Beauty is only skin deep

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In *The Iliad*, Homer describes the epic battles of the Trojan war as vast armies sailed across the Aegean to rescue the Spartan queen Helen, said to be the most beautiful woman who ever lived[1]. Many painters have since tried to recapture her image on canvas—but what did she actually look like? Debate over what constitutes beauty has raged since philosophy began. Most imagination has focused on the face, perhaps the most complex and captivating structure in nature, whose attractiveness influences much of our behaviour and social interaction[2]. From Renaissance artists to the present day, the quantitative definition of human beauty has been a 'Holy Grail'; if the exact contours of the perfect face could be mapped, we would have a form that could not be bettered.

In medical practice, an understanding of beauty is important in various settings. Plastic, maxillofacial and orthodontic surgeons can enhance their outcomes by aiming towards an 'ultimate' aesthetic and functional state[3]. In breast disease, restoration of body form following mastectomy is of great importance to a woman, helping to restore her femininity and confidence. Indeed, the psychological effects of altered self-recognition may form part of a ruinous eating disorder.

Beauty is a perception, the physical form appreciated by the observer. Such a concept suggests that beauty comprises two distinct but competing elements—the one who is beautiful, and the other who considers the one beautiful. Both contribute to whether beauty is deemed to be present—the 'subject versus beholder' hypothesis. In this essay I ponder the motives of each side in turn and the impetus behind beauty itself.

'BEAUTY IS THE GIFT OF GOD'

Imagine that you are asked to divide a line so that the ratio of the shorter section to the longer section is equal to the ratio of the longer section to the whole line (Figure 1). For thousands of years, scholars have believed this to be the most aesthetically pleasing point at which to divide a line, known as the golden section. It is represented by the symbol ϕ deriving its name from the Greek sculptor Phidias who incorporated it into the basic dimensions of his most famous work, the Parthenon[5]. ϕ is related to so many aspects of beauty that Kepler called it the divine proportion[6]. There are countless examples in the natural world, from the pentagonal symmetry of flowers to the logarithmic spiral of the ammonite cephalopods[5,6]. The association with beauty has led to its application in art throughout the ages. Michelangelo's *Temptation and Expulsion from Eden* is a well-known example (Figure 2)[7]. But perhaps the most famous illustration is Leonardo da Vinci's drawing of the Vitruvian man, relating the divine proportion to human anatomy—a universal phenomenon uninfluenced by race, age, sex or geographical and cultural factors[3]. All human beings should have the genetic potential to attain these proportions. It is proposed that such a human form upholds the law of conservation of energy, allowing maximum performance with minimum effort, and the law of conservation of tissue, requiring a minimum number of cells to perform the tasks necessary for survival[6]. However, an individual may fall short of achieving peak efficiency because of genetic and environmental influences, principally malnutrition. Development towards the divine proportion is therefore a visible reflection of health and survival advantage[3].

When considered from the viewpoint of the 'selfish gene', attractiveness has been an issue since the dawn of sexual reproduction; Darwinian evolution relies on the principle of non-random selection. Progress needs a direction in which to move and this is formed principally by the 'survival of the fittest', reaching reproductive maturity and yielding offspring. However, a second filter is formed by competition for partners—sexual selection[8]. The natural variation within a species creates a range of phenotypes and thus a rank of survival advantage, with some better adapted to attract a partner than others, 'survival of the prettiest'. From an evolutionary aspect, function always precedes form[6]. If the genetic objective of life is to mate with the best available partner, any features promoting the owner's genome will be a favourable investment. Many species of fish are brightly coloured and intricately patterned, exposing themselves to predators in the effort to reproduce; the exquisite tail of a peacock may appear to be a costly luxury but has the clear aim of attracting a hen[8]. These characteristics may be intended to express an individual's ability to survive despite such extravagance[9].

