examined and most of the significant findings occurred only in one of the samples. In another study Hume & Montgomery (2001) found no relation between facial symmetry and self-reported health symptoms. Moreover, neither Hönekopp, Bartholomé and Jansen (2004) nor Tomkinson and Olds (2000) have found any clear associations between facial symmetry and self-reported health symptoms or physiological fitness, while Dykiert, Bates, Gow, Penke, Starr and Deary (2012) reported that facial symmetry is not associated with mortality risk in a sample of participants with a mean age of 83.3, who were followed during a 7-year period. In the most recent and also the most extensive study addressing facial symmetry and actual health, Pound, Lawson, Toma, Richmond, Zhurov and Penton-Voak (2014) derived detailed individual health records from a large longitudinal study. The sample consisted of 4732 children whose health status was assessed at 6, 8, 18, 30, 42, 81, 91, 103 and 128 months of age. Photographs of the subjects were obtained in order to analyze facial symmetry. Health reports included information about height, weight, infections (measles, chicken pox, mumps, meningitis, cold sores, whooping cough, urinary infection, eye infection, chest infection, tonsillitis or laryngitis, German measles, scarlet fever, influenza, cold, glandular fever), some other symptoms of

illness (e.g. diarrhoea, vomiting, cough, high temperature, cold, earache, colic or stomach ache, rash, wheezing, breathlessness) and intelligence, which was tested at age 8. Thorough analyses revealed that none of the health measures were associated with facial symmetry, so Pound et al. (2014) concluded that variations in facial symmetry are not related to variations in health during childhood. However, they detected a small but significant positive correlation between facial symmetry and intelligence.

On the other hand, confirmation connecting facial symmetry and health in humans was provided by Hoyme (1993) and Thornhill and Möller (1997) who described the positive correlation between facial asymmetries and certain chromosomal disorders (Rhodes, 2006). In another study, Thornhill and Gangestad (2006) asked young men and women to self-report their respiratory and intestinal infections, the total duration of each type of infection, and antibiotic use over the last 3 years and revealed a relation between self-reported health symptoms and facial asymmetry. Facial asymmetry was associated with respiratory but not with intestinal infections. Furthermore, it was found that the frequency of antibiotics application can also be predicted by facial asymmetry, since these two variables were in low positive correlation (Thornhill & Gangestad, 2006). In addition, Safeck and King (2007) reported that facial asymmetry positively correlates with negative health symptoms and negatively correlates with the general health of chimpanzees, while Little, Paukner, Woodward and Suomi (2012) found that symmetric rhesus macaques are healthier than more asymmetric ones. Finally, the results of two more studies provide indirect support to the hypothesis that facial symmetry signals actual health. In the first of them, Özener and Fink (2010) analyzed facial symmetry of two groups of students differing in socioeconomic status. One group was recruited from a slum district and another from a wealthy urban area. Subjects living in the slum district were found to have higher facial asymmetry than students from a prosperous urban district. Furthermore, Hope, Bates, Penke, Gow, Starr and Deary's (2013) also detected that poorer socioeconomic status during childhood is significantly associated with lower facial symmetry. Since health and socioeconomic status positive correlate, Özener and Fink (2010) and Hope et al. (2013) speculate that their findings also indirectly support the hypothesis that facial symmetry signals actual health.

However, in spite of the small number of studies that found a relation between symmetry and actual health, Little et al. (2008) emphasized that any link between symmetry and genetic quality, no matter how weak, may be sufficient to create a selection pressure to choose symmetric mates. A significant contribution to their claim was provided by Young, Sacco and Hugenberg (2011), who investigated whether disease concerns influence preferences for symmetric faces. They speculated that an increase of perceived vulnerability to disease would elevate preferences for symmetric faces because they are considered as a cue to good health and pathogen resistance. In one of their experiments, Young et al.

