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Facial attractiveness: General patterns of facial preferences

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ABSTRACT This review covers universal patterns in facial preferences. Facial attractiveness has fascinated thinkers since antiquity, but has been the subject of intense scientific study for only the last quarter of a century. Many facial features contribute to facial attractiveness: Averageness and symmetry are preferred by males and females, probably because they signal genetic quality and developmental stability. Men prefer highly feminized female faces because they reflect high estrogen levels and low testosterone levels. This indicates that the woman is reproductively healthy. Women, on the other hand, prefer a moderate level of male facial masculinity, since facial masculinity that is too pronounced signals high level of testosterone and, thereby, a poorly developed pro-family personality. In women, facial hair is detrimental to facial attractiveness. In men, the effect is not consistent. Faces with a clear complexion are attractive to both men and women. Men prefer light and smooth skin in women. Positive facial expressions also enhance facial attractiveness. Many factors, in particular skin condition and facial proportions, affect perceived age, which is an important component of facial attractiveness. Men in particular strongly prefer youthful-looking female faces. Facial preferences enable an individual to recognize reproductively fit mates. Therefore, facial preferences are adaptive, although non-adaptive mechanisms related to general brain function also play a role.

KEY WORDS: physical attractiveness, facial esthetics, human face, beauty

Everything is in the face
Cicero

Facial attractiveness is something that is intuitively perceived rather than measurable with instruments. Until recently, facial attractiveness was more a subject of interest for artists and philosophers than for scientists. However, physical attractiveness has proven to have such serious interpersonal and social consequences that science cannot exclude it from its realm of study. Moreover, scientific research on physical attractiveness is justified because it is connected to the

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features of the perceiver and the person perceived.

Physical attractiveness is assessed on the basis of different sensory data, e.g., voice, scent, appearance. The face is especially important, because it has many morphological elements, is the main channel of interpersonal communication and, in most cultures, is clearly visible.

It is impossible to precisely define physical and facial attractiveness. Nonetheless, an attractive face attracts the perceiver, the perceiver can make a judgment about it, tends to look at it, and wants to make contact with the owner. Usually, but by no means always, the contact desired is erotic in nature.

The author wishes to comprehensively review the current state of knowledge on the attractiveness of the human face. In the first of two parts, this review focuses on general, universal patterns of facial preference. Individual variation in preferences, of course, contribute substantially to attractiveness judgments, but will be presented separately, together with other issues not covered here. For this review, the following abbreviations will be used to avoid repetition: PA for physical attractiveness, and FacA for facial attractiveness.

History of research

Theoretical foundations

History of research on FacA has revealed three phases that differ in theoretical approach. During the first period, facial beauty was understood in a mathematical sense, that is, as specific proportions between elements of the face. This approach was proposed in the fifth century BC by the sculptor Polykleitos, who formulated the system of human body proportions which is now referred to as the classical system, or the canon. Among the many criteria for the ideal face were that the length of the ears should be equal to the length of the nose and that the distance between the eyes should be equal to the width of the nose. Ancient sculptors, beginning with Polykleitos and Phidias, also believed that the relationship between many pairs of measurements should be equal to the golden ratio (ϕ), which is approximately equal to 1.618 (the ratio of A to B conforms to the golden ratio if $(A+B)/A = A/B$).

During the Renaissance, this system was transformed and incorporated by Albrecht Dürer and Leonardo da Vinci into the neoclassical system. Since then, it has been widely used in the arts. However, research showed that the neoclassical system described neither the typical face nor the ideally beautiful face [FARKAS *et al.* 1987*b*, FARKAS 1994, BAKER and WOODS 2001]. Nowadays, most researchers have abandoned the geometrical approach to FacA since they no longer consider it correct nor even scientific at all. Nevertheless, this view is still propounded by some orthodontists and plastic surgeons [JEFFERSON 1996, 2004; MARQUARDT 2002].

Psychologists turned their interest to PA in the 1960s, after two myths about it were disproved. The first of these was that the perception of attractiveness is almost exclusively a matter of private taste and that there are no universal standards of beauty. This was supported by rigorous ethnographic research [FORD and BEACH 1951]. If this were true, there would be no basis for conducting scientific research on PA. This myth was disproved by studies involving many thousands of raters in the United Kingdom [ILIFFE 1960] and the United States [UDRY 1965] which showed wide agreement amongst the raters regarding their assessment of FacA ($r \approx 0.5$).

The second myth was that PA is of little social significance. This myth was disproved by WALSTER *et al*. [1966] who found that, after a blind-date, a person would want to date the other person again solely on the basis of PA. It appeared that the PA of a person influences many of the traits attributed to that person, and thus, how that person is treated by others. That is, perceivers appear to apply the stereotype of "what is beautiful is good" [DION *et al*. 1972].

In the 1970s and 1980s, these discoveries inspired hundreds of experiments on: (1) the consistency of various groups of raters in assessing PA; (2) the relationships between PA and perceived or actual psychological traits; (3) the difference between how physically attractive and physically unattractive people are treated. Although these studies revealed many interesting phenomena, they could not explain *why* one person is considered to be attractive and another not, and *why* something such as PA exists in the first place.

One of the co-authors of the theory of evolution, WALLACE [1889], connected PA with biological fitness. Curiously, DARWIN [1871] did not share this point of view. Instead, he proposed that mating preferences in humans and other animals are based on esthetics.

In the following decades, the biological and evolutionary approach to PA was abandoned because of its connotations with racism, colonialism and nazism. It generated renewed interest in the 1970s with the founding of the science of sociobiology and the development of sexual selection theory. In the 1970s, some arguments that PA is connected with reproductive ability, age, health and conspicuous sexual traits were put forth [EIBL-EIBESFELT 1970, GUTHRIE 1976, SYMONS 1979].

Further theoretical considerations, often based on the results of animal research, have led to the formulation of many testable hypotheses on FacA, including: (1) that an attractive face has average proportions, conspicuous sexual traits, a smooth skin, and symmetry; (2) that all these traits are signs of the good health and genetic quality of the owner; and (3) that the facial features that are perceived as attractive as well as the preferences for these features have been shaped during the course of biological evolution. Research based on the biological approach to FacA increased during the 1990s.

Research methods

For decades, the most common method of studying FacA was based on the assessment of faces in photographs by experimental subjects acting as judges. More recently, faces to be evaluated are frequently presented to the judges as computerized images. In some cases, judges were instructed to watch video films of the faces to be evaluated (e.g., RUBENSTEIN [2005]), or told to evaluate the faces of people in real life (e.g., KNIFFIN and WILSON [2004]), or instructed to imagine a person with specified traits, to assess attractiveness [WAGATSUMA and KLEINKE 1979, KOWNER 1998].

In the majority of studies, both the sample of judges and that of stimulus persons were students. In some studies, the faces represented were of beauty contest competitors [CUNNINGHAM 1986], models [JONES 1995, NGUYEN and TURLEY 1998, PETTIJOHN and JUNGEBERG 2004, YEHEZKEL and TURLEY 2004], and actresses [FERRARIO *et al.* 1995, PETTIJOHN and TESSER 1999], or in works of art [COSTA and CORAZZA 2006]. The judges were sometimes orthodontists or maxillofacial surgeons (e.g., MAPLE *et al.* [2005]), or pedophiles and rapists [MARCUS and CUNNINGHAM 2003].

Examples of recent developments in this research are: (1) assessment of FacA by judges over the internet (e.g., http://www.faceresearch.org), (2) analyses of the relationships between FacA and sex hormone levels [PENTON-VOAK and CHEN 2004, LAW SMITH *et al.* 2006, RONEY *et al.* 2006], or genetic makeup [THORNHILL *et al.* 2003; ROBERTS *et al.* 2005*a*, *b*].

In the past, researchers seeking correlations between FacA and facial traits sometimes used whimsical or ambiguous terminology (e.g., "Roman", "hawk" or "pug" noses in WAGATSUMA and KLEINKE [1979]). In the middle of the 1980s, researchers began to use the facialometric method, in which specified facial features such as distances and angles were measured with calipers on living people or photographs [MCARTHUR and APATOW 1983/1984; BERRY and MCARTHUR 1985, 1986; KEATING 1985; CUNNINGHAM 1986; KEATING and BAI 1986; FARKAS *et al.* 1987*a*; MCARTHUR and BERRY 1987; STRZAŁKO and KASZYCKA 1988, 1992]. Nowadays, these features are measured with the aid of special computer software programs. Few studies, however, have analyzed the relationship between FacA and the spatial locations of anthropometric points [FERRARIO *et al.* 1995].

Newer methods of describing facial shape include: (1) principal component analysis, which describes a face based on a number of mathematically calculated factors related to facial appearance in a global, rather than local, way [JOHNSTON *et al.* 2003, EISENTHAL *et al.* 2006, VALENZANO *et al.* 2006]; and (2) geometric morphometric methodology, which is based on the location coordinates of essential points, or landmarks, instead of on the distances between them [FINK *et al.* 2005*a*, VALENZANO *et al.* 2006].

In order to modify one specific feature of a face on a photo while leaving the other features intact, researchers have retouched photos [CARELLO *et al.* 1989] and computer images [LAENG *et al.* 2007], drawn stubble on models [MUSCARELLA and CUNNINGHAM 1996], or used drawings of faces with definite features in place of photos [BERRY and MCARTHUR 1986, REED and BLUNK 1990]. Judges have been allowed to portray their conception of the most attractive face by using sticks to form the face [HERSHON and GIDDON 1980], moving disks to denote eyes and lips [FRĄCKIEWICZ 2001], or even employing a system of hinged telescopic pipes [SERGL *et al.* 1998]. In the mid-1980s, researchers started to use facial drawings produced by superimposing transparent sheets with specific variations of each facial part (or an analogous computerized technique) [MCARTHUR and APATOW 1983/1984, KEATING 1985, VON FAUSS 1988].

