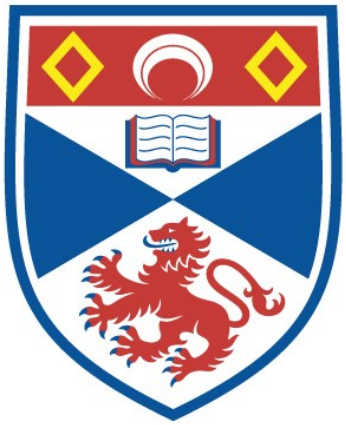
THE ROLE OF APPARENT HEALTH IN FACE PREFERENCES

Benedict Christopher Jones

A Thesis Submitted for the Degree of PhD
at the
University of St Andrews



2005

The role of apparent health in face preferences

by

Benedict Christopher Jones

A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy

University of St Andrews

2004

Supervisor: Professor D. I. Perrett

Declarations

I, Benedict Christopher Jones, hereby certify that this thesis, which is approximately 34,000 words in length, has been written by me, that it is the record of work carried out by me and that it has not been submitted in any previous application for a higher degree.

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Publications list

Parts of this thesis are adapted from the publications listed below

Jones, B. C., Little, A. C., Penton-Voak, I. S., Tiddeman, B. P., Burt, D. M. & Perrett, D. I. Facial symmetry and judgements of apparent health: Support for a "good genes" explanation of the attractiveness-symmetry relationship. *Evolution and Human Behavior*, **22**, 417-429 (2001).

Jones, B.C., Little, A.C., Feinberg, D.R., Tiddeman, B.P., Penton-Voak, I.S. & Perrett, D.I. The relationship between shape symmetry and visible skin condition in male facial attractiveness. *Evolution and Human Behavior*, **25**, 24-30 (2004).

Jones, B. C., Little, A. C. & Perrett, D. I. (2003). Why are symmetrical faces attractive? *Advances in Psychology Research,* in press.

General abstract

This thesis describes a series of empirical studies that investigated the role of apparent health in face preferences. Chapter 1 summarises previous work showing that facial symmetry, averageness and sexual dimorphism influence judgements of facial attractiveness. Chapter 2 describes studies demonstrating that consideration of the role of apparent health in face preferences offers insight into the motivations that underpin attraction to symmetric faces. Chapters 3 – 5 describe studies demonstrating that, while people generally prefer faces that appear healthy to those that appear unhealthy, characteristics of the judges (e.g. hormonal, health and developmental factors) contribute to systematic variation in women's preferences for apparent health. In the final chapter, a positive link between lifestyle health (e.g. exercise behaviour) and facial health was demonstrated. The findings described in this thesis are evidence that preferences for healthy faces are influenced by biological factors and evidence for accuracy in attributions of health to faces.

Acknowledgements

Gracias

I would like to thank my colleagues in the Perception Laboratory who contributed so much to my work and shaped my thinking about how we "read faces" (Dave Perrett, Tony Little, Ian Penton-Voak, Anne Perrett, Mike Burt, Lynda Boothroyd, Elisabeth Cornwell, Fhionna Moore, Miriam Law Smith and Sophia Durranni). I'd also like to thank Lesley Ferrier for assistance with data collection and Susie Whiten, Bob Pitman and Steven Hillier for their advice about hormone analysis. Thanks also to those in the Daly-Wilson Lab (McMaster University) who let me "set up shop" there for 3 months and contributed much to how I think about my work (Martin Daly, Margo Wilson, Lisa DeBruine, Andrew Clark, Pat Barclay, Danny Krupp, Paul Ramos, Mel McKenzie, Ange Chang and Al Honey). Thanks also to Craig Roberts for demonstrating genetics can be fun and to my housemates for putting up with my face-related-chatter (Martin O'Neil, Mark Thompson, Alex Valjero, Vicki Horner).

Muchos Gracias

Special thanks to Dave Perrett for being the best supervisor I can imagine having, my wife Lisa DeBruine for being the best partner I can imagine having and Anne, Barry, Stevie and Lillian Jones for being the best family I can imagine having.

This thesis is dedicated to my granddad, David Jones

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Chapter 1.

Facial attractiveness: visual parameters and theories

1. Abstract

This introductory chapter establishes why it is important to study physical attractiveness generally and facial attractiveness specifically. Evidence that visual parameters such as symmetry, sex-typicality (masculinity-femininity) and prototypicality (averageness) of faces influence their attractiveness is described. Evidence from cross-cultural, developmental and brain imaging studies that suggest judgements of facial attractiveness have a biological basis are outlined and the 2 most common perspectives on biological based face attraction (adaptationist and perceptual bias perspectives) are introduced. This chapter identifies the importance of developing a fuller understanding of the role of apparent health in attraction to faces.

2. Why study physical attractiveness?

Physical attractiveness influences many different aspects of human social interaction (see Feingold, 1995 for a review). For example, people preferentially mate with (Gangestad and Buss, 1993), date (Huston, 1973), associate with (Jacobson and Trivers, 2002), employ (Chiu and Babcock, 2002) and even vote for (Klein and Ohr, 2000) physically attractive individuals. Although both males and females claim in self-report that attractiveness is not of primary importance when choosing a partner (Buss, 1989), the single best predictor of satisfaction with a 'blind date' is facial attractiveness for both men and women (Walster et al, 1966). Furthermore, the physical attractiveness of misbehaving children (Dion, 1972) and individuals appearing in court on charges such as burglary and fraud (Sigall and Ostgrove, 1975) has been found to influence others' perceptions of the seriousness of their misdemeanours. Intiguingly, attractiveness counts against fraudsters when juries pass sentence, while attractiveness reduces the perceived seriousness of the crime of burglary (Sigall and Ostgrove, 1975). The influence of physical attractiveness is even apparent in aspects of human social interaction as fundamental as the bonding between mothers and infants (Hildebrandt and Fitzgerald, 1983) or the level of care nurses provide for premature-born infants (Badr et al., 2001). As physical attractiveness is important for many aspects of everyday life many studies have investigated what physical characteristics are considered to be attractive.

3. Why study facial attractiveness?

Although the attractiveness of bodies has also been investigated (e.g. Singh, 1993; Tovée and Cornelissen, 1999; Yu and Shepard, 1998), most experimental research has focused

on identifying attractive facial characteristics. This emphasis on the study of facial attractiveness is consistent with the claims that the face plays a central role in human social interactions (Bruce and Young, 1986) and is more important for judgements of the attractiveness of the "whole person" (i.e. the face and body presented together) than body attractiveness (Furnham et al., 2001). For example, for women, a youthful facial appearance appears to be more important for their attractiveness than a youthful body shape (Furnham et al., 2004).

There is extensive neural evidence that faces are special in terms of how they are encoded. Findings from brain imaging studies (Kanwisher et al., 1997) and single-cell recordings (Perrett et al., 1992) have identified brain areas that appear to be selectively responsive to faces (or at least classes of stimuli with which we have great visual experience – see later discussion). The face-specificity of these findings has lead some to propose automatic processing of faces (Farah, 1995). Ro et al. (2001) and Gilchrist et al. (2003), using induced change blindness and anti-saccade paradigms respectively, have reported behavioural evidence for mandatory attention to faces. Although Palmero and Rhodes (2003) demonstrated that the design of the Ro et al. (2001) study confounded automatic attention to faces with automatic attention to the "odd-one-out" in a grid-linear presentation of stimuli, this criticism does not apply to the Gilchrist et al. study.

Thus, one answer to the question "why focus on *facial* attractiveness?" is "we automatically encode and process faces during social interactions to a greater extent than other visual cues". Indeed, the configural processing of faces, that emerges very early in

infancy (Le Grand et al., 2003; Walton and Bower, 1993), develops earlier than configural processing of bodies (Slaughter et al., 2002). The configural processing faces enjoy appears to be a property of the expertise of the viewer (acquired through visual experience of faces), rather than a property of faces themselves (Gauthier et al., 1999, 2001). Indeed, experts at classifying other stimuli (e.g. cars) show activation in the visual cortex (fusiform gyrus specifically) when viewing these stimuli that is similar to the location observed for activation when viewing faces (Gauthier et al., 2000). Although these findings suggest apparent face specificity might reflect our great experience with faces, it is clear that faces plays a special role in person perception.

4. What facial characteristics are attractive?

Research suggests that there are 3 important visual cues that contribute to human judgments of facial attractiveness: symmetry, averageness and sexually dimorphic traits.

4.1 Symmetry

A number of studies have tested for an attractiveness-symmetry relationship using photographs of real faces. These studies have typically used one of two techniques to assess facial symmetry: facial metric and perceptual techniques. Using the facial metric technique, each face-image is first scaled and rotated to a standard interpupillary distance. A horizontal axis is then created that bisects both pupil centres. A vertical axis is set perpendicular to, and bisecting, the horizontal axis. Distances between the vertical axis and each of 12 bilaterally paired points (following an original study by Thornhill & Gangestad, 1994, see Figure 1) are measured parallel to the horizontal axis. These signed

distances are then summed to calculate horizontal asymmetry (alternatively referred to as L - R asymmetry, Hume and Montgomerie, 2001). Vertical asymmetry can also be calculated using similar distance measurements. Calculating facial asymmetry using horizontal asymmetries only (in line with Hume and Montgomerie, 2001; Rhodes et al., 2001b), rather than combining vertical and horizontal asymmetries, as other studies have done (e.g. Grammer and Thornhill, 1994; Scheib et al., 1999), may be most relevant to human perceivers as humans are primarily sensitive to horizontal asymmetries in complex biological images (Evans et al., 2000). It has been reported that facial metric techniques of this kind yield measurements of facial asymmetry that can be calculated with high repeatability (e.g. Hume and Montgomerie, 2001). Both studies that have calculated horizontal asymmetry (Hume and Montgomerie, 2001; Rhodes et al., 2001b) and those that have combined horizontal and vertical asymmetries (Grammer and Thornhill, 1994; Scheib et al., 1999) have found that asymmetry was negatively correlated with ratings of the facial attractiveness of both males and females.

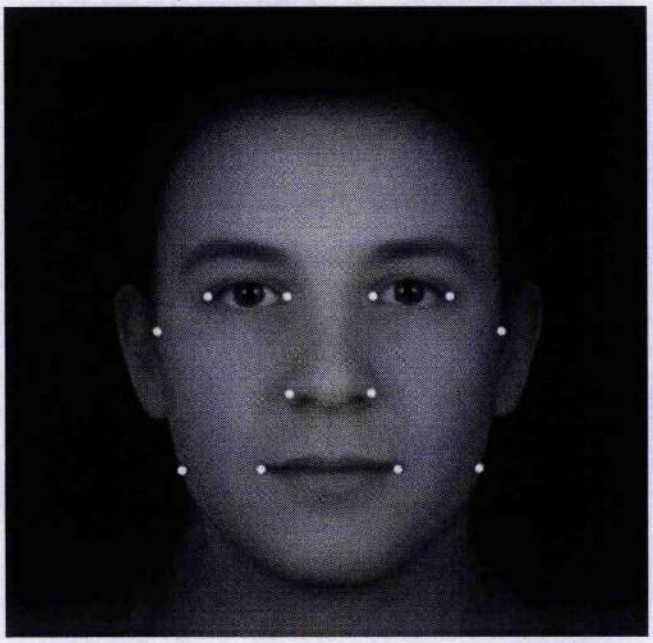

Figure 1. Pairs of bilateral points used to calculate facial symmetry (e.g. Grammer and Thornhill, 1994). This figure is taken from Jones et al. (2001).