(2011) simply measured disease concerns as an individual difference variable, while in another one that variable was situationally primed. Analyses revealed that in both experiments elevated disease sensitivity was positively associated with a preference for symmetric faces, so Young et al. (2011) proposed a domain specific adaptive mechanism developed in order to avoid disease. In a similar study, Little, DeBruine and Jones (2011) also discovered that preference for facial symmetry is moderated by exposure to visual cues of environmental pathogens. In line with Young et al. (2011) findings, preference for symmetrical opposite sex faces was higher after exposure to such cues. In another study it was demonstrated that facial symmetry is perceived as attractive in United Kingdom and in Tanzania, but is much more preferred by Tanzanian tribes than by British participants (Little et al., 2007). Similarly, Watkins, Jones, Little, DeBruine and Feinberg (2012) demonstrated that the sex ratio of the local population influences women's preferences for facial symmetry. Preferences for symmetrical male faces were positively related with the proportion of males in local population (Watkins et al., 2012).

The above mentioned findings demonstrate that even a small association between facial symmetry and actual health results in preferences for facial symmetry and that such a preference especially increases when the number of potential competitors for mates in the local population is high or in case of high pathogen prevalence.

Meta-analysis of the relationship between facial symmetry and health

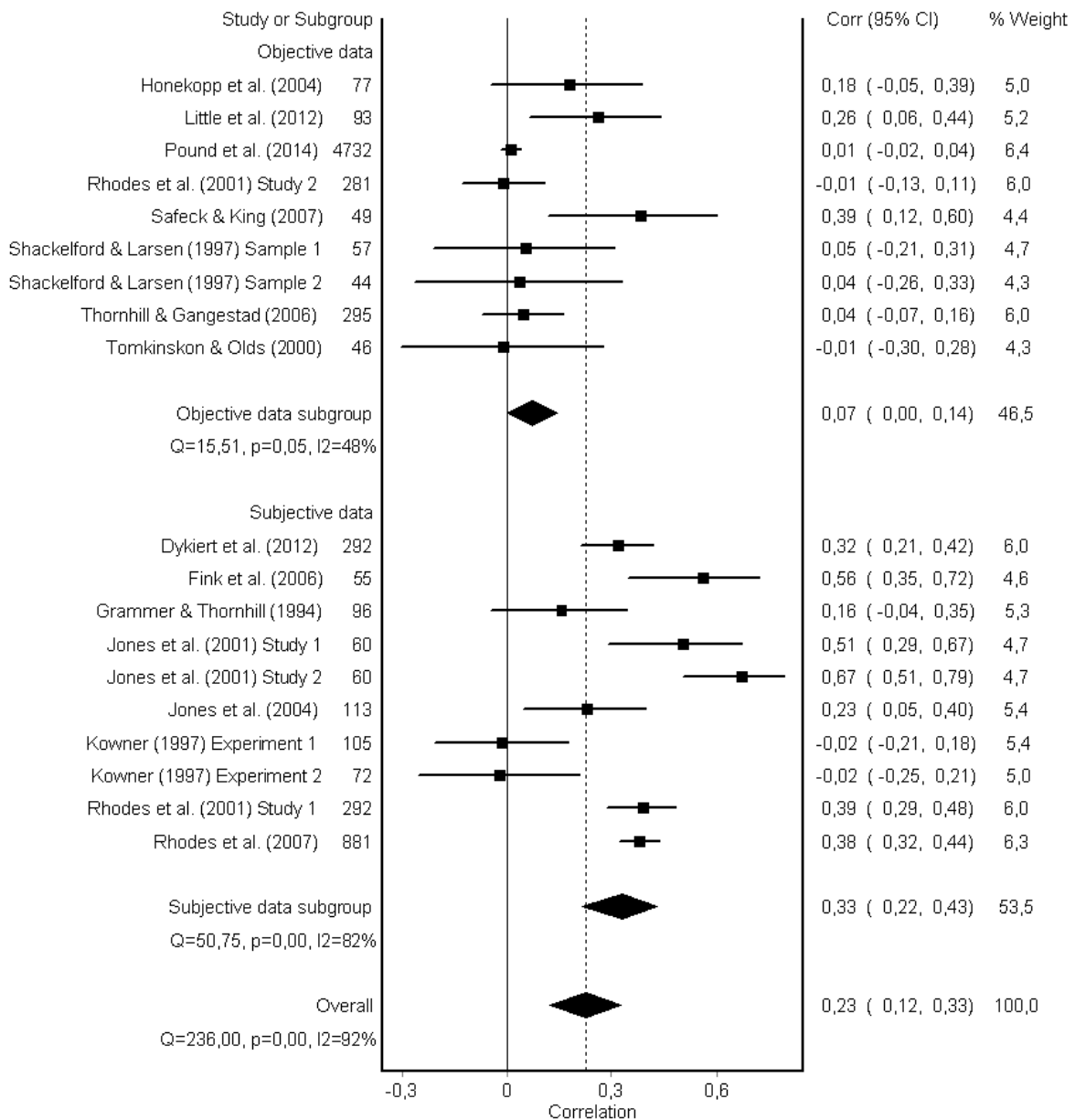
In order to systematically evaluate the findings of previous studies concerning the relation between facial symmetry and health, a meta-analysis was conducted. Since prior research suggests that the association between facial symmetry and health is strong when perceived health is considered but weak when actual health is measured, the type of health assessment (on two levels: perceived and actual) was entered into the meta-analysis as a moderator variable. In order to select the studies for the meta-analysis, three steps were made in the search. In the first step, the following data-bases were searched for articles containing items *health* and *facial symmetry* or *facial asymmetry*: *Web of Science*, *Scopus*, *ResearchGate* and *Wiley Online Library*. After this initial search, reference lists of articles retrieved in the previous step were checked in order to find other studies relevant for the meta-analysis. Finally, articles that cited all the studies retrieved in the first two steps were checked. After all the relevant articles were retrieved, some of them were excluded according to the following criteria: if they did not contain qualitative data (e.g. case reports or review articles), if they did not actually use measures of health but certain variables that positively correlated with health (e.g. socio-economic status) or if measures of facial symmetry could not be distinguished from measures of other facial characteristics or from body symmetry measures. Finally, one of the studies (Study 2 by Rhodes et al., 2001) contained perceived and actual