An important approach to studies on FacA is the merging of two or more facial photographs. In the nineteenth century, Herbert Spencer superimposed semi-transparent sheets with facial photos, and Francis Galton developed a step-wise method of exposing a plate of different facial photos [GALTON 1878]. Over one hundred years later, LANGLOIS and ROGGMAN [1990] developed an analogous computerized method.

A turning point in studies on FacA was the development of computer warping and morphing. Warping is an elastic change of facial shape (Fig. 1). The process resembles localized pulling on the surface of a balloon with a face drawn on it. Morphing is a process of creating a face intermediate in shape and color between two other faces. The intermediate shape is obtained by the process of warping. The first studies on FacA based on these techniques appeared at the beginning of the 1990s [BENSON and PERRETT 1992, JOHNSTON and FRANKLIN 1993, PERRETT *et al*. 1994, KUJAWA and STRZAŁKO 1998]. The techniques themselves have been described by ROWLAND and PERRETT [1995] and TIDDEMAN *et al*. [2001]. By judiciously combining these techniques, the researcher can test many hypotheses on FacA.

Theories of facial attractiveness

Adaptation-oriented theories

There are two types of theories to explain why some faces are considered attractive and others not: adaptation-oriented theories and non-adaptation-oriented theories. The adaptation-oriented theories state that facial preferences are adaptations, that is, they arose by natural selection, and are therefore advantageous to their owner. Natural selec-

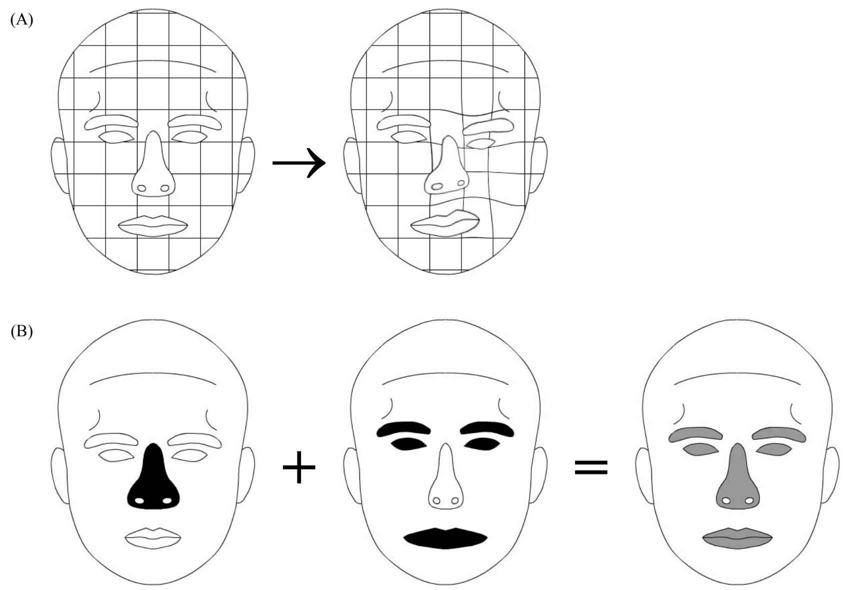

Fig. 1. Warping and morphing of a face. (A) Warping deforms a face in an elastic way. (B) Morphing blends two faces into an image with intermediate shape and color.

tion favored these preferences because an individual possessing them had higher reproductive success. Bonding or mating with a partner who is infertile, unhealthy or genetically loaded is disadvantageous to the individual. On the other hand, having a partner who is phenotypically and genotypically healthy is advantageous. An individual *X* has a high mate value (MV) for an individual *Y* if mating with individual *X* is more profitable for individual *Y* than mating with a random partner. The benefits may be direct or indirect. Direct benefits include investments by the partner in the interested individual and their common offspring. Indirect benefits include passing of good genes from the partner to the common offspring.

The main problem in mating is distinguishing an individual with a high MV from an individual with a low MV based solely on sensory input (Fig. 2). This is made even more difficult by the fact that the prospective partner has a reproductive interest in signaling a high MV, even when this is not the case. Therefore, there are reasons to cheat. There is also a risk of being cheated, and consequently, of losing out in terms of reproductive success. According to the concept of honest signaling, the co-evolution of signals and preferences for them leads to a situation where signals are reliable cues to the quality of the sender (see GANGESTAD and SCHEYD [2005]).

A prerequisite for the evolution of the face and preferences for facial features is that they are in part genetically determined. The coefficient of heritability ranges from 0.34 to 0.65 for various facial features [SUSANNE 1977] and amounts 0.64 for female FacA [MCGOVERN *et al.* 1996]. To the best of my knowledge, no studies on the heritability of preferences for facial features have yet been conducted even though heritability of mating preferences has been proved in animals [JENNIONS and PETRIE 1997].

However, for the adaptive view of facial attractiveness to be true, some conditions need not necessarily be met: (1) People need not be conscious of the adaptive value of their preferences. (2) Individuals possessing preferred traits need not be healthier in the broadest sense of the word, nor have a higher survival rate than others. Specifically, high quality individuals may invest so much energy in the development and the maintenance of traits preferred by the opposite sex that they have less energy for the development and the maintenance of other biological traits, such as immunity to disease [GETTY 2002]. (3) The preferences prevailing in contemporary westernized populations may differ from those that drove sexual selection in humans in the evolutionary past (because of changes in the environment). The above phenomena make it difficult to test the hypothesis that facial preferences are adaptive.

Non-adaptation-oriented theories

Non-adaptation-oriented theories state that preferences for specific facial features are by-products of phenomena that have little to do with the assessment of attractiveness. Therefore, these preferences are not adaptations and do not lead to the choice of a high-MV partner. Non-adaptive preferences may arise in several ways:

Overgeneralization. Assume that it is advantageous for an individual to respond with reaction R to stimulus S and

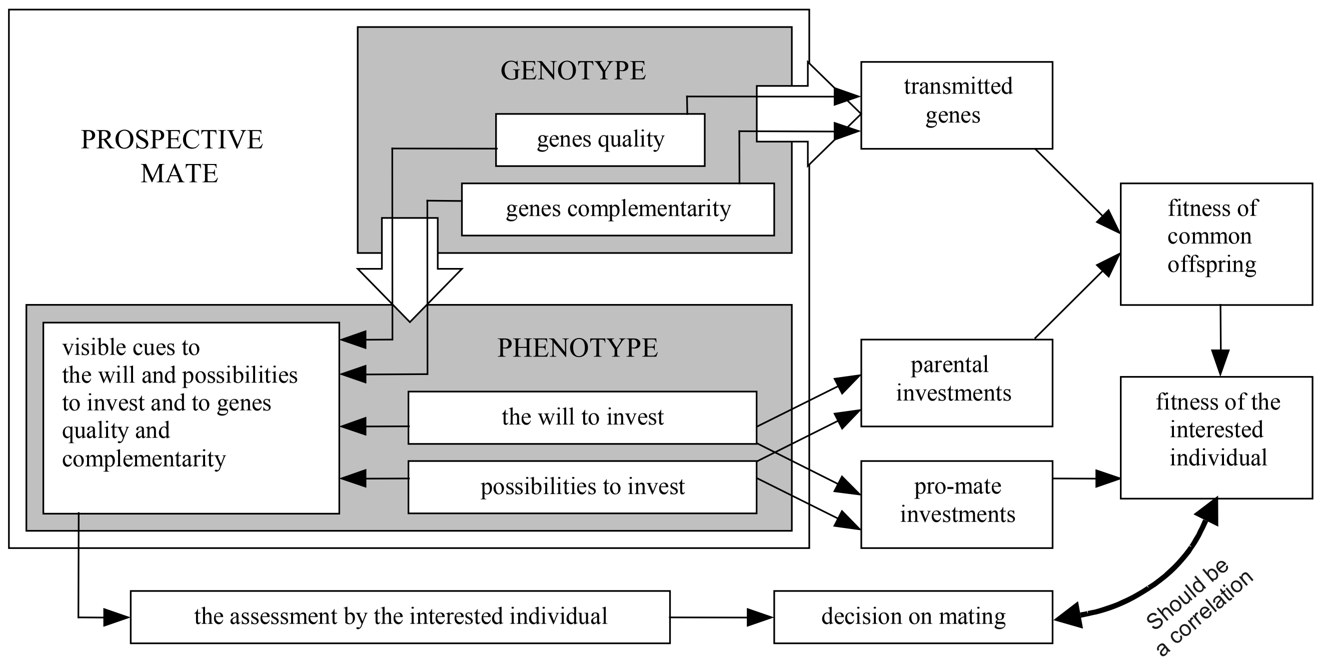

Fig. 2. The evolutionary view of the mechanisms of mate choice. An appropriate partner is one that has a high a mate value. This ensures that the offspring will be biologically fit. Physical appearance and other sensory cues have evolved to facilitate the decision process. An appropriate choice can be made only after evaluating reliable indicators of high genotypic and phenotypic quality.

that the individual possesses an evolutionarily-shaped mechanism of performing the reaction to the stimulus. There may also exist a stimulus T that is similar to stimulus S to the degree that the individual reacts to stimulus T with reaction R, even though the reaction in this case is not advantageous. Therefore, performing reaction R in response to stimulus T is not adaptive but the by-product of the adaptation to stimulus S. In this case, the individual is said to overgeneralize stimulus S (see ZEBROWITZ and RHODES [2004]). For example, female zebra finches prefer males with red beaks. This is an adaptation because a red beak is a sign of health. However, they also prefer males with red slips experimentally attached to their legs – this is an overgeneralization (see JONES [1996*b*]).