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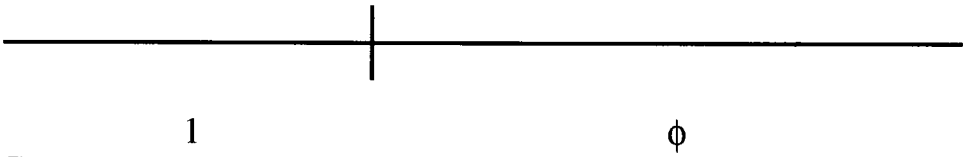

Figure 1 **The golden section, $\phi \approx 1.618$ (Ref 4)**

In human sexual selection, males and females have different reproductive strategies[10,11]. A male requires a partner who is receptive, highly fertile and healthy[11]. In 1871 Charles Darwin noted that 'In civilised life, man is largely . . . influenced in the choice of his wife by external appearance'[12]. It is a fundamental assumption of evolution-based mate selection theories that attractive physical features provide external clues to health and fertility status, the most important requirements for genetic success. Since mating with less fertile females can be costly in terms of lost opportunities, males attach more importance to their partner's appearance. In response, females show greater intra-sexual competition to display characteristics linked with reproductive potential—physical attractiveness, health and youth[10]. Since ancient times, various mechanisms have been used to increase an individual's observed beauty. Artificial reddening of the cheeks gives a 'healthy glow', whilst darkening of the lips and eye margins exaggerates normal sexual responses, suggesting that the subject is receptive. Skin wrinkling is a sign of dermal sun damage, indicating ageing and hence decreased fertility; formulated creams and surgery aim to deceive by restoring a youthful appearance[13]. These adaptations are intended to enhance image perception by a prospective mate. Other features such as good muscle tone, lustrous hair and behavioural indicators of youth may also be involved in the initial stage of sexual selection[11].

On the other hand, females can increase their reproductive success by choosing a high-status male who commands resources and can provide material security for her offspring[11]. Consequently, rivalry to attract women focuses on acquiring and displaying such assets, as constantly demonstrated by young men. Longitudinal data suggest that physically attractive women tend to marry men of high occupational position[10]. Is this to say that, for some at least, 'beauty is only wallet deep?'

The classic aesthetic criteria have been defined since the Greek Golden Age. A relatively short lower face, slender mandible, large eyes, full lips, high zygomatic arches and light unblemished skin are all features linked with facial attractiveness[2,8]. Many of these are reflections of the development of underlying bony structures[3]. The