With the perceptual measure of facial symmetry (Mealey et al., 1999), high symmetry is indicated by high ratings of the similarity between a left-left chimeric face (the original full-face photograph split down a central vertical axis and the left side of the face aligned with a mirror-reflected version of the left side of the face) and a right-right chimeric face (the original full-face photograph split down a central vertical axis and the right side of the face aligned with a mirror-reflected version of the right side of the face). Examples of left-left and right-right chimeric faces are shown in Figure 2. It has been reported that facial symmetry assessed using the facial metric and perceptual measures yielded estimates that were positively correlated (Penton-Voak et al., 2001). Studies that have tested the attractiveness-symmetry relationship using the perceptual assessment of facial symmetry have reported that symmetry was associated with ratings of the attractiveness

of both male (Mealey et al., 1999; Penton-Voak et al., 2001; Rhodes et al., 2001b, 1999) and female (Rhodes et al., 2001b, 1999) faces. Thus, studies using facial metric and perceptual assessments of symmetry have found that symmetry was positively correlated with judgements of facial attractiveness.

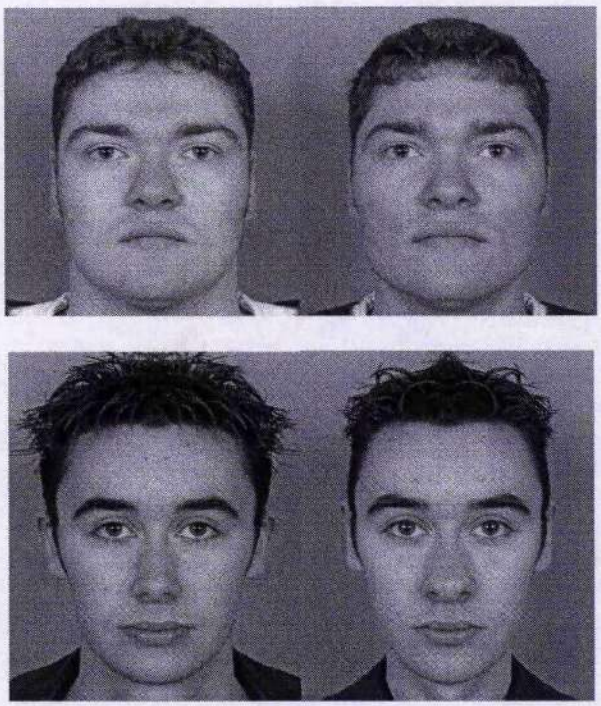

Figure 2. Technique for estimating facial symmetry using a perceptual method (e.g. Penton-Voak et al., 2001). The bottom row shows left-left and right-right chimeric faces generated from an asymmetric face (the chimeras look dissimilar). The bottom top shows left-left and right-right chimeric faces generated from a symmetric face (the chimeras look very similar).

Studies examining either perceptual or facial-metric measured symmetry use photographs of real faces. By contrast, other studies have used computer graphic techniques to

investigate the relationship between facial symmetry and attractiveness. Several researchers used the chimeric faces technique (Figure 2) to manipulate facial symmetry (Kowner, 1996, Langlois et al., 1994; Samuels et al., 1994). Attraction to these symmetrical faces was compared with attraction to the original versions. In these studies the asymmetric (original) faces were preferred. Perrett et al. (1999) noted, however, that chimeric faces tend to have an unnatural look, as the central features tend to appear atypically small or large (see also Swaddle and Cuthill, 1994).

Findings indicate that faces manipulated to be more symmetric, using computer graphic techniques to warp a face into a more symmetric shape, are preferred to the original, relatively asymmetric, images (Little et al., 2001; Perrett et al., 1999; Rhodes et al., 1998, 2001a). An example of the stimuli used by Perrett et al. (1999) and Little et al. (2001) is shown in Figure 3. As facial symmetry alone was varied in these studies, many researchers have concluded that symmetry is not only positively associated with judgements of facial attractiveness but that symmetry also acts as a visual cue for judgements of the attractiveness of real faces (Little et al., 2001; Perrett et al., 1999; Rhodes et al., 1998, 2001a).

Figure 3. Examples of symmetric (left) and original (right) versions of a face. Note the faces possess equivalent surface information (Perrett et al., 1999)

Relationships between facial symmetry and attractiveness judgements of faces in which the visibility of cues to facial symmetry was reduced have also been reported (Penton-Voak et al., 2001; Scheib et al., 1999). These findings suggest that correlates of symmetry influence attractiveness independently of symmetry itself. Although Scheib et al. (1999) found that symmetry remained correlated with attractiveness judgements of faces split down a central vertical axis and presented as half-faces, cues to symmetry may remain in half-faces (Scognamillo et al., 2003). For example, if the nose of a half-face (or any midline feature) appears atypically wide or narrow then this would indicate that the nose was likely to be asymmetric. Penton-Voak et al. (2001) present a more persuasive case, manufacturing 2 composite faces with the mean colour and shape of subsamples of asymmetric and symmetric male faces respectively (Figure 4). As composite faces tend towards high symmetry (Alley and Cunningham, 1991) the 2 faces compared by Penton-Voak et al. (2001) were of equivalent symmetry. Despite the equivalence of symmetry, the composite face comprising males with symmetric faces was judged the more attractive of the 2.

Figure 4. Composites of symmetric (left) and asymmetric (right) male faces (Penton-Voak et al., 2001)

4.2 Averageness

In recent years, digital image manipulation techniques have been developed that can "blend" the face-images of many members of a group to create a composite (or average) face that represents the mean facial shape and colour for the sample (Benson and Perrett, 1992, 1993; Rowland and Perrett, 1995). These composite faces are typically judged as more attractive than images of individual faces (Grammer and Thornhill, 1994; Langlois and Roggman, 1990; Langlois et al., 1994; Little and Hancock, 2002; O'Toole et al., 1999; Rhodes et al., 1999; 2001a). Early image processing techniques for generating composite faces (e.g. Rowland and Perrett, 1995) were unable to maintain texture and were limited to the representation of shape and colour information (although more recently Tiddeman et al., 2001 have developed techniques that extract texture information from faces). As a consequence, only composite faces with unnaturally smooth skin

textures could be generated using these older image processing techniques (see Alley and Cunningham, 1991, for criticism of these older digital blending techniques). Thus, it was suggested that composite faces were only judged attractive because of their smooth skin (Alley and Cunningham, 1991). However, when facial averageness was manipulated in shape only (O'Toole et al., 1999; Little and Hancock, 2002) the attractiveness enhancement effect of averageness remained. These findings indicate that the averageness-attractiveness relationship is not solely due to the smoothing process that occurs when composite faces are manufactured. Indeed, O'Toole et al. (1998) and Little and Hancock (2002) have found that averageness of facial shape and surface information independently positively influence facial attractiveness.

The link between averageness and attractiveness has also been studied with unmanipulated images. Ratings of facial distinctiveness, the converse of facial averageness (Rhodes et al., 1999), are inversely associated with ratings of facial attractiveness (Light et al., 1981; Rhodes et al., 1999). Although raters agree on judgements of distinctiveness (Rhodes et al., 1999), the validity of distinctiveness as a measure of averageness might be questioned as some researchers have suggested perceptual ratings of biological properties need not necessarily reflect the biological properties themselves (Meyer and Quong, 1999). Little and Hancock (2002), however, found that distinctiveness ratings did reflect manipulations of the averageness of computer graphic faces. Moreover, Bruce et al. (1994) found that an objective measure of averageness derived from measurements of facial proportions was significantly correlated with reverse-scored distinctiveness ratings. This also supports the claim that

distinctiveness ratings reflect actual facial averageness. Others (e.g. Wickham and Morris, 2003) have suggested that the link between averageness and attractiveness is far more complex than other researchers have suggested, finding that unattractive faces were rated as distinctive but attractive faces varied widely in rated distinctiveness.

Studies have also explored the relationship between measured facial proportions and judgements of facial attractiveness. These have typically found that averageness was associated with judgements of attractiveness (Farkas and Munro, 1984; Jones and Hill, 1993; Strzalko and Kazycka, 1992; Wickham and Morris, 2003) although Pollard et al. (1999) found no link between measured facial averageness and facial attractiveness.

The findings of studies reporting positive links between averageness and attractiveness have convinced some researchers that averageness is the critical determinant of facial attractiveness (e.g. Langlois et al., 1990). Grammer and Thornhill (1994) and Perrett et al. (1994), however, have disputed this claim, finding that the shapes of highly attractive faces were systematically different from average. Grammer and Thornhill (1994) found that male faces with large facial traits were more attractive than those with traits of average size. Perrett et al. (1994) found that a composite face manufactured in the mean shape of the most attractive 20 faces out of a sample of 60 was more attractive than a composite face manufactured in the mean shape of the sample of 60. Moreover, exaggerating the differences in shape between these 2 faces exaggerated the effect (Figure 5). As highly masculine or highly feminine faces are, by definition,

systematically different from the average shape, potential relationships between facial attractiveness and the dimension masculinity-femininity have been investigated.

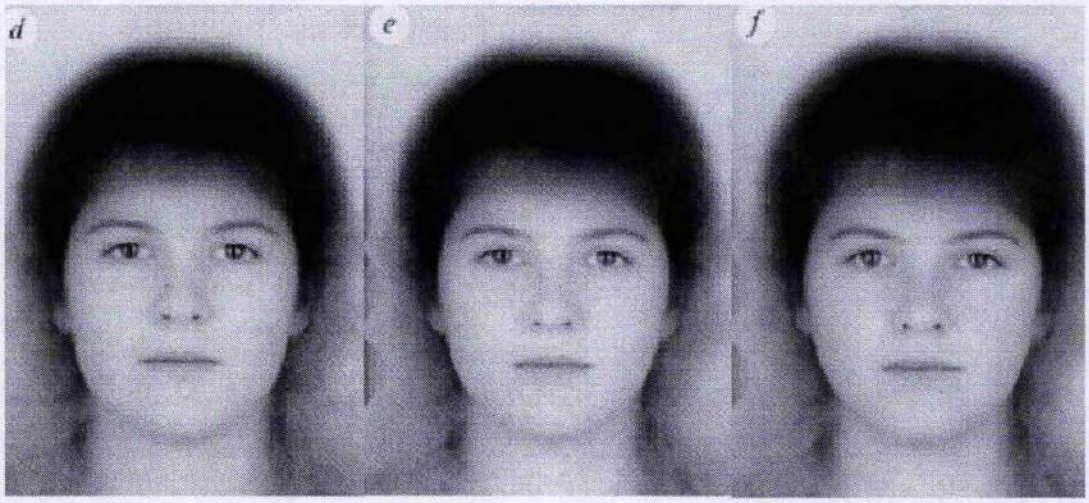

Figure 5. Average female face (left), composite of most attractive 25% of sample (centre) and composite female with shape difference between average and high-attractive average exaggerated (Perrett et al., 1994).