Overdiscrimination. If it is assumed that it is advantageous for an individual to react with reaction R to stimulus S but disadvantageous to react this way to stimulus T, a well-fitting individual will distinguish stimuli S from stimulus T and perform reaction R only in response to stimulus S. In many conditions such as this, an individual reacts especially strongly with reaction R to the stimulus when those elements that differentiate stimulus S from stimulus T are exaggerated. This phenomenon is called overdiscrimination or super-normal reaction to a super-normal stimulus and is widespread in humans and other animals (see ENQUIST and ARAK [1993]).

The fluency of data processing. Not all stimuli are analyzed by the brain with equal speed and efficiency. The attractiveness of some stimuli may be due to the ease with which they are processed by the brain (see HALBERSTADT [2006]).

Mere exposure effect. This phenomenon depends on a change in attitude toward a stimulus to being more positive by merely observing the stimulus (see ZAJONC [2001]).

All of the above mechanisms are based on distinct modes of sensory organ and nervous system function that unadaptively biases preferences toward some kinds of stimuli. This is the reason that these preferences are called sensory or perceptual biases. A quite different and frequently non-adaptive mechanism by which preferences are formed is social learning, most often, mimicking. This phenomenon is common in humans. At the population level, it takes the form of short-lived, constantly changing fashions.

Determinants of attractiveness

Age

A child's face has the following features: high forehead, large, round eyes, bluish sclera, high eyebrows, thick, red lips, short, wide, concave nose, wide cheeks, short ears, and light, soft skin [BERRY and MCARTHUR 1985, 1986; JONES 1996*b*; ETCOFF 1999]. In children, the lower part of head is smaller than in adults [MARK *et al.* 1988]. In adolescence, a boy's face changes much more than does a girl's face. Above all, the jaw and superciliary arches become larger. For this reason, a child's face is more similar to a female face than that of a male. In adulthood and old age, the most apparent facial change is wrinkling [MARK *et al.* 1980]. Other changes also occur, including: (1) descent of the eyebrows over the orbital ridges, which makes the eyes appear smaller; (2) increase in size of cartilaginous structures such as the ears and the nose; (3) thinning of the vermilion [JONES 1996*b*].

Age is an important criterion for mate choice. Men in particular strongly prefer younger females [BUSS 1999]. Even four-month-old infants look longer at the faces of children than at the faces of adults [MCCALL and KENNEDY 1980]. Preferences for youth are reflected in the assessment of FacA of people at various ages, at least as far as female faces are concerned. According to MATHES *et al.* [1985], women's FacA gradually decreases with age, both for men and women judges, although the effect was weaker when the judge was a woman, or when the judge was over 40 years old. On the other hand, for males, age is not generally related to FacA. In both males and females, the relative FacA of a particular individual in comparison with his peers remains constant from childhood to middle adulthood [ALLEY 1993, ZEBROWITZ *et al.* 1993, TATARUNAITE *et al.* 2005].

According to ZEBROWITZ and MONTEPARE [1992], there is a correlation between FacA and perceived age only in infants. HILDEBRANDT and FITZGERALD [1979] determined that cute infants are characterized by large eyes and pupils, and a large forehead. HÜCKSTEDT [1965] found that women prefer babyish proportions to such a degree that they consider children with pathologically enlarged crania to be attractive because this is an exaggerated baby-like trait.

Studies of real faces consistently show that FacA in females is positively correlated with the measured baby-likeness of the facial proportions [CUNNINGHAM 1986, FARKAS *et al.* 1987, FARKAS 1994, CUNNINGHAM *et al.* 1995, JONES 1995, MEHRABIAN and BLUM 1997, BAUDOUIN and TIBERGHIEN 2004, MESKO and BERECZKEI 2004]. FacA in females is also positively correlated with facial youthfulness as perceived by judges (KORTHASE and TRENHOLME [1982], TATARUNAITE *et al.* [2005], but see also BERRY [1991*a*] and ZEBROWITZ and MONTEPARE [1992]). JONES [1995] also showed that models have baby-like facial proportions. The features that decrease perceived age and increase FacA in females are most of all big eyes, short nose, small chin, thick lips, but also narrow jaw, thin eyebrows, and wide-set eyes. Besides having many baby-like traits, an attractive woman should also possess some adult traits, in particular pronounced cheekbones and narrow cheeks [CUNNINGHAM 1986, CUNNINGHAM *et al.* 1995, BAUDOUIN and TIBERGHIEN 2004]. A female face in which all of the proportions are childlike is perceived simply as childish and not as attractive [GRAMMER *et al.* 2003].

The positive correlation between babyfacedness and FacA in women was confirmed by many studies carried out on faces which age-related features were modified [MCARTHUR and APATOW 1983/1984, VON FAUSS 1986, RIEDL 1990, JOHNSTON and FRANKLIN 1993, PERRETT *et al.* 1994, JONES 1995]. The traits having the greatest effect on FacA were a small lower part of the face (narrow jaw, short chin, and lips close to the nose), large eyes and thick lips. JOHNSTON and FRANKLIN [1993] found that the most attractive versions of adult women's faces were those having proportions typical of 11-14 year-old girls.

Real faces studies were less consistent for men than they were for women. JONES [1995] and ZEBROWITZ and MONTEPARE [1992] found no correlation between babyfacedness in males and FacA. BERRY and MCARTHUR [1985] reported that some childlike features, including large, round eyes, high eyebrows and a small chin, increase FacA in males. CUNNINGHAM *et al.* [1990] found that an attractive male face is a specific combination of child-like features, such as large eyes, and mature features, such as a prominent chin. The results of studies conducted on modified faces are consistent in that the most attractive male face has medium values for age-related traits (MCARTHUR and APATOW [1983/1984], RIEDL [1990], JONES [1995], but see also VON FAUSS [1988]).

Both studies based on real as well as on modified faces gave similar, compatible results: (1) in children, at least in infants, FacA is positively correlated with conspicuous baby-like features, (2) there is a substantial preference for baby-faced women, yet also for two adult features, i.e., pronounced cheekbones and narrow cheeks; (3) there is a weak correlation between FacA and facial youthfulness in men (FacA is highest in men with medium or slightly baby-like values for age-related traits).

In many animals, young individuals have special features to signal their age. These traits trigger caring instincts in their parents and inhibit aggressive behavior in all adults. One cue to young age in mammals is a relatively large cranium with large eyes. This kind of age-signaling and its social effects are also found in humans. Children who poorly exhibit their young age get less care from their parents and are maltreated more frequently [MCCABE 1984].

Female reproductive capacity (expressed as the number of pregnancies she can successfully undergo and the number of children she can rear) is very limited. A woman cannot give birth more frequently than once a year. She usually gives birth to a single child. Furthermore, her reproductive potential decreases with age, and ceases when she reaches the age of about 50. Therefore, from a reproductive point of view, it is better for a man to bond with a young woman than with an old one. If the bond is expected to be short-lived, the criterion for partner choice should be the probability that the woman will conceive, which peaks at around the age of 25 years. If the bond is expected to be long-lasting, the criterion for partner choice should be the reproductive potential of the woman (i.e., the number of children she can still bear), which peaks just after puberty. For these reasons, during the course of evolution, men developed a preference for young women, more precisely for apparent, though not necessarily authentic, signals of female youthfulness. Therefore, male preference for young-looking women is an adaptation, and a preference for very young-looking women is an overdiscrimination. In order for male preferences not to be directed toward females that are too young, they have to be dependent on maturity cues such as pronounced cheekbones, narrow cheeks, and also a mature, feminine body shape.

Reproductive capacity is far higher in males than in females. It declines with age far more slowly than in women. Therefore, a woman's reproductive success depends relatively little on the age of her partner, as long as he is neither a child or an old man. In old age, a man's reproductive efficiency decreases substantially. His health, physical fitness and, frequently, social status, deteriorates. The probability that he will die increases, and the probability that he will still be around to carry out his duties to his wife and children decreases. Therefore, there are good reasons why a woman would choose not to mate with an old man. On the other hand, a very young man is usually psychologically immature, emotionally unstable and irresponsible. He has low social status and possesses few resources. The theoretically best partner for a woman is middle-aged, which is why male faces signaling this age are the most attractive to women. At the same time, BORKAN and NORRIS [1980] reported that young-looking old men are healthier and have a lower biological age than their peers. Therefore, youthful appearance in old men is a honest cue of their biological quality.

Averageness

The common belief that exceptionally attractive faces have some special features responsible for their beauty was challenged at the end of nineteenth century by GALTON [1878] who found that an experimentally averaged face (obtained by exposing a plate step-wise to different facial photographs) produced an image of above-average attractiveness, even when the original faces belonged to people who were not at all attractive. Over 100 years later, Judith Langlois and Lori Roggman transferred the technique of face superimposition from plate to computer. This resulted in the most illuminating paper on FacA to date [LANGLOIS and ROGGMAN 1990]. The researchers inputted gray-scale images of faces in a computer, and then collapsed them pairwise by calculating the arithmetical means for pixel brightness at the same coordinates. In spite of various methodological drawbacks, their results were unambiguous: (1) in almost every case, the composite face was more attractive than the original pair of faces; (2) higher order composites, that is, composites produced from other composites, were even more attractive; (3) the effect applied equally to both sexes; and (4) the FacA of a composite did not depend on the FacAs of the original faces. The authors concluded that the averageness is the essence facial attractiveness.