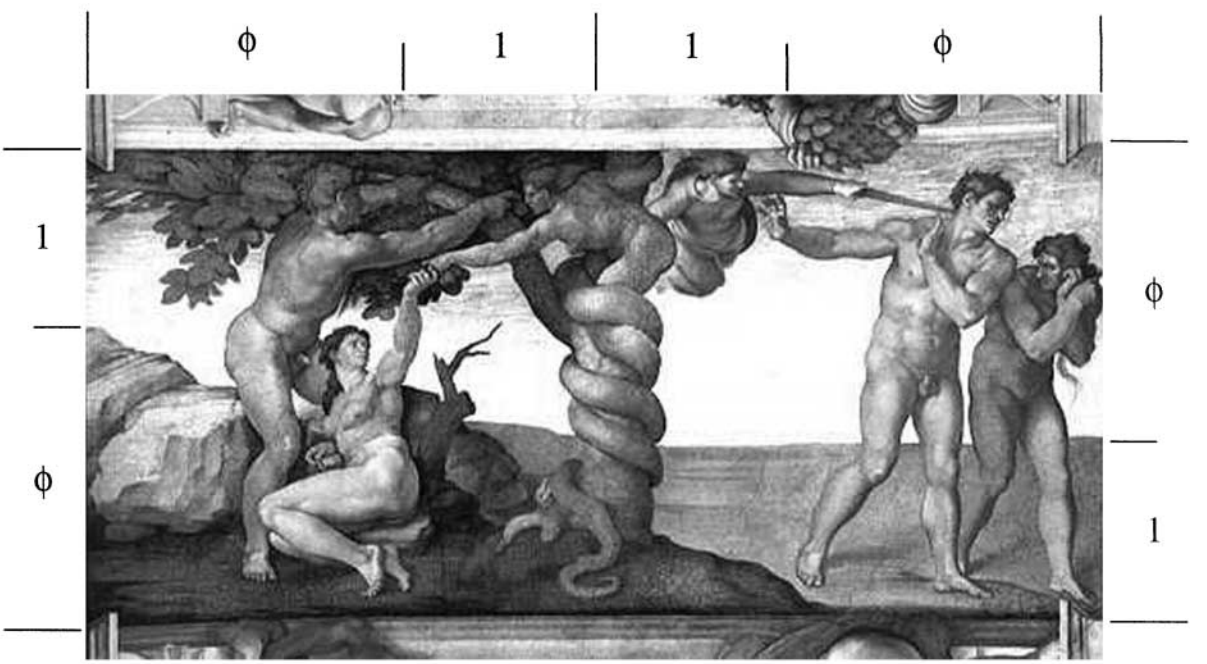

Figure 2 ***Temptation and Expulsion from Eden*** **by Michelangelo (1475–1564).** From the ceiling of the Sistine Chapel, illustrating the importance of ϕ in the panel's organization[7]. Note the positioning of the background and the arrangement of significant events on each side—the taking of the apple and enforcement of exile

morphology of the face depends upon both genetic and environmental factors. Some inherited disorders that result in individuals of low fertility also produce distinct craniofacial deformities, although the reverse does not apply. The face is particularly susceptible to deformation during gestation and the neonatal period, when nutrition plays an important role in development. Later in life, endocrine abnormalities have a substantial impact on both facial form and fertility. The development of secondary sexual characteristics is significant in the perception of attractiveness. Testosterone causes growth of the lower face and jaw, whilst high levels of oestrogen increase lip volume. Baby-like neotenous traits are considered extremely attractive in females[14]. In this way, the face reflects present and developmental factors that may influence fertility.

The relative predominance of oestrogens or androgens has further effects on appearance. Fat distribution has striking gender-specific differences in the abdominal and gluteofemoral regions, and is reflected in the waist-to-hip ratio (WHR), a practical measure of body shape. Oestrogens stimulate deposition in the buttocks and thighs but increase abdominal utilization, resulting in a gynoid 'hourglass figure'; this change is associated with menarche, signifying that a woman is now fertile[11].

Reproductive success requires a greater energy commitment from the female for fetal development and milk production. Fat deposits from the gluteofemoral region are utilized almost exclusively during late pregnancy and lactation[11]. A woman with a low WHR displays adequate energy reserves to promote the survival of her offspring. Historically and cross-culturally, gynoidal fat distribution is associated with female reproductive value; the most consistent feature of stone-age fertility goddesses is their gynoid figure[15]. On the other hand, the bodily feature most altered by pregnancy is the waist. A high WHR may mimic pregnancy and thereby make a woman less attractive; mating with a partner who is already pregnant is evolutionarily untimely[11]. There is growing evidence that WHR is an accurate somatic indicator of reproductive endocrine status and long-term health risk. Those features signalling health play a critical role in mate selection[10,11,16]. Adopting a partner who is relatively resistant to current diseases ensures that he or she will be able to provide high parental care as well as inherent resistance for the offspring[11]. Modern dieting principally aims to reduce abdominal fat, thereby achieving a smaller waist and a lower, more healthy and more attractive WHR[10].

Male reproductive success depends more on muscular strength than fat storage, enabling men to hunt, defend territory and protect their mate and offspring[11]. Such differential demands have required the morphological innovation of an android appearance produced by testosterone.

'BEAUTY IS ALTOGETHER IN THE EYE OF THE BEHOLDER'[17]

As these physical features have evolved to express beauty, a similar development must have occurred simultaneously in areas of sensory recognition to provide the driving force for sexual selection. After all, the perception of beauty requires two complementary processes to express and appreciate its presence. But to what extent does the beholder determine its presence?