4.3 Sexually dimorphic characteristics

4.3.1 Masculinity and male facial attractiveness

Experiments exploring the relationship between sexual dimorphism (secondary sexual characteristics) and male facial attractiveness have reported inconsistent findings. Using facial metric techniques (measurements of face proportions from photographs), Grammer and Thornhill (1994) and Cunningham et al. (1990) found that jaw size (a masculine trait) was positively associated with female judgements of the attractiveness of male faces. In line with these findings, Scheib et al. (1999) reported that female ratings of the attractiveness of male faces were positively associated with a composite facial

masculinity score, derived from measurements of facial proportions (cheekbone prominence, lower face length relative to total face length). Penton-Voak et al. (2001), however, found that prominent cheekbones are a feminine trait.

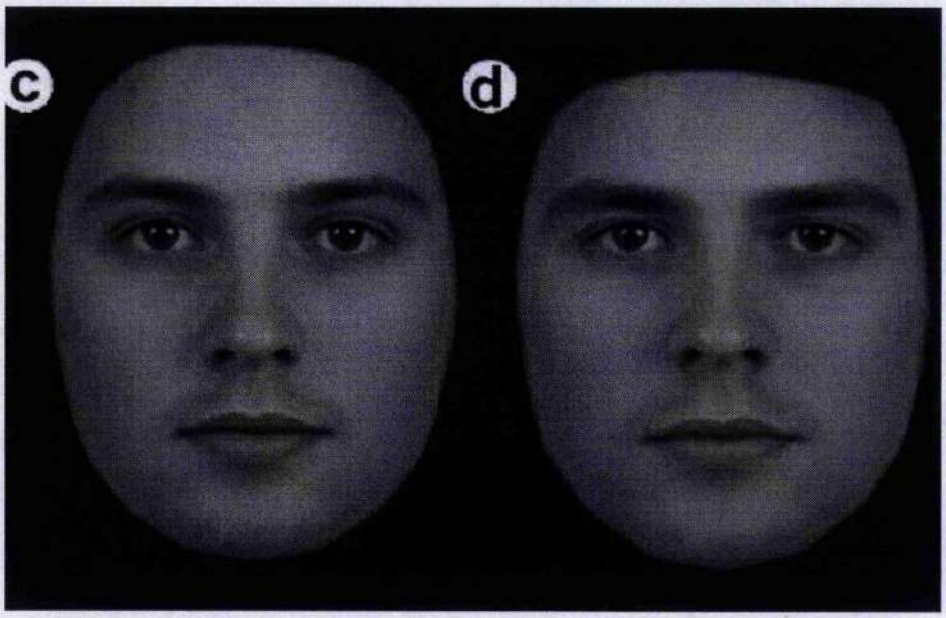

Figure 6. Masculinised (right) and feminised (left) versions of a composite male face (sensu Perrett et al., 1998). Only face shape is altered.

It has been been reported that judges found a computer-generated average male face (see Rowland and Perrett, 1995) most attractive when the facial shape was warped towards the mean of a female sample, rather than when the face shape was masculinised by exaggerating the shape differences between an average male face and an average female face (Perrett et al., 1998) (Figure 6). This technique is referred to here and elsewhere (e.g. Johnston et al., 2001) as the "caricaturing technique". Rhodes et al. (2000), using a similar technique, reported findings consistent with those of Perrett et al. (1998).

Johnston et al. (2001) have suggested that the "caricaturing technique" (Perrett et al., 1998) assumes that an extreme masculine face shape can be generated by a linear extrapolation of the differences between male and female average faces. This linear growth assumption may not be valid as between-sex differences in facial shape are the result of bone growth caused by complex interactions between growth hormone, androgens and oestrogen (Grumbach, 2000; Tanner, 1978). Johnston et al. (2001) reported that females preferred a smooth-textured average male face that had been masculinised by transforming the shape and colour towards that of a male face "evolved" (see Johnston and Franklin, 1993) on the basis of perceived masculinity, rather than when transformed towards the mean of a female sample. Although it has been suggested that perceptual judgements of physical characteristics may not necessarily reflect the biological properties they are held to represent (Evans et al., 2000; Meyer and Quong, 1999; Perrett and Penton-Voak, 1999), ratings of the masculinity of male faces are positively correlated with the individuals' circulating testosterone levels (Penton-Voak and Chen, submitted, see Figure 7). Although Neave et al. (2003) found no relationship between circulating testosterone level and males' facial rated masculinity or dominance, this may reflect differences in the methodologies used to assess masculinity attributions.

Swaddle and Rierson (2002) manipulated the shape of male faces using data from studies of face proportion change during puberty (e.g. Enlow, 1990). This study found that masculinising or feminising male faces did not impact on the attractiveness of the male faces: the average face was preferred over the masculine and feminine versions. By contrast, the masculine face was judged most dominant, indicating that the differences in

masculinity were visible. Other studies have also found neither a general preference for masculinity or femininity (e.g. Cornwell et al., 2004).

Figure 7. Composite faces of males with low (left) and high (right) circulating levels of testosterone (Penton-Voak and Chen, in review)

Although studies of the link between masculinity and male facial attractiveness have yielded inconsistent findings, there is consensus among studies that masculinity of body shape positively influences male body attractiveness. For example, studies have reported that attractive male bodies possess broad shoulders and chests (masculine traits indicating muscularity) (Cunningham, 1990; Maisey et al., 1999). Women, however, do not find *extremely* muscular males highly attractive (Cunningham, 1990). There is also consensus among studies that women do prefer masculine properties in male voices (e.g. low pitch, Feinberg et al., in press; Collins, 2000). By contrast, putative male pheremones are extremely unappealing! (Cornwell et al., 2004).

In summary, masculinity in male faces is not clearly linked to attractiveness. This may be because of systematic variation in female attraction to masculine male faces. Indeed, Cornwell et al. (2004) found that women's preferences for shape masculinity in male faces and a putative male pheromone were positively related, indicating systematic variation in masculinity preferences occurs.

4.3.2 Femininity and female facial attractiveness

By contrast with the inconsistent findings regarding the link between male facial attractiveness and masculinity, studies have typically found that femininity is strongly related to female facial attractiveness. Indeed, strong positive correlations between perceptual ratings of the femininity and attractiveness of female faces suggest the 2 characteristics may be equivalent (O'Toole et al., 1998; Rhodes et al., 2003). Using computer graphic techniques, Perrett et al. (1998), Johnston et al. (2001) and Rhodes et al. (2000) have reported that femininized female face shapes are more attractive than average or masculinized female face shapes (Figure 8). Although femininity of texture (smooth, homogenous texture) is attractive in female faces (Fink et al., 2001), evidence for a link between femininity (paleness) of coloration and attractiveness is equivocal (Frost, 1988; Fink et al., 2001). Studies of the attractiveness of female bodies also suggest that femininity is attractive. Female bodies with low waist-to-hip ratios (WHR) that indicate a curvaceous body shape are attractive to Western observers (Furnham et al., 1997; Singh, 1993). A curvaceous body shape reflects a feminine pattern of fat deposition (Furnham et al., 1997; Singh, 1993). Although there is debate about the extent to which femininity of body shape is more important for female body attractiveness than total

amount of body fat (i.e. body mass index, BMI), with some findings suggesting that BMI is more important than WHR (e.g. Tovee et al., 1999), these studies have found that WHR contributes to female body attractiveness. There is, however, considerable debate about the extent to which a low WHR is preferred in all cultures (Furnham et al., 2002; Freedman et al., 2004; Sugiyama , 2004; Yu and Sheppard, 1998).

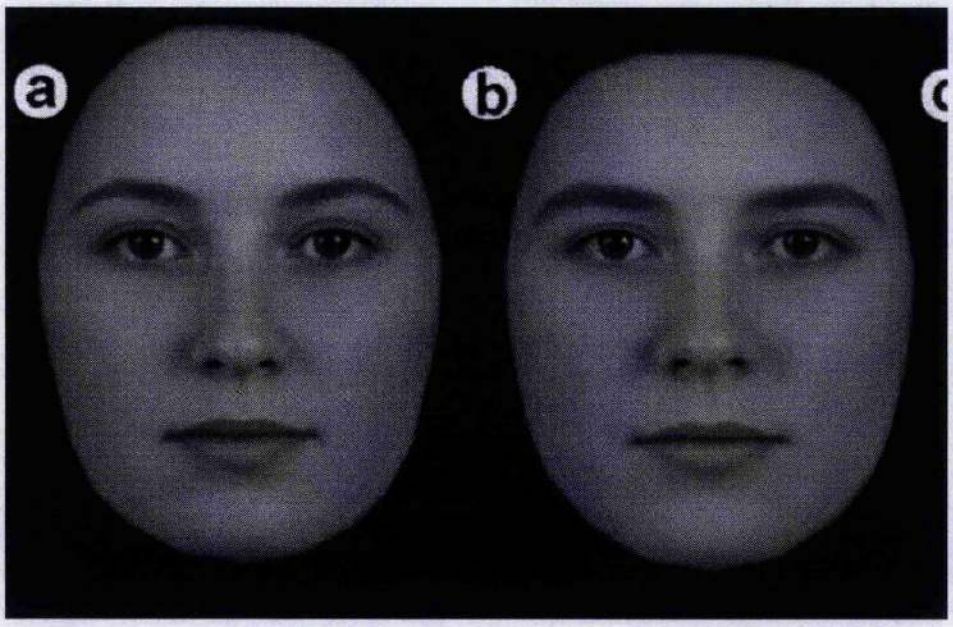

Figure 8. Masculinised (right) and feminised (left) versions of a composite female face (sensu Perrett et al., 1998). Only face shape is altered.

5. Agreement in attractiveness: evidence for biological based attraction

While a feature of many of the studies outlined so far was to test for agreement on face preferences among adults from the same cultures as the faces they viewed, the level of cross cultural agreement on attractiveness has also been investigated. The studies of masculinity-femininity preferences carried out by Penton-Voak et al. (1999) and Perrett

et al (1998) both manipulated the facial shape of Japanese and European faces and found no differences between Japanese and European raters' preferences. Moreover, Perrett et al. (1994) found that highly attractive faces deviated significantly from the average shape for Japanese and European samples. Rhodes et al. (2001) also found that preferences for symmetrical and average faces were stable across cultures. In a recent meta-analytic review, Langlois et al. (2000) reported that there was compelling evidence in the extant literature that judgements of facial attractiveness are stable across cultures. Not all studies have found agreement between judges from diverse cultures. For example, Penton-Voak et al. (2001) reported that Jamaican women preferred more masculine male faces than European or Japanese women. Japanese women also prefer more feminine male and female Japanese and European faces (Perrett et al., 1998).