These results were extensively criticized, however. ALLEY and CUNNINGHAM [1991] disputed that the most beautiful faces are average in shape. After all, it had recently been established that FacA (at least in females) is increased by departures from averageness toward babyfacedness, and not by averageness itself. Critics [ALLEY and CUNNINGHAM 1991, BENSON and PERRETT 1992] suggested that the high FacAs recorded for the composites were not due to average proportions, but to smooth, clean, flawless skin, symmetry, and youthful appearance, or that the reason lay in the fact that the images were imperfectly merged, which blurred the face and enlarged facial elements such as the eyes and lips. Langlois and Roggman attempted to refute the criticism with theoretical arguments and further experiments [LANGLOIS *et al*. 1994]. But they succeeded only partially. They qualified their conclusion by stating that while averageness is not decisive in determining FacA, it is the most important factor of FacA.

With warping, the negative effects of simply superimposing faces on one another can be avoided. The results of studies using warping were clear, and the conclusions drawn from them can be summarized as follows: (1) Warping a face toward averageness increases FacA; (2) Caricaturing, or warping in the opposite direction, decreases FacA; (3) Averaging facial shape improves FacA more than averaging (i.e., smoothing) of facial texture in both male and female faces; (4) Averageness increases FacA in both frontal and profile views (frontal: BENSON and PERRETT [1992], RHODES and TREMEWAN [1996], KUJAWA and STRZAŁKO [1998], O'TOOLE *et al*. [1999], RHODES *et al*. [1999], LITTLE and HANCOCK [2002], VALENTINE *et al*. [2004]; profile: SPYROPOULOS and HALAZONETIS [2001], PEARSON and ADAMSON [2004], VALENTINE *et al*. [2004], VALENZANO *et al*. [2006]).

From studies in which the co-variables were controlled, it was concluded that averaging face shape increases FacA in and of itself and not by merely smoothing the skin [LITTLE and HANCOCK 2002, RHODES and TREMEWAN 1996], by lowering the perceived age [O'TOOLE *et al*. 1999], by improving symmetry [BAUDOUIN and TIBERGHIEN 2004, RHODES *et al*. 1999, VALENTINE *et al*. 2004], or by giving the face a positive expression [RHODES *et al*. 1999]. Most studies conducted on real faces confirm that FacA is correlated with the level of averageness [LIGHT *et al*. 1981; FARKAS *et al*. 1987; STRZAŁKO and KASZYCKA 1988, 1992; FARKAS 1994; RHODES and TREMEWAN 1996; RHODES *et al*. 1999, 2005*b*; GRAMMER *et al*. 2002; BAUDOUIN and TIBERGHIEN 2004; but see also POLLARD 1999, and JONES 1995]. EDLER *et al*. [2006] found that the level of improvement in FacA after cosmetic surgery is positively correlated with the degree to which the proportions of the face were altered towards averageness.

In her meta-analysis, RHODES [2006] found a strong correlation between FacA and averageness ($r = 0.52$). The correlation held true for both male and female faces and was higher in manipulated faces ($r = 0.67$) than real faces ($r = 0.40$). For real faces, the correlation was much higher when facial averageness was assessed by independent judges ($r = 0.47$) than when measured objectively ($r = 0.09$). This proves that the methods used to measure averageness were unsatisfactory.

Adaptation-oriented explanations are based on the assumption that individuals with average faces have a higher biological quality than others. They therefore have a high MV for a potential mate. If so, the preference for facial averageness is adaptive and may have been shaped by evolution. The relationship between averageness and biological fitness may have evolved by natural or sexual selection:

(1) The performance efficiency in a given individual depends on the size and shape of various parts of his body, including the components of his face. Therefore, natural selection adjusted facial proportions to be optimal for the environment our ancestors lived in. Natural selection continues to act in a stabilizing manner. Nonetheless, in the faces of some individuals, there are departures in one direction or another from the optimal proportions. Therefore, individuals with average facial proportions are more biologically fit than individuals with atypical facial proportions.

(2) Since the association of facial averageness with biological quality arose as the result of natural selection, a preference for mates with average faces should also have evolved. This preference for

average faces is an additional selective pressure for facial averageness, and this is known as sexual selection. In the population as a whole, the correlation between facial averageness and biological quality will persist because average facial features can develop only in individuals with a high biological quality. Factors such as mutations, malnutrition and infections lower biological quality and disturb the normal development the face so that it is atypical in some respects.

To be able to determine how far the shape of a face departs from the average, an observer has to possess a neutral model of the face, or prototype, with which he can compare the faces he sees. More precisely, he needs not only one prototype, but several prototypes, or several subtypes of a single prototype. This allows him to recognize and judge the faces of men, women, and children, *etc*.

The credibility of adaptation-oriented explanations was challenged by the discovery that people prefer not only average faces, but also average-looking animals and objects such as dogs and cars [HALBERSTADT and RHODES 2000, 2003; HALBERSTADT 2006]. They also preferred arrangements of abstract elements such as dots that were similar to arrangements to which they had been previously exposed during the course of the experiment [WINKIELMAN *et al.* 2006]. Furthermore, the correlations between attractiveness and averageness for non-facial categories are approximately as strong as they are for faces. This suggests that the human brain tends to prefer stimuli that are typical for the category to which they belong. The preference for average faces is only therefore a specific example of this general tendency. In that case, the preference for average faces would not just be as a result of a specific adaptation that evolved to enable individuals to find high-quality mates. The most popular non-adaptation-oriented explanations for the preference for average stimuli are those known as Processing Fluency and Familiarity:

(1) Processing Fluency. Typical faces are more similar to neutral facial prototypes than atypical faces. Therefore, they are more quickly and accurately processed [HALBERSTADT 2006]. This makes them more pleasant to look at, and therefore, more attractive.

(2) Familiarity. Through mere exposure, familiar objects are regarded as more attractive than unfamiliar objects. LANGLOIS and ROGGMAN [1990] found that average faces were assessed as being more familiar. This is understandable as most of the faces we see during our lives have proportions close to average, and relatively few of the faces we see are very atypical. For these reasons, it was hypothesized that average faces are attractive simply because they are more familiar or perceived as such.

Unfortunately, studies on the role of processing fluency and familiarity in determining the attractiveness of average faces are not consistent [RUBENSTEIN *et al.* 1999; RHODES *et al.* 2001*a*, 2005*a*; HALBERSTADT 2006]. Therefore, we cannot easily resolve the question of whether preference for average faces is a specific, non-adaptive example of a general preference for averageness in any category, whether the general preference is an overgeneralization of the adaptive preference for average faces, or whether the preference for average faces depends on both non-adaptative and adaptive mechanisms.

Facial sexual dimorphism

In small children, facial dimorphism is minimal. Substantial differences only appear in puberty, when facial features undergo more radical changes (in both size and proportions) in males and females. These changes are more marked in males than in females. Adult female faces are therefore more similar to children's faces than male faces. The differences between male and female faces correspond largely to the differences between adults' and children's faces. Compared to the female face, the male face is large, angular and convex in profile view. It also has small, deep-set eyes, prominent superciliary arches, thick, bushy eyebrows that are low-set, less prominent cheekbones, a wide, protruding nose, thin lips, a wide mouth, big chin and a wide jaw [ETCOFF 1999]. In both males and females, high testosterone levels during the fetal stage or during puberty magnify masculine facial traits [PENTON-VOAK and CHEN 2004, FINK *et al.* 2005*a*]. In women, estrogen levels during puberty determine fat deposition throughout the body. In the face, adipose tissue develops in the lips, which makes them look full, protruding, and even curled up [ETCOFF 1999]. In relation to overall facial size, women have relatively thicker lips than children, while children have thicker lips than men. In this sense, the thick lips of the adult female face are a hyper-childlike feature. On the other hand, in terms of the prominence of the cheekbones, the width of the cheeks, and the width of the nose, adult male faces are more similar to children's faces than are female faces [CUNNINGHAM 1986; CUNNINGHAM *et al.* 1990, 1995; KOEHLER *et al.* 2004].

KOEHLER *et al.* [2004] found a positive correlation between FacA and perceived facial femininity in women. Many researchers have used morphing to construct sets of female faces that represented various mixtures of the typical male face and the typical female face. Some of the images included in the sets were hyper-feminine faces with exaggerated feminine features. Most male subjects considered the hyper-feminine faces to be even more attractive than a 100% typical female face [PERRETT *et al.* 1998, RHODES *et al.* 2000, JOHNSTON *et al.* 2001, DEBRUINE *et al.* in press]. However, highly exaggerated feminine facial features reduces FacA because they make a woman appear dominating [JOHNSTON *et al.* 2001]. In many studies, male subjects preferred female faces with thick and prominent lips [GIDDON 1995, BAUDOUIN and TIBERGHIEN 2004, TURKKAHRAMAN and GOKALP 2004, SCOTT *et al.* 2006]. BISSON and GROBBELAAR [2004] found that, compared to ordinary women, female models had thicker upper and lower lips having double the surface area and a more distinct Cupid's bow. The meta-analysis carried out by RHODES [2006] showed that the correlation between FacA and facial femininity in women is strong for both real and modified faces ($r = 0.64$).

In studies on the correlation between FacA and facial masculinity in men, the results were inconsistent: (1) A negative correlation between FacA and facial masculinity was found in studies using digitally modified faces [PERRETT *et al.* 1998, RHODES *et al.* 2000, LITTLE *et al.* 2001, LITTLE and HANCOCK 2002], real faces [BERRY and MCARTHUR 1985], and drawings [MCARTHUR and APATOW 1983/1984]. (2) A positive relationship between FacA and facial masculinity was found in studies using digitally modified faces [JOHNSTON *et al*. 2001, SCARBROUGH and JOHNSTON 2005, DEBRUINE *et al*. 2006], real faces [CUNNINGHAM *et al*. 1990, GRAMMER and THORNHILL 1994, SCHEIB *et al*. 1999, PENTON-VOAK *et al*. 2001, NEAVE *et al*. 2003, KOEHLER *et al*. 2004, FINK *et al*. 2007], and drawings [KEATING 1985]. (3) Two studies on real faces found no correlation between FacA and facial masculinity [RHODES *et al*. 2003, WAYNFORTH *et al*. 2005]. (4) In two studies using digitally modified faces, there was a curvilinear relationship between FacA and facial masculinity, with the highest values for FacA coincident with moderate values for facial masculinity [KEATING and DOYLE 2002, SWADDLE and REIERSON 2002].