health measures of the same participants. These measures could not be combined for the purpose of this meta-analysis because they represent different levels of the moderator variable. Since it would not be appropriate to enter the results obtained from the same participants twice, only actual health scores were included into the meta-analysis as a more valuable, objective measure. After the above described search and filtering procedures were conducted, a total of 19 studies were selected for meta-analysis: 9 with actual and 10 with perceived health measures. Since most of the studies reported correlation coefficients between facial symmetry and health, the results of other studies were also transformed to correlation coefficients. In studies with multiple health outcome measures, the average correlation coefficient between facial symmetry and health was computed without placing any ponder weights to certain health outcome measures. Whenever

the results were presented separately for male and female participants within the same study, an average correlation coefficient was computed with respect to sample sizes. All final raw correlation coefficients were subjected to Fisher *z* transformation within the meta-analysis. Since heterogeneity across studies was high, random effect model was applied. Meta-analysis was conducted using *MetaXL* tool in *Microsoft Excell*.

The results of the meta-analysis are presented in Figure 1. As expected, the overall correlation between health and facial symmetry across all 19 studies was significant and positive ($r = .23$; 95% CI = 0.12–0.33; $p < .01$). Furthermore, the type of health assessment was a significant moderator to explain the variation between the studies. The relationship between facial symmetry and perceived health was moderately strong ($r = .33$; 95%CI = 0.22–0.43; $p < .01$), while the correlation

Figure 1. Meta-analysis of the relationship between facial symmetry and health



between facial symmetry and actual health was very low but significant ($r = .07$; 95%CI = 0.00–0.14; $p = .05$).

In other words, this meta-analysis revealed that individuals with high facial symmetry are actually just slightly healthier but are perceived as much healthier than less symmetrical people, which is in line with the evolutionary hypothesis that weak association between symmetry and genetic quality is sufficient to create a selection pressure to choose symmetrical mates (e.g. Little et al., 2008).

Facial symmetry and personality traits indicating good psychological health

If facial symmetry reflects not only physical, but also psychological health, then facial asymmetry should be associated with higher scores on personality traits that indicate psychological or emotional distress. The first authors who pursued this research question and attempted to investigate if facial symmetry signals emotional health or positive personality characteristics were Shackelford and Larsen (1997), whose study was described in detail earlier in this review. Within that correlational study, the relationship between facial symmetry, personality measures, diary reports of behavior and observer ratings of personality traits were analyzed among other measures of health outcomes. It was found that individuals with asymmetrical faces were rated as more neurotic, emotional, angry and anxious, than symmetrical ones, who were assessed as more agreeable and conscientious.