High agreement between individuals in what they judge an attractive face is not limited to comparison between adults' face preferences or to comparisons between cultures. There is evidence that even young infants share the face preferences of many adults (Langlois et al., 2000). For example faces judged attractive by adult women are also judged attractive by infants (Langlois et al., 1987; Rubenestein et al., 1999; Samuels et al., 1994; Slater, 1998) although the strength of these preferences may differ (Rhodes et al., 2002). Many researchers have interpreted this high agreement between individuals, ages and cultures as evidence that judgements of facial attractiveness have a biological basis and are not arbitrary decisions (as others have suggested, e.g. Hogg and Graham, 1995).

Converging evidence that facial attractiveness has a biological basis comes from recent fMRI investigations of the neuropsychological correlates associated with viewing faces. Kampe et al. (2001) and O'Doherty et al. (2003) reported that viewing attractive faces was associated with increased activation in the nucleus acumbens / ventral striatum. These areas are thought to regulate reward (Schulz et al., 1997). These effects may interact with other aspects of facial appearance such as the gaze direction, emotional expression or sex depicted in the image (Aharon et al., 2001; Kampe et al., 2001; O'Doherty et al., 2003).

Although these studies, together with those emphasizing high agreement in attractiveness suggest that attractiveness has a biological basis, the nature of this biological basis remains controversial. The 2 most commonly applied perspectives on biological-based attraction are the adaptationist and perceptual bias perspectives.

6. Perspectives on biological based attraction

6.1 An overview of adaptationist perspectives on facial attraction

Many researchers and theorists have proposed that judging facial attractiveness is an evolved behaviour that identifies high quality potential mates (Fink and Penton-Voak, 2002; Gangestad and Simpson, 2000; Miller and Todd, 1998; Thornhill and Gangestad, 1999, 1993). This position is often referred to as the adaptationist perspective (also evolutionary advantage view, mate choice theory, good genes theory). Mate quality remains relatively poorly defined, although Thornhill and Gangestad's (1999) definition (quality defined as immunesystem and reproductive health or fitness) is, perhaps, the

most widely adopted. Attraction to immunocomopetent and / or reproductively healthy mates is potentially adaptive as offspring viability is increased (Fink and Penton-Voak, 2002; Gangestad and Simpson, 2000; Miller and Todd, 1998; Thornhill and Gangestad, 1999, 1993).

The ideas that facial attractiveness communicates health information and that we have evolved to favour faces possessing these cues (Fink and Penton-Voak, 2002; Gangestad and Simpson, 2000; Miller and Todd, 1998; Thornhill and Gangestad, 1999, 1993) are key to the adaptationist perspectives. Indeed, there is some evidence that facial attractiveness communicates health. Males' facial attractiveness has been to be found to be associated with good genes for immunocompetence (Roberts et al., 2003), good semen quality (Soler et al., 2003) and longevity (Henderson and Anglin, 2003). Females' facial attractiveness has been to be found to be associated with longevity (Henderson and Anglin, 2003), low numbers of past health problems (Hume and Montgomerie, 2001) and other indices of their health (low waist to hip ratio: Penton-Voak et al., 2003; normal body mass index: Hume and Montgomerie, 2001). Kalick et al. (1998), however, found no evidence for a positive link between male and female facial attractiveness and medical health records. Attractive faces are also perceived as healthy (Grammer and Thornhill, 1994; Kalick et al., 1998; Rhodes et al., 2001; Henderson and Anglin, 2003). Intriguingly, Roberts et al. (2004) recently found that female facial attractiveness increased during the late follicular, most fertile phase of the menstrual cycle, but only in those not using hormonal contraceptives. This suggests that cues to reproductive status

are visible and preferred in female faces, providing further support for an adaptationist perspective on attractiveness.

Further evidence supporting an adaptationist view of attractiveness comes from studies of correlations between the attractiveness of different physical traits (e.g. body and face) and traits in different modalities (e.g. voice and face). Females with attractive faces also possess attractive bodies (Thornhill and Grammer, 1999), for example, while females with attractive faces also possess attractive voices (Collins and Missing, 2002). These findings suggest that attractiveness judgements reflect attraction to a common underlying quality, such as long-term health.

6.2 An overview of perceptual bias perspectives on facial attraction

An alternative to the adaptationist perspective is the perceptual bias perspective. From this perspective, the biological-based nature of attraction to faces arises because attractive faces are those that are processed most easily by the visual system (e.g. Enquist et al., 2002; Halberstadt and Rhodes, 2000). As outlined previously, prototypical faces are judged attractive. Such faces are also processed most easily by the visual system and are judged familiar (Halberstadt and Rhodes, 2000; Rhodes).

Consistent with this view, attraction to the average is not specific to face preferences: rated averageness is preferred in birds and watches (Halberstadt and Rhodes, 2000) while manipulations of the avergeness of cars, birds and fish increase their attractiveness (Halberstadt and Rhodes, 2003). Perceived familiarity of the images appears to mediate

these preferences (Halberstadt and Rhodes, 2000), suggesting that attraction to average faces is somewhat similar to the mere exposure effect (Bornstein, 1989: prior exposure to stimuli increases their attractiveness). Indeed, short-term adaptation of prototypes following exposure to manipulated faces is sufficient to alter face preferences (Rhodes, Halberstadt & Brajkovich, 2001).

There is, however, evidence that facial averageness is associated with female medical health (at least in late youth, Rhodes et al., 2001). This latter finding is consistent with Thornhill and Gangestad's (1993) proposal that attraction to average faces may have developed because facial averageness is potentially linked to good genes for immunocompetence (see also, Langlois et al., 1990). Indeed, both ratings and manipulations of facial averageness are positively associated with health attributions (Rhodes et al., 2001).

Adaptationist (or "good genes") and perceptual bias accounts have also been applied to the links between sexual dimorphic traits and facial attractiveness. The following section addresses the nature of the link between sexually dimorphic traits and facial attractiveness in more detail. The nature of the link between symmetry and facial attractiveness is discussed in detail in chapter 2.

6.3 Adaptationist and perceptual bias perspectives on attraction to sexually dimorphic traits

Sexually dimorphic facial traits, and sexually dimorphic traits generally, are thought to reflect the action of sex hormones (Enlow et al., 1990). In males at least, there is evidence that circulating testosterone is positively related to males' facial masculinity (Penton-Voak and Chen, in press; but see also Neave et al., 2003). The same hormones that mediate the expression of pronounced sex-typical traits in all species are also immunosupressants, however (Hamilton and Zuk, 1982; Folstad and Karter, 1992). Thus, only genetically healthy males can afford the handicap of high masculine traits, while only genetically healthy females can afford the handicap of high feminine traits (Zahavi, 1975; Hamilton and Zuk, 1982; Folstad and Karter, 1992). Masculine (in males) and feminine (in females) characteristics may also be associated with fertility (Zaadstra et al., 1993). Thus, attraction to masculine male and feminine female faces might be expected as these traits are cues to immunocompetence and fertility (Fink and Penton-Voak, 2002; Gangestad and Simpson, 2000; Miller and Todd, 1998; Thornhill and Gangestad, 1999, 1993). Indeed, Rhodes et al. (2003) found that ratings of males' facial masculinity were positively related to males medical health and apparent facial health. In females, however, there was no link between perceived facial femininity and medical health.

Many studies, however, have found that masculine male faces are not preferred by females (Perrett et al., 1998; Penton-Voak et al., 1999; Little et al., 2001; 2002). Perrett et al. (1998) suggested that this aversion to masculine to male faces was due the negative personality attributions made to masculine male faces. Indeed, Mazur and Booth (1998) reported that facial dominance (i.e. masculinity, Swaddle and Rierson, 2002) was associated with negative social behaviour in males. Circulating testosterone is negatively

associated to males' scores on an investment index (i.e. masculine males invest less in partners, Gray et al., 2002). Females may have to balance attraction to facial masculinity (potentially a cue to immunocompetence) and femininity (pro-social behaviour) (Fink and Penton-Voak, 2002; Gangestad and Simpson, 2000; Miller and Todd, 1998; Thornhill and Gangestad, 1999, 1993). This trade off lies at the heart of what is perhaps the strongest evidence for adaptationist accounts of face preferences.

As preferences for masculine male faces are potentially adaptive, at least partly, because they are likely to increase offspring viability (Fink and Penton-Voak, 2002; Gangestad and Simpson, 2000; Miller and Todd, 1998; Thornhill and Gangestad, 1999, 1993), Frost (1994) suggested that preferences for these male traits might positively relate to the reproductive status (likelihood of conception occurring following sex) of the female perceivers. Consistent with Frost's suggestion, female preferences for masculine characteristics of male faces do positively co-vary with female reproductive status estimated from position in the menstrual cycle for women not using hormonal contraceptives (Frost, 1994; Johnston et al., 2001; Penton-Voak et al., 1999; Penton-Voak and Perrett, 2000). When conception risk is low during the cycle, attraction to feminine male faces is strongest. This variation in preferences for masculine male faces is strong evidence for hormonally-mediated adaptive design in face attraction (Penton-Voak and Perrett, 2000; Gangestad and Simpson, 2000). These and other sources of individual differences in female attraction to masculine male faces (attraction to masculine male faces positively related to WHR, other-rated facial attractiveness: Penton-Voak et al., 2003; self-rated attractiveness: Little et al., 2001; see Chapter 4) are also problematic for

prototype-based accounts of attraction to sexually dimorphic characteristics in faces which propose invariant attraction to sex-typical facial traits (Ghirlanda et al., 2002).

7. Summary and outline of following chapters

Central to the adaptationist perspective on face attraction is the communication of health information. Surprisingly, however, little is known about the role of apparent health in facial attractiveness. The previous sections outlined how studies of the inter-relationship between attractive aspects of faces (e.g. averageness, symmetry and attractiveness, Rhodes et al., 1998), the accuracy of face attributions (e.g. immunocompetence and health judgements, Roberts et al., 2003) and sources of individual differences in face preferences (e.g. the effects of cycle and hormonal contraceptive use on attraction to facial masculinity, Penton-Voak et al., 1999, Little et al., 2002) have provided insight into the nature of biological based face preferences. Thus, investigation of the role of apparent health in face attractiveness, the accuracy of judgements of apparent facial health and individual differences in attraction to apparent health may illuminate the nature of biological based facial attractiveness. The following chapters describe experiments investigating these issues.