In her meta-analysis, RHODES [2006] showed that there was a negative correlation between FacA and facial masculinity in studies using digitally modified faces (r = -0.47) but a positive correlation in studies conducted on real faces (r = 0.35). Therefore, the results obtained partly depend on the experimental method used.

In studies on real faces, being correlational ones, the possible influence of covariables such as complexion, skin texture, facial expression and stubble were not controlled for. Therefore, the positive correlations observed in these studies do not necessarily indicate that there is a causal relationship between facial masculinity and FacA. For most studies using digitally modified faces, one of the preparative stages involves digital modification of original faces to produce facial composites which have visibly smoother complexions than the originals. This reduced the perceived age for the modified faces [LITTLE and HANCOCK 2002]. This, in turn, may affect the correlation between FacA and facial masculinity [RHODES 2006]. One way to avoid these problems is to use warping to modify real faces, and not the composites made from them. In two studies that used this approach [KEATING and DOYLE 2002, SWADDLE and REIERSON 2002], the highest values for FacA were coincident with moderate values for facial masculinity. If these results are accurate, it is easy to explain (1) why no correlation between FacA and facial masculinity was detected in some studies (because not all statistical methods can identify parabolic relationships), and (2) why positive or negative correlations were found in some studies (because many small-effect random impacts can move the FacA peak in either direction along the face masculinity axis). Therefore, studies to date suggest that women prefer facial shapes that are near the masculine average. However, in studies on real faces, women preferred facial shapes which were above the masculine average. This is probably because masculinity of male facial shape is correlated with some facial features that determine FacA (e.g., symmetry or skin quality) [SCHEIB *et al*. 1999].

Since female faces and children's faces have similar features, men prefer highly feminized female faces for the same reasons that they prefer baby-faced women. Evolutionary pressure for youthful appearance applies exclusively, or at least mainly, to women. Therefore, the differences between male and female faces correspond to the differences between adults' and children's faces.

Conspicuously reddened lips are under the control of estrogen, and are probably a signal of fecundity. It is more difficult to explain why high estrogen levels are manifested in this particular way. It has been suggested that conspicuously red lips resemble the female genitals in shape and color, and thereby sexually arouse men. Therefore, they might have been subject to sexual selection during the course of evolution [MORRIS 1967]. On the other hand, JONES [1996*a*] suspected that conspicuous red lips signal that the woman does not suffer from anemia or infections, and are therefore a reliable signal of the woman's current health and fecundity.

Men with highly masculinized faces are perceived to be, and actually are of high biological quality, including good genes and health in the broadest sense of the word [RHODES *et al.* 2003, ZEBROWITZ and RHODES 2004, THORNHILL and GANGESTAD 2006, FINK *et al.* 2007]. However, they are also perceived as having poor pro-family attitude (willingness to invest time and resources in both the woman and the common offspring) and as being dominant, aggressive, and even asocial [KEATING 1985, KEATING and BAI 1986, BERRY 1991*b*, PERRETT *et al.* 1998, JOHNSTON *et al.* 2001, KEATING and DOYLE 2002]. The above correlations can be attributed to the action of testosterone. High testosterone levels are a reliable indicator of high biological quality and determine the high level of facial masculinity [PENTON-VOAK and CHEN 2004, RONEY *et al.* 2006]. Men with high testosterone levels have less successful relationships with their women and children, are more likely to cheat on their partners, be single than involved in a relationship, and exhibit antisocial behavior (see PENTON-VOAK and PERRETT [2001], PENTON-VOAK and CHEN [2004], WAYNFORTH *et al.* [2005]). Therefore the curvilinear relationship between FacA and facial masculinity in male faces may be explained as a compromise made by women between biological quality and good character. On the other hand, a highly masculinized male face, being a signal of physical strength [FINK *et al.* 2007] and dominant, aggressive personality [KEATING 1985, CUNNINGHAM *et al.* 1990], allows the man to successfully compete with other men, to reach a high social status, and to have better access to more and better women. Therefore, quality-dependent facial masculinity in males may have evolved initially through intra-sexual selection. Only later, after these traits became honest cues to male quality, did masculinized male faces become attractive to women. Inter-sexual selection then began to influence the further evolution of the male face.

Some male facial features might have evolved through natural selection rather than intra-sexual or inter-sexual selection. For example, men have larger noses and mouths than women because our male ancestors were more frequently required to subject themselves to prolonged physical effort which demanded intensive breathing. Similarly, thick eyebrows and prominent superciliary arches in men have evolved to protect their eyes from the sun and sweat. Some studies on preferences that are dependent on contingencies provide strong evidence that the preference for facial masculinity in male faces is adaptive. For example, women prefer more masculinized male faces while in the fertile phase of their menstrual cycle than the infertile phase. This is because they are more likely to be seeking a man with good genes when the probability of conception is high (e.g., PENTON-VOAK *et al*. [1999]). Female preferences for facial masculinity in male faces may also be a by-product of age preference, as is the case with male preference for facial femininity in females. BOOTHROYD *et al*. [2005] found that perceived age in male faces was correlated with perceived masculinity. Furthermore, women who preferred older men also preferred men with more facial masculinity.

On the basis of their experiments with artificial neural networks (ANNs), ENQUIST and ARAK [1993] concluded that preferences for conspicuous sexual features evolved as a by-product of the need to distinguish between males and females. An ANN (representing an individual of a given sex) that has been taught to react (i.e., to mate with) to a stimulus of type *A* (the opposite sex individuals) and ignore a stimulus of type *B* (the same sex individuals) reacts especially strongly to a stimulus of type *A* in which the differences between types *A* and *B* are exaggerated (that is, individuals with exaggerated sexual features). This is an example of overdiscrimination, and, over many simulated generations, results in an increasing preference for highly conspicuous traits in the opposite sex (stimuli of type *A*) as well as increasing sexual dimorphism (differences between stimuli of type *A* and *B*). This co-evolution of preferences and stimuli is an example of so called runaway selection. After a time, it is counteracted by the negative effects of exaggerated sexual traits which include high production costs, dysfunction due to deformed organs, and overall reduced survival rates. ENQUIST and ARAK [1993] proposed that the mechanism observed in studies on ANNs is also responsible for the evolution of dimorphism in the human face and for the evolution of preferences for dimorphic facial features. (Note that the mechanism presented above can increase the already existing dimorphism but cannot initiate it.)

GHIRLANDA *et al*. [2002] claimed that they observed overdiscrimination in chickens (that is, in natural neural networks) which had been taught to distinguish between male and female faces and concluded that preferences for highly dimorphic facial features are non-adaptive.

Further research is therefore needed. However, the adaptation-oriented and non-adaptation-oriented explanations are not necessarily mutually exclusive. Both adaptive and non-adaptive mechanisms might have played a role in the evolution of preferences for facial dimorphism.

Symmetry

There are several kinds of asymmetry of biological structures:

Directional asymmetry (DA): Differences of values of a trait between the sides are systematic, and the mean value of the difference in the population differs from zero significantly. That is, in most individuals, the value on one side (left or right) is larger than on the other. For example, in humans the left kidney is located a few centimeters higher than the right one. SIMMONS *et al*. [2004] found DA for most of measured facial traits (23/35 in men, 28/35 in women).

Anti-symmetry (AS): Values of a trait strongly differ between the sides but the larger side in some individuals is the left one, while in the others the right one. Claw-size in fiddler crabs is a good example of this.

Fluctuating asymmetry (FA): Differences in values of a trait between sides are random, while the mean value of the difference in the population may be zero (i.e., no DA) or non-zero (i.e., DA exists).

DA and AS have functional significance, or are the by-products of functionally significant DA or AS in another trait. Thus, they are determined by processes controlled by the organism. On the other hand, FA is caused by random deviations from the normal and is not controlled by the organism. Two methods are used to estimate the level of facial asymmetry:

Measurements. With this method essential points (landmarks) are first located on a facial photograph. For paired points such as the outer corners of the eyes, the distance of each point from other paired or unpaired points is recorded. The difference between the distance on the left and that on the right indicates the level of asymmetry. For unpaired points such as the tip of the nose, the deviation from the vertical axis is recorded.

Assessment by judges (perceived asymmetry). Judges may assess facial asymmetry either directly or indirectly. In direct assessment, the judges simply estimate the level of asymmetry they see in a face. In indirect assessment, two chimeras are made for each face. A chimera is an image that consists of one side of the original face combined with its mirror image. One chimera is based on the left side of the face and the other based on the right side of the face. Judges then assess how similar the two chimeras are to each other.

ZAIDEL *et al*. [1995] found that the chimera based on the right side of a face was more attractive than chimera based on the left side of the face. This means that the right side of the face is more attractive than the left side. The authors suspected that this was due to the obscuring of attractiveness cues by facial expression which is more strongly expressed on the left side of the face [KOWNER 1996].

Numerous studies have been carried out on the relationship between FacA and the level of facial asymmetry because the level of asymmetry is believed to be an indicator of developmental stability and, therefore, biological quality. The method employed has a considerable influence on the result obtained.