The second study investigating the relation between facial symmetry and personality was conducted by Noor and Evans (2003). In order to examine whether facial symmetry has a causal effect on personality perception, specifically on the domains of the five-factor model (Costa & McCrae, 1992; McCrae & Costa, 1997), they experimentally manipulated symmetry in photographs of female targets into symmetrical and asymmetrical versions and presented them to participants together with the original photographs. Similar to the findings of Shackelford and Larsen (1997), the asymmetrical faces were rated as more neurotic, less agreeable and less conscientious, while facial symmetry did not affect ratings of openness and extraversion (Noor & Evans, 2003).

Following the research of Shackelford and Larsen (1997) and Noor and Evans (2003), Fink, Neave, Manning and Grammer (2005) aimed to extend their findings by investigating if the association between facial symmetry and actual personality characteristics follows the same pattern as the association between facial symmetry and perceived personality traits. They asked the participants to fill out a personality inventory and photographed their faces in order to assess the facial symmetry. In contrast to Shackelford and Larsen (1997) and Noor and Evans (2003), who concluded that agreeableness, and conscientiousness correlate positively with facial symmetry, Fink et al. (2005) found a negative association between facial symmetry and agreeableness and no correlation between symmetry and conscientiousness. Moreover, Fink et al. (2005)

discovered a negative association between facial symmetry and openness, and a positive correlation between facial symmetry and extraversion, while Noor and Evans (2003) reported that these two personality traits were not related to facial symmetry. The only finding of Fink et al. (2005) in line with the results of Shackelford and Larsen (1997) and Noor and Evans (2003) is the negative correlation between neuroticism and facial symmetry, but that correlation was only marginally significant. Fink et al.'s (2005) findings of a positive correlation between facial symmetry and extraversion, and a negative correlation between facial asymmetry and neuroticism, are in line with the hypothesis that facial symmetry is a cue for positive personality traits that indicate health. However, the negative associations between facial symmetry and both agreeableness and openness, found within the same study, suggest that facial symmetry reflects undesirable traits. Since prior to their study only two published reports addressed the relation between facial symmetry and personality, Fink et al. (2005) were very cautious in their interpretation of the contradictory findings and stated that further research is required before establishing any specific conclusions.

In another study, Fink and his colleagues explored whether attractiveness moderates the association between facial symmetry and personality attributions (Fink et al., 2006). They presented facial images to participants, who were required to rate them using the following adjectives: attractive, healthy, sociable, intelligent, dominant, lively, careful, self-confident, balanced and anxious. The data revealed that highly symmetrical faces received more positive attributes than faces low in symmetry. Symmetrical faces were rated as more attractive, healthy, sociable, intelligent, lively, self-confident and balanced, while asymmetrical faces were rated as more anxious. Even when attractiveness ratings were analyzed as covariate, the results remained almost unchanged, suggesting a direct positive correlation between facial symmetry and positive personality characteristics (Fink et al., 2006). On the basis of these results and the findings of several previous studies, Fink et al. (2006) explained the link between facial symmetry and personality in a similar way to the way that the relation between facial symmetry and health is explained. Since facial symmetry indicates individuals' quality, which is most relevant in social encounters and mate choice, individuals who choose symmetric partners will obtain mates that are able to provide better genes and resources to their offspring. Fink et al. (2006) claimed that such positive fitness effects are not only restricted to better physical health, but also to more positive personality characteristics. Fink et al. (2006) speculated that the mechanisms underlying associations between facial symmetry and positive personality traits may relate to the effect of sex steroids on the developmental processes of the face and on sex dependent aspects of personality. Specifically, hormones that affect growth rates and facial proportions, such as testosterone and estrogen (Gangestad & Thornhill, 2003), may suppress the immune system (Folstad & Karter, 1992) and therefore reduce facial

symmetry and ultimately affect personality (Fink et al., 2006).

Pound, Penton-Voak and Brown (2007) replicated Fink et al.'s (2005) study on a larger sample and found a significant positive correlation between facial symmetry and self-reported extraversion. However, they found no associations between facial symmetry and neuroticism, openness, agreeableness or conscientiousness. Chronologically, this was the fifth study that investigated the relationship between facial symmetry and personality. When the results of these studies are summarized, it can be concluded that they found some evidence that individuals with more symmetrical faces possess more healthy personality traits.