Chapter 2 describes studies that investigated the relationship between facial symmetry and apparent health in faces. Chapters 3, 4 and 5 investigated the effects of hormonal profile, condition (both physical and psychological) and pubertal maturation on female preferences for apparent health in faces. Chapter 6 tested for an association between apparent health in faces and health of lifestyle.

Chapter 2.

Why are symmetrical faces attractive?

1. Abstract

Many studies have reported that symmetric faces are judged more attractive than relatively asymmetric faces. As the attractiveness of facial symmetry appears to be stable across cultures it has been suggested that the attractiveness-symmetry relationship has a biological basis. Two accounts of the nature of this biological basis have been advanced. The perceptual bias account suggests that symmetry is found attractive as a by-product of the relative ease with which the perceptual system can process all symmetric stimuli. By contrast, the good genes account notes that facial symmetry may act as an indicator of an individuals' ability to maintain good health and suggests that the attractiveness-symmetry relationship reflects psychological adaptations that have evolved to facilitate discrimination between potential mates on the basis of physical condition. This chapter reviews extant empirical data relevant to many of the issues associated with both the good genes and perceptual bias explanations and describe 4 studies that were carried out that tested hypotheses generated from the 2 theories. My review of the extant data and the new empirical studies carried out suggest that symmetrical faces are attractive because they have a particularly healthy appearance. This supports the good genes view of the attractiveness-symmetry relationship.

2. Why is facial symmetry attractive?

It has been suggested that judgements of physical attractiveness owe much to media promulgated preferences (Hogg and Graham, 1995; Katzmarzyk and Davis, 2001; Petrie et al., 1996). In other words, what we find attractive is "dictated" to us by exposure to media-generated and perpetuated ideals. For example, traits possessed by celebrities presented as attractive on film and television may increase the attractiveness of members of the public who also possess those traits. These ideals might be expected to be culture-specific. Judgements of facial attractiveness, however, appear to be stable across many diverse cultures, suggesting that some characteristics of attractive faces are universally attractive (Cunningham et al., 1995; Zebrowitz et al., 1993; Perrett et al., 1994, 1998; Rhodes et al., 2001a; for a meta-analytic review see Langlois et al., 2000). Many researchers have interpreted the existence of universally attractive traits as evidence that judgements of facial attractiveness have a biological basis (e.g. Morris, 1967; Perrett et al., 1998; Rhodes et al., 2001a). Facial symmetry appears to be a trait that is generally attractive (see Chapter 1) and also attractive across diverse cultures (Rhodes et al., 2001a). This suggests that the attractiveness of symmetry has a biological basis. Two explanations have been advanced as to the nature of this biological basis. These are often referred to as the good genes explanation and the perceptual bias explanation.

2.1 Good genes explanation

Many theorists (e.g. Fink and Penton-Voak, 2002; Gangestad and Simpson, 2000; Miller and Todd, 1998; Thornhill and Gangestad, 1999, 1993) have suggested that fluctuating asymmetry (individual variation between left and right traits that tend to be symmetric at

the population level, Ludwig, 1932; Van Valen, 1962) in humans is associated with developmental stability. Developmental stability is a direct measure of how well an individual's genome can resist disease and maintain normal development in the face of environmental perturbation (Møller, 1990; Parsons, 1992). As developmental stability appears to be heritable (see Møller and Thornhill, 1997 for a review of the heritiability of developmental stability), preferences for individuals with low fluctuating asymmetry are potentially adaptive, since mate selection on the basis of markers of developmental stability will increase offspring viability (Wedekind, 1992). Although this meta-analysis concluded that developmental stability is heritable, this remains a highly controversial issue for many researchers (Enquist et al., 2002). It has been suggested that the attractiveness of symmetrical faces reflects this adaptive preference for symmetrical individuals. In other words, symmetry may be associated with judgements of facial attractiveness because symmetry is a visual marker for qualities that are important within the context of mate selection (i.e. aspects of physical condition such as immunocompetence, fertility and physical fitness). Thus, the good genes explanation of the attractiveness-symmetry relationship suggests symmetry is attractive because it facilitates discrimination between potential mates on the basis of apparent quality (Fink and Penton-Voak, 2002; Gangestad and Simpson, 2000; Miller and Todd, 1998; Thornhill and Gangestad, 1999, 1993). This good genes explanation of the attractiveness-symmetry relationship contrasts markedly with the perceptual bias explanation. Although most research has focused on the putative *heritable* benefits associated with choosing a symmetric partner, symmetry (particularly soft-tissue asymmetry) may reflect possible

immediate benefits such as fertility. Indeed, around ovulation (high fertility), female faces are more symmetric than at other times (Cetinkaya, 2004).

2.2 Perceptual bias explanation

In order to recognize a face as being a face (rather than, say, a car or a flower) the perceptual system may match a representation of the stimuli to internal prototypical representations (see Bruce and Green, 1990, pp. 381 – 391 for a discussion of this issue and alternative theories of object classification). Symmetrical faces closely match these prototypical representations because prototypical representations are necessarily symmetrical (Enquist et al., 2002). Prototypical representations will be symmetrical because random deviations from perfect symmetry in each individual face will "even out" as the prototype develops (see Alley and Cunningham, 1991 for a discussion of the symmetrical nature of prototypical representations). The perceptual bias explanation of the attractiveness-symmetry relationship suggests that symmetrical faces are found attractive because of the effect exposure to stimuli that closely resemble prototypes has on the human nervous system (Enquist et al., 2002). Thus, the perceptual bias explanation of the attractiveness of symmetry suggests that symmetrical faces are found attractive as a by-product of the ease (in terms of efficiency) with which the perceptual system can process symmetric stimuli (e.g. Bradbury and Vehrencamp, 1998; Enquist and Arak, 1998; Enquist and Ghirlanda, 1998; Enquist et al., 2002).

3. Testing the good genes and perceptual bias explanations.

Both the good genes and perceptual bias explanations of the attractiveness-symmetry relationship raise a number of questions about the nature of the link between attractiveness and facial symmetry. These issues arise from the difference in emphasis the two explanations place on the role of symmetry in attractiveness judgements. For example, the good genes explanation of the attractiveness-symmetry relationship emphasises the role of facial symmetry in mate choice while the perceptual bias account emphasises the benefits for the efficiency of the visual recognition system when processing all symmetric stimuli. The following sections of this manuscript discuss empirical data relevant to these issues.

3.1 Does symmetry reflect physical condition?

The good genes account of the attractiveness-symmetry relationship suggests that facial symmetry is a marker for the physical condition of an individual. Tests for relationships between physical health and either facial attractiveness (Kalick et al., 1998) or facial symmetry (Rhodes et al., 2001b) have, however, found no significant associations. Though Shackelford and Larsen (1999) found weak associations between facial attractiveness and physical health, these results were not replicated across their two samples and the validity of the self-report health measures they used has been questioned (Rhodes et al., 2001b). Hume and Montgomerie (2001) have also reported associations between facial attractiveness and past health problems, though again this finding was reliant on self-reported measures of physical health. Enquist et al. (2002) have suggested that the failure to demonstrate that either facial symmetry or attractiveness reliably signal

physical condition undermines the plausibility of the good genes explanation of the attractiveness-symmetry relationship.

The good genes explanation, however, makes a claim concerning how mate selection, at a point in human history prior to the introduction of modern medicine, has shaped psychological adaptations that mediate current mate preferences. Consequently, associations between actual health in modern humans and either facial attractiveness or facial symmetry are not necessarily predicted by the good genes explanation of the attractiveness-symmetry relationship. Thus, it would appear that critics of the good genes explanation of the attractiveness-symmetry relationship have overstated the importance of demonstrating the existence of links between physical condition and facial symmetry in modern humans.

This issue aside, the general medical health investigated by Kalick et al. (1998), Shackelford and Larsen (1999), Rhodes et al. (2001b) and Hume and Montgomerie (2001) need not necessarily be the aspects of mate quality signalled by symmetry. For example, it has been suggested that physical strength and fighting ability may have been important aspects of mate quality in ancestral males, as strong males who could fight well would have been better able to compete for and retain resources (Furlow et al., 1998; Manning and Taylor, 2001). Indeed, males with symmetrical bodies are more likely to have both engaged in and won physical confrontations with other males than those with relatively asymmetric bodies (Furlow et al., 1998). Potential relationships between male facial symmetry and variables such as fighting ability and physical strength have not been

tested, however. Body symmetry also seems to be correlated with fertility (Manning et al., 1997, 1998) and intelligence (Furlow et al., 1997, 1998) in modern humans. Although Zebrowitz et al. (2002) found that facial symmetry was correlated with intelligence quotient (IQ), researchers testing for relationships between aspects of mate quality and facial symmetry have typically overlooked variables such as intelligence and fertility.

3.2 Does facial symmetry look healthy?

Although it is unclear whether or not facial symmetry signals actual physical health, there is evidence that symmetrical faces do *look* particularly healthy. Rhodes et al. (2001b), Grammer and Thornhill (1994) and Penton-Voak et al. (2001) found that facial symmetry was positively associated with ratings of the apparent health of an individual made when viewing full-face photographs. These findings are consistent with the good genes explanation of the attractiveness-symmetry relationship as this suggests that symmetry is attractive because it looks healthy (Grammer and Thornhill, 1994). By contrast, the perceptual bias account might predict that the relationship between facial symmetry and judgments of apparent health simply reflects an "attractiveness halo" where positive attributes (e.g. extraversion, stability, good health) are automatically ascribed to good looking, symmetrical individuals (see Feingold, 1992; Langlois et al., 2000 for meta-analytic reviews of research on attractiveness halo effects).

3.3 Is prototype formation sufficient for preference for symmetry?

Central to the perceptual bias account of symmetry preferences is the notion that prototype formation alone is sufficient to engender a preference for symmetry. In support

of this, Jansson et al. (2002) conducted a study in which chickens (*Gallus gallus domesticus*) were trained to respond to rewarding stimulus (slightly asymmetric crosses). Following this training period, the chickens responded to a novel symmetric cross more than the asymmetric training stimuli. Crucially, the symmetric cross was a prototype representing the asymmetric training stimuli. Chickens who had not received the initial training period did not show a preference for symmetry. Thus, it would appear that, for chickens at least, prototype formation is sufficient for preferences for symmetry to be evident.

3.4 Is facial symmetry attractive independent of prototypicality?

The perceptual bias explanation of the attractiveness-symmetry relationship suggests that symmetrical faces are attractive because they closely resemble internal prototypical representations of faces (Enquist et al., 2002). Indeed, prototypical faces generated using computer graphic techniques (see Benson and Perrett, 1992, 1993; Rowland and Perrett, 1995) tend to be highly symmetrical (Alley and Cunningham, 1991). There is evidence, however, that facial symmetry is attractive independently of prototypicality.