(1) In many of the studies performed on real faces a positive correlation between FacA and facial symmetry was found. Some of these studies were based on facial measurements [GRAMMER and THORNHILL 1994, RIKOWSKI and GRAMMER 1999, HUME and MONTGOMERIE 2001, JONES *et al*. 2001, PENTON-VOAK *et al*. 2001, BAUDOUIN and TIBERGHIEN 2004]. Others were based on direct [RHODES *et al*. 1998, 2001*c*; KOEHLER *et al*. 2004; SIMMONS *et al*. 2004] or indirect assessment of asymmetry [MEALEY *et al*. 1999, PENTON-VOAK *et al*. 2001]. FARKAS [1994] and JONES [1996*b*] found little support for positive correlation between FacA and facial asymmetry. Only SHACKELFORD and LARSEN [1997] found a negative correlation. CUNNINGHAM [1986] and LANGLOIS *et al*. [1994] found no correlation between FacA and facial symmetry.

(2) A chimera is constructed from the image of only one side of the face and is therefore perfectly symmetrical by definition. Nevertheless, FacA was lower in chimeras than in real faces [LANGLOIS *et al*. 1994; KOWNER 1996, 1997;

RHODES *et al.* 1999*a*; NOOR and EVANS 2003].

(3) A symmetrical image can be constructed by morphing a face with its mirror image. In two studies, FacA was higher in the symmetrical face than the original face [RHODES *et al.* 1998, 2001*b*]. SWADDLE and CUTHILL [1995], however, found that FacA was lower in the symmetrical face than in the original face.

(4) Warping allows construction of a symmetrical image without changing skin texture. The texture of the images to be compared may be derived from the original face (rendering it asymmetrical to some degree) or from a composite image (when it remains smooth and symmetrical). Warping can also be used to exaggerate asymmetry in the original face. In all studies using warping, there was a positive correlation between FacA and facial symmetry [RHODES *et al.* 1998, 1999*a*, 2001*a*; PERRETT *et al.* 1999; LITTLE and JONES 2003].

In most studies on real faces, there was a positive correlation between FacA and facial symmetry. The few studies in which there was not a clear positive correlation found were mostly conducted some time ago when methodologies were not as refined. In the process of constructing chimeras, the face is bisected exactly along the vertical axis of the face. However, because few faces are perfectly symmetrical, the vertical axis of the face rarely goes through the middle of every structure which is located in the center of the face. Therefore, chimeras may have some structures unnaturally large or small, and they are considered by judges to be strange and atypical RHODES *et al.* [1999*a*]. This is why, in all studies using chimeras, the chimeras were found to be less attractive than the faces from which they had been constructed. In images created by morphing, skin blemishes may be duplicated, which decreases FacA. This is believed to be the reason why SWADDLE and CUTHILL [1995] found a negative correlation between FacA and facial symmetry. On the other hand, RHODES *et al.* [1998, 2001*a*] circumvented this problem by graphically removing all facial blemishes before morphing, and found a positive correlation between FacA and facial symmetry. Warping allows modification the level of asymmetry without any serious side-effects. In all studies using warped images, there was a positive correlation between FacA and facial symmetry. Furthermore, preference for symmetry is so strong that judges consider symmetrical versions of their own or their acquaintances' faces to be more attractive than the originals [LITTLE and JONES 2003].

SIMMONS *et al.* [2004] found that directly perceived asymmetry was correlated with the measured FA but not with DA. This means that perceived symmetry is not based on DA, probably because people are accustomed to DA and therefore ignore it when evaluating facial symmetry. In her meta-analysis, RHODES [2006] found that for real faces there was a weak positive correlation between FacA and facial symmetry ($r = 0.23$). For morphed and warped faces, there was a moderate positive correlation ($r = 0.43$). For chimeras, there was a strong negative correlation ($r = -0.62$). This is true for both male and female faces and for both male and female judges. The correlation between FacA and facial symmetry was somewhat stronger when facial symmetry was assessed by judges ($r = 0.30$)

than when it was determined by measurement ($r = 0.19$).

In the 1990s, results of studies using chimeras or poorly constructed morphed images supported the hypothesis that facial asymmetry reduces FacA only when it is extreme or pathological, and that at normal levels asymmetry actually increases FacA. Normal faces are slightly asymmetric because of DA: for example, facial expressions are more pronounced on the left side of a face and vocal movements on the right. Recent studies, however, proved that the correlation between FacA and facial symmetry is positive. The studies also suggested that judges either do not notice or even ignore DA when evaluating FacA [RHODES *et al*. 1998, SIMMONS *et al*. 2004].

If facial asymmetry is correlated with some other facial feature, a preference for that feature may be falsely interpreted as a preference for facial symmetry. Several features are possible covariates: age [FINK *et al*. 2005*b*], facial averageness [JONES 1996*b*], sexual dimorphism [SCHEIB *et al*. 1999], and skin condition [JONES *et al*. 2004*b*]. However, facial symmetry also increases FacA in faces that are digitally modified without changing the level of masculinity or without changing skin texture, which may provide cues to age and health. Furthermore, RHODES *et al*. [1999*a*,*b*] found that facial symmetry and facial averageness contributed independently to FacA. Therefore, facial symmetry in and of itself affects FacA even if it is correlated with other determinants of FacA such as age, averageness, sexual dimorphism and skin condition.

Many genetic (inbreeding, mutation) and environmental factors (parasitic, malnutrition, environmental pollution, alcohol consumption and smoking by parents during pregnancy) disturb the symmetry of an animal's body and a human body and face [JONES 1996*b*, ETCOFF 1999, ŻĄDZIŃSKA 2003]. It is believed that a low level of FA indicates (i) that the individual is able to develop symmetric structures that are normal for the species even despite adverse environmental conditions, and (ii) the accumulation of environmental stresses to which the individual has been exposed during the course of his lifetime [THORNHILL and MØLLER 1997].

Facial asymmetry may be so severe as to impair normal facial function. For example, an asymmetric jaw can reduce chewing efficiency or even cause the head to lean to one side, which can even lead to scoliosis [JEFFERSON 1996]. An asymmetric nose can impede breathing which can reduce stamina [MANNING and PICKUP 1998]. Therefore, natural selection favors symmetrical faces, and, in turn, the preference for symmetrical faces should appear in the opposite sex. Consequently, individuals with symmetrical faces have an advantage not only in terms of anatomical function but also in terms of reproductive success.

Sexual selection for symmetrical faces should have produced a positive correlation between the level of facial symmetry and biological quality of the individual (because only high-quality individuals are able to develop a highly symmetrical face). Indeed, a high degree of facial asymmetry is positively correlated with many somatic and mental disorders [THORNHILL and MØLLER 1997]. However, the correlation between low levels of asymmetry and biological quality is not high (see RHODES [2006]).

It has been proposed that the preference for facial symmetry is only a specific example of the preference for symmetry in general, and is therefore not an adaptation which allows an individual to recognize potential partners with high biological quality. Indeed, common objects and patterns are perceived as more pleasant if they are symmetrical (see LITTLE and JONES [2003], CARDENAS and HARRIS [2006]). Explanations for the generality of preference for symmetric forms were attempted in terms of processing fluency. But it may also be explained by the fact that our bodies as a whole are vertically symmetrical (this would be an example of overgeneralization of the mere exposure effect for vertical symmetry) [LITTLE and JONES 2003].

Non-adaptive preferences for symmetry were also observed in ANNs. ENQUIST and ARAK [1994] found that when an ANN was learning to recognize an asymmetric stimulus presented from different rotational angles, it was developing a preference for a symmetric version of the stimulus. JOHNSTONE [1994] trained an ANN to recognize bilaterally symmetrical objects by presenting the ANN with images, all of which were randomly asymmetric to either the left or the right. After training, the ANN was most responsive to perfectly symmetric images, even though it had never encountered them before. JANSSON *et al.* [2002] and SWADDLE *et al.* [2004] conducted the same experiment on birds (*i.e.*, natural neural networks) and their results were consistent with those of Johnstone. On the other hand, LITTLE and JONES [2006] found that the intensity of the preference for facial symmetry is not correlated with the ability to detect facial asymmetry. This supports the adaptation-oriented rather than the non-adaptation-oriented explanation of the preference for facial asymmetry.

Therefore, support exists for both for the adaptation-oriented and the non-adaptation-oriented explanations for preference for facial symmetry. However, both explanations are not necessarily mutually exclusive and both adaptive and non-adaptive mechanisms may contribute to the existence of the preference.

Other determinants of facial attractiveness

The preference for light skin is present in most human populations [VAN DEN BERGHE and FROST [1986]. However, the preference within a population is for skin tones that are lighter for that population and not the lightest possible skin tones. In most cultures, the preference for light skin in women is stronger than the preference for light skin in men [VAN DEN BERGHE and FROST 1986]. There is also a general preference for light hair in women and for dark hair in men [FEINMAN and GILL 1978, JONES 1996*b*]. Probably, several mechanisms contribute to the preference for skin color:

In hunter-gatherer populations, a woman is pregnant a large part of the time. Her calcium requirement increases because of the developing fetus. Intestinal calcium absorption is enhanced by vitamin D. The synthesis of vitamin D depends on capacity of the skin to allow the UV component of sunlight to penetrate. UV penetration is more efficient when the skin is light in color. This would explain why natural selection favored lighter skin in women more so than in men. On the other hand, UV light is harmful (it destroys folic acid). Adults are exposed to more UV light than children are. Therefore, skin color is darker in adults. Because the biologically optimal skin color is lighter in women than men, the preference for light skin color should be stronger in men than women [RUSSELL 2003].

Light skin became a trait associated with childishness and femininity and men prefer women with feminine and childish traits. This gave rise to the preference for markedly lighter skin and hair color [FROST 2006]. Estrogen lightens the skin whereas progesterone darkens it. Therefore, skin color in women is darker during pregnancy and lighter around the time of ovulation [FROST 1988]. This is more cogently explained by sexual selection rather than natural selection because natural selection would dictate that skin color in females be lighter during pregnancy when the calcium requirement is particularly high.