Judgment of facial attractiveness is thought to be an instinctive phenomenon. Babies as young as three months have a marked preference for attractive faces, as defined by adult preferences[18]. This suggests an innate ability of humans to appreciate facial form and balance. Cross-cultural studies have shown that the basis for determining beauty is consistent irrespective of the ethnic origin of either participant[6]. However, some secular influences have been proposed by comparisons between sixteenth century nude paintings and present-day fashion models[11].

Beauty can be defined biologically as something that the visual processing segment of the nervous system finds attractive[19]. Ganglion cells in the retina are arranged in overlapping concentric circles, linked by inhibitory pathways. At the border between darkness and light, these cells become highly stimulated, resulting in an intense excitatory signal to the brain whilst inhibiting neighbouring cells[20]. Through this arrangement, the visual cortex is particularly sensitive to contrast, which it perceives as an attractive stimulus. This forms the visual objective for artificial enhancement of the eyes with cosmetics: increasing the intensity of the dark–light boundary excites the retina of the observer. Such adaptations are possible because beauty is essentially a visual phenomenon and is therefore exposed to the influences of optical illusions. However, there is more to beauty than meets the eye. The observation of true beauty arouses an emotional level of pleasure that is perceived not in the cognitive neocortex but deep within the subconscious limbic system[6]. Such an arrangement has developed in response to the pressures that have shaped the brain throughout its evolution[8]. An attractive woman who 'turns heads' clearly provokes an instinctive response by stimulating primitive reflexes in the beholder.

Appearance does not just arouse emotions in others; conditions such as acne vulgaris can detract from facial image particularly in the mind of the subject[21]. Self perception is an important factor affecting an individual's psyche; confidence in one's own appearance provides the necessary stability for social interactions whilst, during depressive episodes, low self-esteem distorts judgment of mien, worth and ability.

The face is used for both communication and the display of beauty—separate functions that may have distinct neuroanatomical pathways. Some facial characteristics are asymmetrical and are associated with hemispheric

specialization. The right cerebral hemisphere is dominant in facial recognition and identification, whilst the left is associated with the perception and production of language. However, the degree of labour division differs between the sexes; men are more functionally lateralized for visuo-spatial skills, women for language[22].

All faces are asymmetrical when viewed as split-face images; that is, left–left and right–right composites of the same face appear different. With this technique, the left side of the face has been found to be more expressive than the right in both sexes. Beauty, however, has been shown to be more pronounced on the right side of women's faces, with no difference in men. Lateralizing of facial expressions on the left, to be perceived by the left hemisphere of the observer, allows beauty to be emphasized on the right side of the face and perceived by a male's right (preferred) hemisphere[22]. Segregation of expression and beauty may be related to competing evolutionary pressures—sex-related differences in hemispheric specialization evolving in parallel to facial asymmetry, to optimize the exchange of signals between face and brain[23]. Indeed, the finding that no such mechanism for characterizing beauty is present in females confirms that beauty is a male-driven emotion based in evolutionary neuropsychology, rather than a purely social concept[22].

'THE SAYING THAT BEAUTY IS BUT SKIN-DEEP IS BUT A SKIN-DEEP SAYING'[24]

In conclusion, beauty is a universal phenomenon, present across many species and all ages. Indeed, the outward reflection of beauty reaches anatomically deeper than bone and evolutionarily beyond the genes. Throughout the higher animal kingdom, reproductive division of labour between the sexes has led to greater success through role specialization. Beauty is a consequence of this process, exploited to demonstrate fecundity and attract a suitable partner. In human beings, it has become a principally male concept of favourable female appearance, not through social conventions but via evolution[23]. As a marker of female reproductive potential, it incites deep-seated emotional responses; the possession of an inherent drive to seek beautiful, ideally proportioned mates ensures that sexual selection exerts control over the gene pool[3]. This is by no means to say that females cannot experience beauty. The humanities are often described in such terms, a piece of music or a work of art. However, to draw the present evidence to its natural conclusion, women do not innately possess the same allure to the female form as do men.

But as 'the snake' put it: 'I'm tired of all this nonsense about beauty being only skin-deep. That's deep enough. What do you want—an adorable pancreas?'[25]

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