Many researchers have suggested that reverse-scored distinctiveness ratings reflect facial prototypicality (e.g. Rhodes et al., 1999; Wickham et al., 2000). In other words, these researchers suggest that faces judged to be highly distinctive are both non-prototypical and non-average. In studies that have used this technique to assess facial prototypicality, distinctiveness is normally defined as the ease with which that person could be picked out from a crowd. Consistent with the suggestion that prototypical faces are highly

symmetrical, Rhodes et al. (1999) found that facial symmetry was associated with reverse-scored ratings of facial distinctiveness (i.e. prototypicality). Rhodes et al. (1999) also found that both reverse-scored distinctiveness and symmetry positively influenced judgements of facial attractiveness independently of one another. This latter finding suggests that the relationship between symmetry and facial attractiveness is not mediated by prototypicality as the perceptual bias account suggests.

Some researchers have suggested that perceptual ratings do not necessarily reflect biological properties (Evans et al., 2000; Meyer and Quong, 1999; Scheib et al., 1999), and therefore reverse-scored ratings of distinctiveness may not reflect actual prototypicality. Little and Hancock (2002) found that distinctiveness ratings did reflect manipulations of the prototypicality of computer graphic faces (see Benson and Perrett, 1993 for methods for manipulating the prototypicality of computer graphic faces). That Bruce et al. (1994) found that an objective measure of prototypicality derived from measurements of facial proportions was significantly correlated with reverse-scored distinctiveness ratings also supports the claim that distinctiveness ratings reflect actual facial prototypicality. Thus, the findings of Rhodes et al. (1999) are problematic for the perceptual bias account of the attractiveness-symmetry relationship as they are evidence against the claim that the attractiveness of symmetry simply reflects the prototypicality of symmetrical faces.

3.5 Is there an opposite-sex bias in strength of preferences for facial symmetry?

Comparing attractiveness judgements under opposite- and own-sex conditions is an example of a manipulation of viewing context that is common in studies of facial attractiveness. The perceptual bias account would not predict the occurrence of an opposite-sex bias in sensitivity to symmetry when judging facial attractiveness as the efficiency gains that the visual recognition system enjoys when processing symmetrical stimuli will be equivalent regardless of viewing context. In other words, the perceptual bias explanation suggests that the attractiveness of symmetry is context-invariant. By contrast, if the attractiveness of symmetrical faces reflects adaptations facilitating discrimination between potential mates on the basis of apparent physical condition, as the good genes explanation suggests, then an opposite-sex bias in sensitivity to symmetry when judging facial attractiveness might be expected.

Consistent with this good genes prediction, a number of studies have reported opposite-sex biases in sensitivity to symmetry when judging facial attractiveness. Little et al. (2001) found that female judgments of male facial attractiveness (opposite-sex judgments) were more sensitive to symmetry than female judgments of the attractiveness of female faces (own-sex judgments). Penton-Voak et al. (2001) also reported that the relationship between symmetry and female judgments of male facial attractiveness (opposite-sex judgments) was stronger than that between symmetry and male judgments of the facial attractiveness of other males (own-sex judgments).

These opposite-sex biases in sensitivity to facial symmetry (context-specific effects) cannot be explained by a purely perceptual bias account that suggests the attractiveness

of symmetry is context-invariant. That there is an opposite-sex bias in sensitivity to facial symmetry when judging attractiveness and perceived health is, however, consistent with the claim that the processing of symmetry by the perceptual system is an adaptation facilitating discrimination between potential mates on the basis of apparent physical condition. Whilst perceptual bias may interact with perceiver motivation to facilitate context-sensitive perceptual bias, in the case of opposite-sex biases in sensitivity to symmetry this motivation would appear to have an adaptive basis.

3.6 Are preferences for facial symmetry condition-dependent?

There is evidence that mate choices in non-human species often reflect the condition of the perceiver as much as they reflect the condition of the perceived. For example, female three-spined sticklebacks that are in good physical condition have a stronger preference for high quality males than female sticklebacks in relatively poor physical condition (Bakker et al., 1999). In an effort to test for analogous condition-dependent mate preferences in human females, Little et al. (2001) investigated the influence of self-rated attractiveness (thought by Little et al. to be a measure of female mate quality) on the strength of female preferences for symmetry in male faces. That self-rated female attractiveness has been found to be highly correlated with other's ratings of female facial attractiveness (Penton-Voak et al., 2003) supports the idea that self-rated attractiveness is a measure of female mate quality. Little et al. (2001) found that females who rated themselves as highly attractive had a stronger preference for male facial symmetry than females who rated themselves as relatively less attractive.

Little et al. (2001) explained this finding by noting that high quality females may be better able to retain high quality, and presumably highly symmetrical, males as long-term mates. Poorer quality females would lose out on male investment if they were to mate with, but not be able to retain, high quality males. High quality females may be able to maximize the available investment. Indeed, there is evidence that in many species, including humans, high quality males are less likely to invest in both relationships and offspring than relatively poorer quality males (see Gangestad and Simpson, 2000 for a review). Little et al. (2001) suggested that poorer quality females might have adaptive preferences for males that they are able to retain and that this is reflected in their relatively weak preference for symmetrical male faces.

As the perceptual bias account of the attractiveness-symmetry relationship suggests that preferences for symmetry occur independently of context, it cannot accommodate the finding that female preferences for symmetry in male faces are, to some extent, condition-dependent. By contrast, condition-dependent preferences for symmetry are consistent with the good genes explanation of the attractiveness-symmetry relationship as this emphasizes the role of symmetry in determining mate preferences. Thus, condition-dependent preferences for facial symmetry support the good genes explanation of the attractiveness-symmetry relationship and are problematic for the perceptual bias account.

3.7 Is symmetry attractive in mate choice-irrelevant stimuli?

If preferences for facial symmetry reflect adaptations facilitating discrimination between potential mates on the basis of cues to physical condition, as the good genes account

suggests, then preferences for characteristics thought to be cues to good genes might only occur when judging the attractiveness of mate choice-relevant stimuli such as faces (Halberstadt and Rhodes, 2000). Preferences for symmetry have been observed, however, when judging the attractiveness of many types of objects (Rensch, 1963) and decorative art (Gombrich, 1984). These preferences serve no obvious purpose (within the context of mate selection) and are consistent with the context-invariant nature of the perceptual bias explanation of the attractiveness of symmetry. By contrast, that symmetry is attractive in mate choice-irrelevant stimuli is problematic for the good genes explanation of the attractiveness-symmetry relationship[1].

A recent study by Little and Jones (2003) investigated the relationship between symmetry and the attractiveness of both inverted and upright (i.e. non-inverted) face images. Upright faces "enjoy a type of configural processing that is abolished when faces are shown inverted" (O'Donnell and Bruce, 2001, p756). This causes inverted faces to be treated as non-faces by the perceptual system (see Leder and Bruce, 1998 for a discussion of this issue). Inverted faces are therefore an example of mate choice-*irrelevant* stimuli while upright faces are an example of mate choice-*relevant* stimuli. The good genes account would not necessarily predict that symmetry would be associated with attractiveness when judging inverted faces (i.e. mate choice-irrelevant stimuli) but would predict that symmetry would be associated with attractiveness in upright faces (i.e. mate choice-relevant stimuli). By contrast, inversion of faces should not affect the

[1] Preferences for symmetry in mate choice-irrelevant stimuli may be due to an over-generalisation of preferences for symmetry in mate choice-relevant stimuli, however (Little and Jones, 2003).

attractiveness-symmetry relationship if the attractiveness of symmetry is context-invariant as the perceptual bias account suggests.

Little and Jones (2003) found that symmetry influenced the attractiveness of only upright faces. Preferences for symmetry were only significantly more pronounced than chance when judging the attractiveness of the upright faces. Thus, symmetry appears to be more important for attractiveness judgments of mate choice-*relevant* stimuli (the upright face images) than for attractiveness judgments of mate choice-*irrelevant* stimuli (the inverted face images). This is consistent with the good genes account of the attractiveness-symmetry relationship.

It might be that symmetry was preferred only in upright faces because people have only experience of upright faces and, therefore, only have an upright face prototype. Little and Jones also found that symmetry was preferred in familiar faces (a class of stimuli for which people are likely to have an asymmetric prototype). That symmetry was found attractive in stimuli for which prototypes would be asymmetric is further evidence that the attractiveness of symmetry is, to some extent, independent of prototypicality.

3.8 Is symmetry a visual cue for judgements of facial attractiveness?

It has been reported that faces that have been manipulated, using computer graphic techniques, to be more symmetrical are preferred to the original, relatively asymmetrical, images (Little et al., 2001; Perrett et al., 1999; Rhodes et al., 1998, 2001a). As facial symmetry alone was varied in these studies, many researchers have concluded that

symmetry not only predicts judgements of facial attractiveness but that symmetry also acts as a visual cue for judgements of the attractiveness of real faces (Little et al., 2001; Perrett et al., 1999; Rhodes et al., 1998, 2001a). The findings of a number of recent studies raise doubts about this interpretation, however.

When participants were asked to rate the symmetry of 2D images of real faces, these perceptual judgements did not correlate with symmetry measurements (Scheib et al., 1999). This finding suggests that symmetry may not be a viable visual cue for judgments of facial attractiveness as it would appear that participants can not accurately detect asymmetries in real faces. Bruyer and Craps (1985) also found that participants were poor at detecting facial asymmetries in 2D face images. Whilst asymmetry detection when viewing 3D face images has never been tested, the findings of Scheib et al. (1999) and Bruyer and Craps (1985) suggest that the magnitude of asymmetries that occur in the human face are simply too small to be easily detected. Thus, Scheib et al. (1999) suggested that it may be correlates of symmetry that are the critical visual cues for judgements of the attractiveness of real faces.

Scheib et al. (1999) reported that facial symmetry predicted judgements of the attractiveness of male faces regardless of whether faces were presented as full-face images or presented as half-faces (i.e. full-face images split down a central vertical axis and either the left or right half masked). As the visibility of cues to symmetry is reduced in half-faces[2], Scheib et al. concluded that (i) there are additional cues to attractiveness

[2] Some cues to symmetry may be visible in half-faces, however. A highly asymmetric face may break down into half faces with either atypically narrow central facial features (i.e. nose and mouth) or atypically wide

that co-vary with facial symmetry, (ii) that these co-variates are visible in half-faces and (iii) that these co-variates are sufficient to determine judgements of male facial attractiveness independently of facial symmetry. Penton-Voak et al. (2001) also found evidence for co-variates of symmetry predicting male facial attractiveness when cues to symmetry were not visible.

Penton-Voak et al. (2001) reported that a composite face (see Rowland and Perrett, 1995) representing the mean shape and colour of a sample of males with highly symmetrical faces, was judged as more attractive than a composite face that represented a sample of males with less symmetrical faces. Thus, symmetry of the individual faces (i.e. those contributing to the composites) predicted the attractiveness of the composite faces. As composite faces are likely to be of equivalent high symmetry (Alley and Cunningham, 1991), Penton-Voak et al. concluded that correlates of facial symmetry that are attractive to females must have remained visible in the composite faces.