In western societies, there is currently a fad for tanned skin [JONES 1996*b*, FINK *et al*. 2001]. It is believed that this is because tanned skin is a marker of high socio-economic status (SES) because only individuals with a high SES possess the time for tanning. The preference for skin color may therefore be conditioned by the preference for a partner with a high SES. Light skin is also a better clue to health than dark skin. Many disorders, including anemia, cyanosis, jaundice and infection, are easier to detect in an individual with lighter skin. Therefore, it makes sense not to choose a partner with dark skin, because they may be concealing cues to poor biological quality [ETCOFF 1999].

The parallel evolutionary changes in skin color and preferences for skin color in women and men can be explained in terms of the common genetic determination of skin color in both sexes [FROST 2006]. In turn, the parallel evolutionary changes in skin and hair color and the preferences for them can be explained in terms of the common genetic determination of skin and hair color. Because skin color is lighter in women than men, the contrast between skin color and eye and lip color is greater in women than men. RUSSELL [2003] showed that digitally increasing the contrast by darkening the eyes and lips increases FacA in female faces but decreases FacA in male faces.

Little is known about preferences for eye color. FROST [2006] proposed that eye color and hair color are determined by frequency-dependent selection. This means that rare, exceptional colors are preferred. LITTLE *et al*. [2003] found that both men and women preferred the same eye color and hair color that their opposite-sex parent possessed. LAENG *et al*. [2007] found a particularly strong preference of blue-eyed men for blue-eyed women, which is probably an adaptation for detection of non-paternity.

Healthy hair is shiny and strong [ETCOFF 1999]. It is a reliable indicator of overall reproductive and non-reproductive health in women [HINSZ *et al*. 2001]. If a woman has healthy hair, it makes sense for her to display it, that is, to wear the hair long and loose. According to this supposition, HINSZ *et al*. [2001] found a positive relationship between hair quality and hair length in women (age being controlled for). Using images to which hairstyles were digitally added, MESKO and BERECZKEI [2004] showed that FacA was correlated with hair length in women and this was especially true if the hair was worn loose. Hair length and hair quality are negatively correlated with old age, regardless of health status [HINSZ *et al.* 2001]. Hair quality also decreases with every successive pregnancy (see HINSZ *et al.* [2001]). In summary, hair length and hair quality in women reflect general health, reproductive health, age and the number of past pregnancies.

Little is known about women's preferences for hair length and hair quality in men. PANCER and MEINDL [1978] found that women prefer men with long hair. However, this preference is most probably subject to cultural factors and changes over time. MUSCARELLA and CUNNINGHAM [1996] photographed men wearing wigs ranging from full hair to complete baldness. Both receding hairlines and baldness decreased FacA and perceived aggressiveness. On the other hand, they increased perceived age and social maturity. The authors proposed that baldness is an adaptive process and serves as an indicator of old age and reduced reproductive drive. This reduces competitive and aggressive behavior in younger males. Thus, an old man can invest in his offspring and grandchildren without interference from younger males. In women, on the other hand, intra-sexual competition is weaker than in men and does not usually involve physical violence [BUSS 1999]. This explains why baldness evolved only in men.

Facial hair seems not to serve a purpose as far as health and survival are concerned [BARBER 1995]. It occurs only in adults, and almost exclusively in males. The development of facial hair is under control of the male sex hormones. A lack of facial hair is an indicator of youthfulness and femininity. In women, the presence of facial hair decreases FacA [ETCOFF 1999, FINK *et al.* 2001]. The results of studies for the correlation between FacA and facial hair in men are conflicting. Some studies found a positive correlation [PELLEGRINI 1973, PANCER and MEINDL 1978, HATFIELD 1986, REED and BLUNK 1990, HELLSTRÖM and TEKLE 1994] while others found a negative correlation [FEINMAN and GILL 1977, CUNNINGHAM *et al.* 1990, WOGALTER and HOSIE 1991, MUSCARELLA and CUNNINGHAM 1996]. Nevertheless, there is general agreement that men with beards are perceived as older, more mature, manly, dominant, aggressive and threatening [CUNNINGHAM *et al.* 1990, REED and BLUNK 1990, WOGALTER and HOSIE 1991, BARBER 1995, MUSCARELLA and CUNNINGHAM 1996]. Because a beard accentuates the lower part of the face, men with beards are perceived as more masculine, just as are men with large jaws and chins. The effect of facial hair on FacA may be similar to the effect of facial proportions in males on their FacA. Facial hair indicates high biological quality and social status[1], and a weak will to invest in his mate and offspring. Therefore, in regard to facial hair, women have to compromise when choosing a partner.

With age, facial skin becomes matt, limp, and wrinkled, the cheeks cave in and the facial bones become more conspicuous [ETCOFF 1999]. The same traits may occur in younger individuals. Skin condition is therefore a cue to age and health, so it is hardly surprising that it affects FacA. Many skin changes that are

[1] Of course, each man decides for himself whether to wear a beard or not. However, the presence of the beard is also a signal of his ability and readiness to compete with other men who test the honesty of the signal. MUELLER and MAZUR [1997] showed that military men whose physiognomy dishonestly signaled their physical, social and intellectual abilities, received the worst treatment.

clearly symptomatic of disease processes (e.g., acne, eruptions, warts, moles, cysts, tumors and lesions) reduce FacA [MORRIS 1967]. Some of these changes, such as inflammation and acne, are induced by relatively high levels of androgens. Therefore, these changes reduce FacA in women more so than in men [ETCOFF 1999, FINK and NEAVE 2005].

Images with perfectly clear and smooth skin (constructed by digitally averaging skin texture) possess a higher FacA than the originals [BENSON and PERRETT 1992, O'TOOLE *et al*. 1999, LITTLE and HANCOCK 2002]. Men prefer female faces with smooth and slightly reddened skin [FINK *et al*. 2001]. FINK *et al*. [2006] found that the more heterogenously distributed visible skin color was in female faces (a cue to an old age), the lower was the FacA. In studies on male faces, JONES *et al*. [2004*a*,*b*] found a correlation between FacA and health assessed either on the basis of the whole face or on the basis of a section of cheek skin. In summary, there is a preference for skin that indicates good health (in both sexes), and, in females, youthfulness and low androgens levels.

In faces that were equalized in terms of skin texture, FacA positively correlates with facial profile averageness [VALENZANO *et al*. 2006]. FacA is higher in a composite image constructed by digitally averaging profiles than in the original faces [SPYROPOULOS and HALAZONETIS 2001, PEARSON and ADAMSON 2004]. FacA is also higher in profiles which have been warped toward the average shape [VALENTINE *et al*. 2004]. In several studies in which the protrusion of the maxilla and jaw were digitally manipulated, FacA was highest in faces that were typically orthognathic [GIDDON *et al*. 1996, TURKKAHRAMAN and GOKALP 2004, HONN *et al*. 2005, MAPLE *et al*. 2005].

There are no symmetric elements in facial profiles, so symmetry cannot effect FacA in profile views. Therefore the positive effect of shape averaging on FacA can be explained only in terms of averageness and not symmetry.

In profile view, as in frontal view, the differences between men's and women's faces correspond to the differences between adults' and children's faces. In women, the profile has a smaller jaw, a less protruding nose, and larger, more protruding lips. FacA is higher in women with less protruding chins and noses, more protruding lips, a forwardly positioned jaw angle, and a generally flatter contour than in men [FERRARIO *et al*. 1995, POLK *et al*. 1995, SERGL *et al*. 1998, PEARSON and ADAMSON 2004, TURKKAHRAMAN and GOKALP 2004, MATOULA and PANCHERZ 2006]. However, there is at best a weak preference for high dimorphism in male faces [SWADDLE and REIERSON 2002]. There is also a preference for childlike features in women, such as a slightly up-turned or concave nose [SERGL *et al*. 1998, CHOE *et al*. 2004, PEARSON and ADAMSON 2004, VALENZANO *et al*. 2006].

In a study using morphed and warped images, SPYROPOULOS and HALAZONETIS [2001] showed that FacA is higher in profiles in which the skin had been smoothed by averaging.

Generally, facial expressions signaling interest and kindliness increase FacA in both males and females [RHODES *et al*. 1999*a*,*b*]. RONEY *et al*. [2006] showed that kindliness and the liking of children perceived in a male face affected FacA independently of each other. Smiling increases FacA in both males and females

[REIS *et al.* 1990, RHODES *et al.* 1999*a*, TATARUNAITE *et al.* 2005]. FacA is highest for smiles that show a lot of white teeth but that do not show the gums or the buccal corridors [MOORE *et al.* 2005, ONG *et al.* 2006, PAREKH *et al.* 2006].

In facial photographs, enlarging the pupils increases FacA [ETCOFF 1999]. This is because in normal light dilated pupils indicate interest. The direction of the gaze is also important. FacA is highest when the gaze is directed at the observer and not off to the side [JONES *et al.* 2006]. FacA is also higher in individuals who shift their gaze toward the observer than in individuals who stop looking at the observer [MASON *et al.* 2005]. JONES *et al.* [2006] found that a smile increases FacA if the individual is looking at the observer because the observer interprets the smile as a reward. On the other hand, a smile decreases FacA if the individual is looking elsewhere because the observer feels disappointment.

RUBENSTEIN [2005] instructed judges to evaluate FacA and facial emotional expressiveness after watching ten-second-long film clips. Each clip presented a person with a neutral expression reading a book. The judges were also instructed to evaluate single-frame images from each clip. The correlation between assessments of dynamic and static facial views was surprisingly low ($r = 0.2$). The correlation between FacA and facial expressiveness was high for film clips ($r = 0.48$), but low for photographs ($r = 0.11$). This proves that the determinants of FacA differ depending on whether moving images or still images are being evaluated. Studies based on static facial images therefore have limitations. This indicates the need for more research carried out under conditions that are closer to natural conditions.