Facial asymmetry and pro-social personality traits

After the research of Pound et al. (2007), the focus changed in later studies concerning facial symmetry and personality. While earlier studies (published between 1997 and 2007) examined the association between facial symmetry and personality characteristics that indicate health, more recent studies (published after 2007 till today) aimed to investigate the relation between facial symmetry and aversive personality traits. The central concern of these more recent studies was to evaluate two novel hypotheses: the reactive heritability hypothesis and the shared heritability hypothesis, which predict that socially aversive traits are positively associated with facial symmetry.

According to the reactive heritability hypothesis, the development of aversive social traits is influenced by facial symmetry because individuals make inferences regarding their relative position in the population. The central idea of that standpoint is that facial symmetry influences the relative social position which consequently affects personality development (Holtzman et al., 2011). For example, extremely symmetrical people have a high potential value as romantic partners even if their behavior is socially aversive, while asymmetrical individuals have to employ pro-social behavior as a compensation for their lack of symmetry in order to establish relationships with potential partners (Holtzman et al., 2011; Little et al., 2011).

In contrast to such an indirect explanation, the shared heritability hypothesis presumes that symmetry and socially aversive traits are dually inherited (Holtzman et al., 2011). According to this hypothesis, symmetry is a moderately heritable indicator of fitness (Johnson, Gangestad, Segal & Bouchard, 2008) linked to short-term mating (Thornhill & Gangestad, 1994), which is preferred by socially aversive individuals (Holtzman et al., 2011). Therefore, symmetry is continuously selected in a short-term mating context and preference for short-term mating is reinforced by socially aversive traits, so the human short-term mating context provides a selection pressure for both symmetry and socially aversive traits (Holtzman et al., 2011).

Results obtained by Holtzman et al. (2011), who inspected the relationships between more than 200 personality variables and facial symmetry are in accordance with the hypotheses that pro-social traits negatively correlate with facial symmetry. They found a negative correlation between facial symmetry and variables such as calmness, socialization, responsibility, amicability, trust, tough-mindedness, empathy and good attachment; while aggression, depression, anxiety, self-consciousness, angry hostility, worry and pessimism, impression management, stress reaction and alienation were positively related to facial symmetry. The big five personality traits were also measured within the same study. Positive correlations were found between neuroticism and facial symmetry and amongst agreeableness and facial asymmetry. Holtzman et al. (2011) indicated that their results are in line with previous findings suggesting that intrasexual competitiveness (Simpson, Gangestad, Christensen, & Leck, 1999), antisociality (Lalumière, Harris, & Rice, 2001) and dominance (Grammer & Thornhill, 1994) are positively linked to symmetry (Holtzman et al., 2011).

Shortly after the study of Holtzman et al. (2011), Muñoz-Reyes, Gil-Burmann, Fink and Turiegano (2012) investigated the relationship between facial symmetry and different aspects of self-reported aggression in a large sample of adolescents, whose photographs were taken within the study. In line with the results and conclusions of Holtzman et al. (2011) who reported positive associations between socially aversive traits and physical symmetry, Muñoz-Reyes et al. (2012) found positive correlation between facial symmetry and hostility and also between facial symmetry and anger. As well as Holtzman et al.'s (2011) findings, these results also fit well with the previously illustrated reactive heritability and shared heritability explanations provided by Holtzman et al. (2011).

The most recent study regarding the association between facial symmetry and personality was conducted by Borráz-León and Cerda-Molina (2015). In order to investigate the relationship between facial symmetry and dominant and assertive personalities, they collected data from 100 male students and analyzed correlations between these variables. Assertive personality was positively related with facial symmetry while dominant personality and facial symmetry did not correlate. These findings are not in accordance with the results of Holtzman et al. (2011) and Muñoz-Reyes et al. (2012), who found that facial symmetry is positively related to anger and hostility but negatively related to pro-social personality traits.