Scheib et al. (1999) proposed that facial masculinity might co-vary with, and determine attractiveness independently of, symmetry. This relationship might be anticipated, as both masculinity and symmetry are theoretically associated with immunocompetence and, as a consequence, may be attractive to females (Fink and Penton-Voak, 2002; Gangestad and Simpson, 2000; Miller and Todd, 1998; Thornhill and Gangestad, 1999, 1993). Consistent with this prediction, Scheib et al. (1999) reported a positive association between facial symmetry and a composite masculinity index derived from the shape of

central facial features. These deviations from "averageness" in the half-face may inform the viewer of how symmetrical the full-face is.

facial characteristics thought to be male sex-typical traits (cheekbone prominence and face length relative to lower face length). Penton-Voak et al. (2001) disputed this link between facial masculinity and symmetry, finding that cheekbones were more prominent in a female sample than a male sample. A masculinity index derived from measurements of facial characteristics, first identified as being sexually dimorphic, was not associated with symmetry in male faces (Penton-Voak et al., 2001). Furthermore, the relationship between masculinity and attractiveness in male faces is somewhat disputed (see Chapter 1, Penton-Voak and Perrett, 2001 for a review). Perrett et al. (1998), for example, found female preferences for male faces with a feminine shape, while other studies have found that masculine facial characteristics are attractive to females (e.g. Johnston et al., 2001). Penton-Voak et al. were unable to ascertain what cues co-vary with symmetry but posited that apparent healthiness of facial skin might be one such characteristic (see also Symons, 1979).

4. Rationale for studies

4.1 Study 1: The inter-relationship between attractiveness, apparent health and symmetry in faces

Both Grammer and Thornhill (1994) and Penton-Voak et al. (2001) found that judgements of health were related to symmetry in male faces. In line with these findings, Rhodes et al. (2001b) reported associations between rated facial symmetry and judgements of apparent health for both male and female faces. The apparent health of symmetric faces could, however, reflect an "attractiveness halo" where positive attributes

(e.g. extraversion, stability, good health) are ascribed to good-looking, symmetric individuals (Penton-Voak et al., 2001). Indeed, there is some evidence that apparent good health may simply be a stereotype associated with attractive individuals (Kalick et al., 1998). If the relationship between symmetry and judgements of apparent health was mediated by an attractiveness halo effect, it would pose difficulties for a "good genes" explanation of the attractiveness-symmetry relationship (see Feingold, 1992; Langlois et al., 2000 for meta-analytic reviews of research on attractiveness halo effects). In Study 1, therefore, I explored the interplay between measured facial symmetry, judgements of apparent health and judgements of attractiveness within a partial correlation design. The "good genes" explanation of attractiveness predicts that, rather than being the result of an attractiveness halo, the association between symmetry and judgements of apparent health mediates the attractiveness-symmetry relationship. Consequently, if the association between facial symmetry and apparent health judgements remains when controlling for the effects of attractiveness, the "good genes" explanation is supported. It is also supported if the attractiveness-symmetry relationship disappears when controlling for apparent health. On the other hand, if judgements of apparent health do not mediate the attractiveness-symmetry relationship, this relationship should remain when controlling for the effects of judgements of apparent health. Similarly, the null hypothesis would predict that there would be no relationship between judgements of apparent health and facial symmetry when controlling for attractiveness.

4.2 Study 2: Is facial symmetry a cue for apparent health?

It has been reported that manipulating digital face images so as to increase symmetry engenders an increase in ratings of apparent health (Rhodes et al., 2001b). This finding suggests that symmetry is a cue to judgements of health. If the processing of symmetry by the perceptual system is an adaptation facilitating discrimination between potential mates on the basis of apparent health (Møller and Thornhill, 1998), a strong adaptationist position might predict an opposite-sex bias in sensitivity to facial symmetry. In contrast, no such bias is predicted by accounts claiming that symmetry is found attractive as a by-product of the ease with which the recognition system can process symmetric stimuli (e.g. Bradbury and Vehrencamp, 1998; Enquist and Arak, 1998; Enquist and Ghirlanda, 1998). Consistent with the strong adaptationist position, Little et al. (2001) report that manipulations of symmetry have a greater impact on attractiveness ratings of opposite-sex faces than ratings of own-sex faces. As yet, there have been no reported tests for such a bias when judging apparent health.

4.3 Studies 3 and 4: The relationship between shape symmetry and visible skin condition for male facial attractiveness

Studies of attractiveness using computer graphic faces have reported preferences for faces that had been manipulated to be more symmetrical (Little et al., 2001; Perrett et al., 1999; Rhodes et al., 1998, 2001a). As facial symmetry alone was varied in these studies, many researchers have proposed that symmetry is an important visual cue for judgements of the attractiveness of real faces (Little et al., 2001; Perrett et al., 1999; Rhodes et al., 1998, 2001a). Although studies of facial attractiveness using real faces have reported positive relationships between symmetry and attractiveness (Grammer and Thornhill,

1994; Mealey et al., 1998; Penton-Voak et al., 2001; Rhodes et al., 1999, 2001b; Scheib et al., 1999), relationships between facial symmetry and attractiveness judgements of faces in which the visibility of cues to facial symmetry was reduced have also been reported (Penton-Voak et al., 2001; Scheib et al., 1999). These latter findings suggest that correlates of symmetry influence facial attractiveness independently of symmetry itself. Penton-Voak et al. (2001) were unable to ascertain what cues co-vary with symmetry in male faces, but posited that apparent healthiness of facial skin might be one such characteristic. Indeed, visible skin condition and facial symmetry may be expected to co-vary as healthy-looking skin and symmetrical features are both potential cues to general health (Thornhill and Gangestad, 1999).

The link between apparent health of facial skin, symmetry and male facial attractiveness was investigated here in 2 studies. First, the relationship between male facial symmetry and perceived facial skin health was explored in real faces (Study 3). Image processing techniques were then used to investigate whether facial colour and texture cues were sufficient to maintain the attractiveness-symmetry relationship when the influence of facial shape was minimised (Study 4).

5. Study 1: The inter-relationship between attractiveness, apparent health and symmetry in faces

The aim of Study 1 was to investigate the inter-relationship between facial symmetry, apparent facial health and facial attractiveness.

5.1 Method

Participants

10 male (21-26 years old) and 10 female (20-28 years old) participants took part in Study 1. All participants reported normal or corrected-to-normal vision and were naïve to the purpose of the experiment.

Stimuli

Full-face photographs of 30 males and 30 females (20-30 years of age, all undergraduate students at the University of St. Andrews) were used. Each full-colour photo was taken with a digital camera (resolution set at 1200x1000 pixels) and under standardised diffuse lighting conditions. Background was constant in all photographs. Facial expression was neutral, hair pulled back from the face and facial adornments (e.g. jewellery or make up) removed prior to photographing. All males were clean-shaven. Images were normalised on interpupillary distance. All individuals photographed were unfamiliar to those participants who took part in the ratings phase of the study.

Measures

Asymmetry: Each digital face-image was first scaled and rotated so as to standardise interpupillary distance to 100 units. A horizontal axis was then created that bisected both pupil centres. A vertical axis was set perpendicular to, and bisecting, the horizontal axis. Distances between the vertical axis and each of 12 bilaterally paired points (see Figure 1 in previous chapter) were measured parallel to the horizontal axis. These signed distances

were then summed to calculate horizontal asymmetry (alternatively referred to as L - R asymmetry, Hume and Montgomerie, 2001).

Calculating facial asymmetry using horizontal asymmetries only (in line with Grammer and Thornhill, 1994; Hume and Montgomerie, 2001; Rhodes et al., 2001b), rather than combining vertical and horizontal asymmetries as other studies have done (e.g. Penton-Voak et al., 2001; Scheib et al., 1999) pays close attention to the finding that human perceivers are primarily sensitive to horizontal asymmetries in complex biological images, including faces (Evans et al., 2000). It has been reported that facial metric techniques of this kind yield measurements of facial asymmetry that can be calculated with high repeatability (Hume and Montgomerie, 2001). It has also been found that facial asymmetry calculated using distance measurements from 2D images correlated significantly with perceptual measures of facial asymmetry (Rhodes et al., 2001b).

Attractiveness and apparent health ratings: Each participant rated all of the photographs for the attributes *attractiveness* and *health* using a Likert-type 1-7 scale (1 = very low, 4 = neutral, 7 = very high). Item order was fully randomised and the order in which attractiveness and health ratings were given was counterbalanced across participants. Photographs were 6x4 cm in size and printed in 24-bit colour when presented for rating. Viewing distance was approximately 50 cm.

5.2 Results

Inter-rater reliability

Inter-rater agreement for ratings of both attractiveness (Cronbach's Alpha = 0.83) and apparent health (Cronbach's Alpha = 0.92) were higher than 0.8 and rating was therefore taken to be reliable (Bohrnstedt, 1970). Ratings from male and female participants were combined for subsequent analyses.

Simple correlations

These results are summarised in Table 1 (all probabilities are one-tailed as the direction of the correlations was predicted on the basis of previous studies). For ratings of attractiveness, significant negative correlations with measured facial asymmetry were observed for both male faces and female faces. The slopes of these correlations did not differ significantly (Fisher r-to-z transformations: $z = 0.09$, $p = 0.464$). Similarly, for ratings of apparent health, significant negative correlations with facial asymmetry were observed for both male and female faces. Again, the correlations did not differ significantly in slope ($z = 0.03$, $p = 464$). Finally, significant positive correlations between ratings of attractiveness and apparent health were observed for both male and female faces. In contrast to the previously reported simple linear correlations, the slopes of these associations were significantly different ($z = 1.91$, $p = 0.042$), indicating that ratings of apparent health and attractiveness were more closely related for female faces.

Table 1. Bivariate correlations between ratings in Study 1. Male and female raters are pooled, and all probabilities are one-tailed.

Sex of face presented	Correlation between	r	N
male	asymmetry and health judgements	- 0.504**	30

female	asymmetry and health judgements	- 0.510**	30
male	asymmetry and attractiveness	- 0.429**	30
female	asymmetry and attractiveness	- 0.409*	30
male	attractiveness and health judgements	0.487**	30
female	attractiveness and health judgements	0.783***	30

* significant at .05 level

** significant at .01 level

*** significant at .001 level

Partial correlations

These results are summarised in Table 2 (as for the simple linear correlations, probabilities are one-tailed as the direction of the correlations was predicted on the basis of previous studies). The correlation between ratings of apparent health and measured facial asymmetry persisted when controlling for perceived attractiveness for both male and female faces. The slopes of the two correlations did not differ significantly ($z = 0.16$, $p = 0.44$). By contrast, the association between ratings of attractiveness and measured facial asymmetry did not persist when controlling for perceived health for ratings given in response to either male faces or female faces. Finally, when controlling for the effects of asymmetry, a significant positive association between ratings of apparent health and attractiveness was observed for both male and female faces. In this instance, the slopes of the two correlations were significantly different ($z = 1.85$, $p = 0.032$). As for the simple correlations, ratings of health and facial attractiveness were more closely related when judging female faces than when judging male faces.