Conclusions

The human face consists of many elements and features, most of which contribute to facial attractiveness. Most researchers have focused on averageness, symmetry and dimorphism, and relatively few have focused on head hair, facial hair, and skin, hair and eye color. Only rarely have studies on the effect of skin condition and facial expression been carried out. Although age is not a facial feature in and of itself, it has a significant effect on how a person is evaluated in social and erotic terms. Therefore many previous studies have focused on how age and age-related changes determine FacA.

In both men and women, FacA is increased by symmetry, averageness, a smooth and clear complexion, and a pleasant expression. This is true irrespective of whether the judges are of the opposite or the same sex. FacA in females is improved by all of the typically feminine features: prominent lips, a small lower part of the face, small supra-orbital ridges, light skin, light hair, and an absence of facial hair. On the other hand, male faces with a moderate level of masculinity are considered more attractive than faces with a high level of masculinity. Although skin condition is the main indicator of a person's age, all of the factors mentioned above also play a role. Facial cues to young age are important determinants of FacA in women.

The most strongly correlated factors with FacA are facial femininity in women and averageness in both sexes (for each trait, r exceeds 0.5). Facial symmetry itself seems to be a relatively weak determinant of FacA. The weight of possible other determinants of FacA is not yet recognized. The strong correlations between FacA and some facial morphological features shows that the search for the physical basis of facial beauty has validity. There is some evidence that preferences for specific facial traits are evolutionary adaptations that facilitate the choice of an appropriate mate or lifetime partner. However, non-adaptive mechanisms are also responsible for the existence of these preferences.

This paper has focused on only some of the many aspects of FacA. It has briefly surveyed the history of research on FacA and the main theories that have been proposed to explain FacA. It has reviewed and discussed in detail the results of studies on general patterns in facial preferences. However, there are many issues that have not been covered here: (1) Variation in facial preferences between populations, within populations and within individuals, (2) The relationship between FacA and biological quality and mate value of the face's owner, (3) The various neural, physiological and behavioral responses to attractive faces, (4) The social and biological consequences of perceiving some people as attractive, and others as unattractive, (5) The selection pressures by which evolution has shaped facial preferences in humans. All of these aspects will be discussed in the author's forthcoming paper on FacA.

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Streszczenie

Praca omawia ogólnoludzkie wzorce postrzegania atrakcyjności twarzy. Atrakcyjność twarzy jest tematem rozważań od tysięcy lat, jednak dopiero kilkadziesiąt lat temu stała się przedmiotem badań naukowych. Już w starożytnej Grecji istniały koncepcje łączące piękno ludzkiej twarzy z tzw. złotą proporcją jej odcinków (tzn. stosunek ich długości miał być równy 1,618) lub równą długością określonych jej wymiarów. Poglądy te pochodziły z rozważań geometrycznych, nic więc dziwnego, że nie znalazły uzasadnienia we współczesnych badaniach nad postrzeganiem atrakcyjności twarzy.

Dzisiejsze, ewolucyjne podejście do zagadnienia atrakcyjności twarzy zakłada, że dostrzeganie piękna lub brzydoty twarzy jest adaptacją osoby postrzegającej. Adaptacja ta polega na

pozytywnym odbiorze tych twarzy, których wygląd sugeruje (sygnalizuje) obecność pożądanych cech u ich właścicieli, np. zdrowia lub „dobrych genów". Istnieją także alternatywne, nieadaptacyjne próby wyjaśnienia fenomenu atrakcyjności fizycznej, odwołujące się do ogólnych mechanizmów funkcjonowania mózgu. Badania empiryczne pokazują, że ludzkie preferencje w stosunku do pewnych twarzy są wynikiem działania zarówno mechanizmów adaptacyjnych jak i nieadaptacyjnych.

Wyróżniono wiele czynników, które wpływają na atrakcyjność twarzy. Jednym z ważniejszych jest wiek, wyraźnie związany z cechami uznawanymi za atrakcyjne. Okazało się na przykład, że mężczyźni wykazują tak silną preferencję dla oznak młodości na twarzy kobiet, że za najatrakcyjniejsze uważają proporcje twarzy typowe dla 11-14-letnich dziewcząt. Oprócz dziecięcych proporcji większości cech , atrakcyjna kobieta powinna jednak posiadać też cechy świadczące o jej dojrzałości. Takie preferencje u mężczyzn zapewne zostały ukształtowane ewolucyjnie, w związku z wysokim potencjałem reprodukcyjnym oraz wysoką zdolnością rozrodczą młodych kobiet. Z kolei kobiety nie wykazują wyraźnych preferencji dla oznak wieku na twarzach mężczyzn, choć nisko oceniają obie skrajności: twarze bardzo młode oraz twarze starców. Istnieją doniesienia, że u dzieci (a przynajmniej u niemowląt) młody wygląd podnosi atrakcyjność twarzy.

Już w XIX w. zauważono, że twarze o przeciętnych proporcjach cechują się ponadprzeciętną atrakcyjnością. Nowoczesne techniki komputerowej obróbki obrazu twarzy (tzw. warping i morfing) pokazały, że korzystny wpływ przeciętności proporcji na atrakcyjność twarzy ma miejsce zarówno dla widoku z przodu jak i z profilu, dla twarzy obu płci oraz według sędziów obu płci. Do dziś nie rozstrzygnięto czy preferencja dla przeciętnych twarzy jest adaptacją pozwalającą wybrać dobrego partnera (przeciętność proporcji miałaby tu być oznaką zdrowia somatycznego i genetycznego) czy też skutkiem sposobu funkcjonowania mózgu (atrakcyjność form przeciętnych znaleziono dla wielu innych typów bodźców, np. psów, samochodów itd.).

Różnice pomiędzy twarzą mężczyzny a twarzą kobiety w dużym stopniu pokrywają się z różnicami pomiędzy twarzą osoby dorosłej a twarzą dziecka. Nic więc dziwnego, że mężczyźni za atrakcyjniejsze uznają silnie sfeminizowane twarze kobiet. Twarze takie wydają się młodsze, co sugeruje wysoki potencjał reprodukcyjny, a ponadto sygnalizują też wysoki poziom estrogenu, a zatem zdrowie reprodukcyjne. Kobiety preferują twarze mężczyzn o umiarkowanym stopniu maskulinizacji. Powiązania atrakcyjności twarzy mężczyzny z jej stopniem maskulinizacji są bardziej złożone: maskulinizacja oznacza wysoki poziom testosteronu, a to, z jednej strony sygnalizuje posiadanie przez mężczyznę „dobrych genów", a z drugiej może oznaczać zmniejszoną wierność mężczyzny i jego chęć inwestowania w potomstwo.

W kilku pracach z lat 1990. wykazano ujemny związek między symetrią twarzy a jej atrakcyjnością, jednak wkrótce okazało się, że były to artefakty wynikające z zastosowania wadliwych metod cyfrowej obróbki twarzy. Nowsze badania, przeprowadzone z użyciem techniki warpingu, wykazały, że wzrost symetrii twarzy zwiększa jej atrakcyjność. Istnieje hipoteza, że symetryczna twarz, podobnie jak wszelkie inne symetryczne obiekty, jest uważana za atrakcyjną dlatego, że neuronowa obróbka obiektów symetrycznych jest szybka i mniej zawodna niż obiektów niesymetrycznych. Bardziej prawdopodobne wydaje się jednak wyjaśnienie adaptacyjne: asymetria twarzy jest oznaką niezdolności organizmu do precyzyjnego wytwarzania struktur fenotypowych na podstawie genotypu. Wybór twarzy symetrycznej oznacza więc wybór osobnika o wysokiej stabilności rozwojowej, a zatem o „dobrych genach".

Generalnie, mężczyźni preferują jasny odcień skóry u kobiet, co wydaje się być formą preferencji w stosunku do młodego wieku (ponieważ dzieci mają jaśniejszą skórę niż dorośli) oraz wysokiego poziomu estrogenu (estrogen rozjaśnia skórę). Preferencje mężczyzn ze względu na kolor włosów i oczu są urozmaicone, co próbuje się tłumaczyć działaniem doboru zależnego od częstości. Mężczyźni są wrażliwi na jakość włosów, która jest wskaźnikiem ogólnego zdrowia kobiety. Owłosienie twarzy (zarost) jest cechą typowo męską, dlatego jego obecność u kobiety obniża jej atrakcyjność. Broda u mężczyzn jest odbierana przez kobiety równie dwuznacznie jak silnie zmaskulinizowana twarz, dlatego kobiety, na ogół, pozytywnie oceniają obecność cienia po zgolonej brodzie (oznaka męskości), ale już nie obecność brody.

Czysta (tzn. wolna od brodawek itp.) i zdrowo wyglądająca skóra pozytywnie wpływa na atrakcyjność twarzy obu płci. Ponadto u kobiet atrakcyjność twarzy jest obniżana przez oznaki zaawansowania wieku (zmarszczki) lub względnie wysokiego poziomu androgenów (np. trądzik młodzieńczy). Wyraz twarzy sugerujący pozytywne nastawienie podnosi atrakcyjność tej twarzy. Znaczenie ma tu uśmiech, rozszerzone źrenice, wzrok skierowany na patrzącego, a także „odczytywana” z twarzy uprzejmość i lubienie dzieci.

Podsumowując, wyniki badań dowodzą, że istnieją pewne ogólne wzorce preferencji w stosunku do twarzy, które w dużej mierze są kryteriami rozpoznawania wartościowych, z reprodukcyjnego punktu widzenia, partnerów. Preferencje w stosunku do twarzy mają zatem charakter adaptacji, choć w niektórych przypadkach istotną rolę mogą odgrywać nie-adaptacyjne mechanizmy związane z ogólnymi zasadami funkcjonowania mózgu.