Therefore, two out of three recent studies concerning facial symmetry and personality are in accordance with the reactive and the shared heritability hypotheses, while five earlier studies were not designed to not evaluate these hypotheses. Nevertheless, although these earlier studies pursued different research questions, the big five personality traits were assessed within four of them. Amongst these traits, agreeableness is of central interest for the reactive and the shared heritability hypotheses,

Table 1. Associations between facial symmetry and pro-social or hostile personality traits

Study (authors/publication year)	Personality trait	Correlation with facial symmetry	Type of trait assessment
Shackelford & Larsen (1997)	agreeableness	positive	perceived by raters
Noor & Evans (2003)	agreeableness	positive	perceived by raters
Fink et al. (2005)	agreeableness	negative	self-report
Fink et al. (2006)	dominance	no relation	self-report
Pound et al. (2007)	agreeableness	no relation	self-report
Holtzman et al. (2011)	pro-social traits	negative	self-report
Muñoz-Reyes et al. (2012)	aggression/anger	positive	self-report
Borráz-León & Cerda-Molina (2015)	dominance	no relation	self-report

which both predict that facial symmetry should be negatively associated with agreeableness. In two of these four studies (Shackelford & Larsen, 1997; Noor & Evans, 2003) facial symmetry was in positive correlation with agreeableness, contrary to the reactive and the shared heritability hypotheses. In one of the remaining two studies, agreeableness was negatively associated with facial symmetry (Fink et al., 2005), while in the other one these two variables were not related (Pound et al., 2007). All these findings are summarized in Table 1.

As displayed in Table 1, facial symmetry was positively associated with pro-social traits only in two of eight studies. The results of these two studies (Noor & Evans, 2003; Shackelford & Larsen 1997) are therefore contrary to the reactive and the shared heritability hypotheses. However, personality traits were not measured via self-reports in only these two studies so it seems that individuals with symmetrical faces were perceived as more agreeable because of a halo-effect. Since facial symmetry is positively associated with attractiveness, more symmetrical individuals were considered to have more desirable personality characteristics. When these two studies are excluded from consideration, half of the remaining studies reported negative correlation between pro-social traits and facial symmetry (Fink et al., 2005; Holtzman et al., 2011; Muñoz-Reyes et al., 2012) which is in accordance with the reactive and the shared heritability hypotheses, while in the other three studies (Borráz-León & Cerda-Molina, 2015; Fink et al., 2006; Pound et al., 2007) no significant correlation was observed between facial symmetry and pro-social personality traits (Table 1).

When the results of all the studies that explored the associations between facial symmetry and health are summarized, it can be concluded that they provide some evidence supporting the hypothesis that individuals with more asymmetrical faces possess more pro-social personality traits. At the same time, these studies also give some support to the hypothesis that individuals with more symmetrical faces possess more healthy personality traits. However, these hypotheses are not in direct contradiction.

For example, the hypothetical finding that facial asymmetry is positively associated to neuroticism and agreeableness would fit well into both of them.

Conclusions

Facial symmetry signals attractiveness and good health, while asymmetry reflects an individual's inability to resist environmental and genetic stressors. However, within this present study, a strong link between facial symmetry and health was observed only in those studies measuring perceived health, while evidence corroborating the connection between facial symmetry and actual health is scarce. The present meta-analysis demonstrates that the correlation between perceived health and facial symmetry is positive and moderately strong ($r = .33$), whilst the correlation between facial symmetry and actual health is also positive but very weak ($r = .07$). This is in line with the evolutionary hypothesis suggesting that even a very weak connection between symmetry and health is sufficient to create high preferences for symmetrical individuals.

According to the hypothesis that facial symmetry indicates health, facially asymmetrical individuals are more likely to possess personality traits that indicate psychological or emotional distress than symmetrical individuals. The other two plausible hypotheses, the reactive heritability and the shared heritability hypotheses, predict that facial symmetry positively correlates with aversive traits. According to the reactive heritability hypothesis, development of pro-social traits is influenced by facial symmetry because only asymmetrical individuals are required to employ pro-social behavior in order to compensate for their facial asymmetry, which makes them look less attractive and less healthy. The shared heritability hypothesis presumes that symmetry and socially aversive traits are dually inherited because symmetry is continuously selected in the short-term mating context and a preference for short-term mating is reinforced by socially aversive traits. A review of the research published up until today suggests that the relation between facial symmetry and personality is ambiguous. While some studies support

the hypothesis that facial symmetry indicates healthy personality traits, others provide evidence that pro-social traits positively correlate with facial asymmetry. However, these two hypotheses are not mutually exclusive and future research should aim to examine them more thoroughly.

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