Table 2. Partial correlations between ratings in Study 1. Male and female raters are pooled, and all probabilities are one-tailed.

Sex of face presented	Correlation between	Controlling for effects of	Partial r	df
male	asymmetry and health judgements	attractiveness	- 0.374*	29
female	asymmetry and health judgements	attractiveness	- 0.335*	29
male	asymmetry and attractiveness	health judgements	- 0.244	29
female	asymmetry and attractiveness	health judgements	- 0.031	29
male	attractiveness and health judgements	asymmetry	0.347*	29
female	attractiveness and health judgements	asymmetry	0.714***	29

* significant at .05 level

** significant at .01 level

*** significant at .001 level

5.3 Discussion

The simple linear correlations found in Study 1 show that high attractiveness is attributed to individuals whose faces are symmetrical. This finding is consistent with other studies (Grammer and Thornhill, 1994; Hume and Montgomerie, 2001; Mealey et al., 1999; Perrett et al., 1999; Rhodes et al., 1998, 1999, 2001a; Scheib et al., 1999). The simple linear correlations also show that good health is attributed to individuals whose faces are symmetrical which, again, is consistent with other studies (Grammer and Thornhill, 1994; Penton-Voak et al., 2001; Rhodes et al., 2001b).

The relationship between measured facial symmetry and ratings of apparent health remained when controlling for attractiveness. This is inconsistent with the suggestion that

the association between facial symmetry and judgements of apparent health may be caused by an attractiveness halo (Penton-Voak et al., 2001), whereby symmetric and therefore attractive individuals are automatically ascribed positive attributes, including apparent good health (Feingold, 1992; Langlois et al., 2000). By contrast, the association between facial symmetry and attractiveness disappeared when controlling for the effects of judgements of apparent health. This supports the view that the attractiveness-symmetry relationship is mediated by the link between facial symmetry and judgements of apparent health and is consistent with the "good genes" explanation of attractiveness.

The slopes of the correlations between ratings of apparent health and attractiveness were significantly different for ratings of male and female faces. This indicates that the link between judgements of apparent health and attractiveness was stronger for judgements of female faces than for judgements of male faces. This effect was also observed when controlling for asymmetry. Though a "good genes" explanation of attractiveness might predict a stronger relationship between ratings of attractiveness and health for male faces than female faces (Grammer and Thornhill, 1994), the observed effect is consistent with the finding that past health problems predicted female facial attractiveness better than it predicted male facial attractiveness (Hume and Montgomerie, 2001).

6. Study 2: Is facial symmetry a cue for apparent health?

Study 2 explored the impact of manipulations of facial symmetry on perceived health. A strong adapationist position would predict an increased sensitivity to facial symmetry when judging the apparent health of opposite-sex face images. Apparent health ratings of

images of normal faces were compared with ratings of images of faces in which symmetry was increased by digitally "warping" the image.

6.1 Method

Participants

13 male (20 - 30 years old) and 13 female (20 - 30 years old) participants took part in Study 2. All participants reported normal or corrected-to-normal vision and were naïve to the purpose of the experiment. None of the participants in Study 2 had taken part in Study 1.

Design

A within-subjects design was used with factors *facial symmetry* (2 levels: normal, more symmetrical) and *sex of face* (2 levels: own-sex, opposite-sex).

Stimuli

Male and female faces (Caucasian, 15 male and 15 female, ages 20-30 years, posing with neutral expressions and head pointing straight at camera) were photographed with a digital camera (24-bit colour, resolution set at 531 x 704 pixels) and under standardized diffuse lighting conditions. Background was constant in all photographs. All faces were without make-up or adornments (e.g. earrings), hair was pushed back off the forehead and all males were clean-shaven. All individuals photographed were employees at a U.K. industrial research center and were unfamiliar to the participants in the ratings phase of the study. Images were scaled and rotated to standard pupil center positions. 224

predefined feature points were marked on each face in order to capture the distinctive shape of individual facial features while maintaining an equivalent spacing on the left and right sides of the face (Benson and Perrett, 1991; Perrett et al., 1994; Rowland and Perrett, 1995). A more symmetrical version of each face was then created by averaging the height and lateral position (relative to a midline perpendicular to and bisecting the interpupillary line) of corresponding pairs of feature markers on the left and right sides of the face. Each digital face image was then remapped (Benson and Perrett, 1991; Perrett et al, 1994; Rowland and Perrett, 1995) into the corresponding symmetrical shape. Images were then cropped to reduce visibility of the hair and neck. Figure 2 in the previous chapter shows normal and more symmetrical (i.e. "warped") versions of a digital face image.

Procedure

Each participant rated all 60 faces for "apparent general medical health" using a 1 – 7 Likert-type scale (1 = very low, 4 = neutral, 7 = very high). Faces were randomly allocated to 1 of 2 blocks of 30 items except that in no single block was a face presented in both normal and symmetrical versions (Perrett et al., 1999). Within each block participants were free to revise ratings in light of subsequently presented items and order of presentation of faces was fully randomised. Photographs were printed in 24bit colour and 6x4 cm in size when presented for rating. Viewing distance was approximately 50 cm.

6.2 Results

Mean ratings of apparent health for own-sex symmetrical, opposite-sex symmetrical, own-sex normal and opposite-sex normal faces were calculated for each participant and used in subsequent analyses. As the distribution of ratings was not significantly different from a normal distribution, parametric tests were used for subsequent analyses.

A within-participants analysis of variance (ANOVA) showed a significant main effect for *facial symmetry* ($F(1, 103) = 114.6$, $p < 0.001$) and no main effect for *sex of face* ($F(1, 103) = 0.4$, $p = 0.8$). The significant main shows that increasing facial symmetry increased ratings of apparent health (mean rating of original face = 3.3, S.E. = 0.08; mean rating of symmetric faces = 4.4, S.E. = 0.06).

There was a significant 2x2 interaction (Figure 9) between *facial symmetry* and *sex of face* ($F(1, 103) = 4.2$, $p = 0.042$). Further analyses showed that manipulating facial symmetry had a significant impact on health ratings for both opposite-sex ($F(1, 51) = 96.2$, $p < 0.001$) and own-sex conditions ($F(1, 51) = 32.4$, $p < 0.001$). The difference between ratings of the original faces and ratings of the symmetrical faces was significantly more pronounced when rating opposite-sex faces than rating own-sex faces ($F(1, 51) = 8.8$, $p = 0.005$).

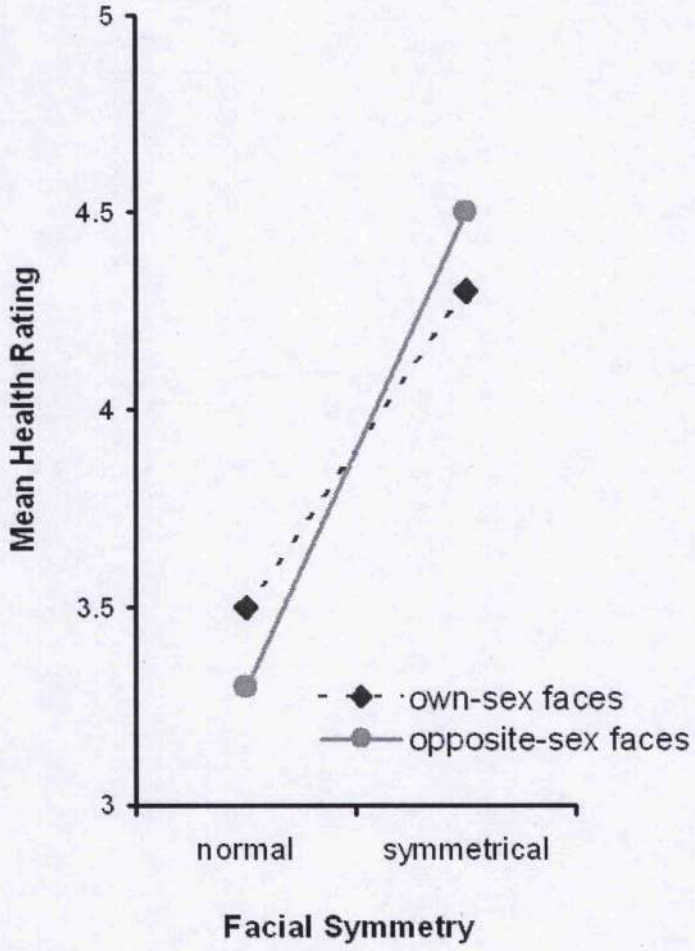

Figure 9. The significant 2x2 interaction between facial symmetry and sex of face observed in Study 2. Symmetry appears to be a cue to apparent health, particularly when judging opposite-sex faces.

6.3 Discussion of Study 2

The observed main effect for facial symmetry shows that increasing symmetry increased ratings of apparent health. Though this link between facial symmetry and apparent health occurred when rating both own- and opposite-sex faces, analyses indicated an opposite-

sex bias in sensitivity to facial symmetry when judging health. This finding is consistent with the suggestion that the perceptual analysis of facial symmetry may be an adaptation facilitating discrimination between potential mates on the basis of apparent health (Møller and Thornhill, 1998). That symmetry is a *cue* to perceived health replicates the finding of Rhodes et al. (2001b) and is consistent with the *associations* between symmetry and judgements of apparent health found in Study 1.

7. Study 3: The relationship between shape symmetry and visible skin condition for male facial attractiveness

Study 3 tested for a positive correlation between shape symmetry and ratings of the apparent healthiness of skin in male faces. This issue was only investigated in male faces as makeup use will alter perceptions of women's skin condition.

7.1 Method

Full-face colour photographs of 113 Caucasian males (20-30 years) were taken with a digital camera (resolution set at 1200x1000 pixels) and under standardised diffuse lighting conditions. Background was constant in all photographs. Facial expression was neutral and hair pulled back from the face. Each digital face-image was first scaled and rotated so as to standardise interpupillary distance to 100 units. All males photographed were unfamiliar to those taking part in the ratings phase of the study.

Facial symmetry was assessed using a perceptual technique (Mealey et al., 1999; Penton-Voak et al., 2001; Rhodes et al., 2001a) where high symmetry was indicated by high ratings of the similarity between a left-left chimeric face and a right-right chimeric face (chimeras are original full-face photographs split down a central vertical axis and each individual side of the face aligned with a mirror-reflected version of itself). By contrast with other studies that have used this technique, in the present study texture and colour information of each face was made symmetrical prior to the generation of chimeras (see Tiddeman et al., 2001), minimising non-shape differences between the left and right sides of each face. Examples of chimeric faces can be seen in Figure 10.

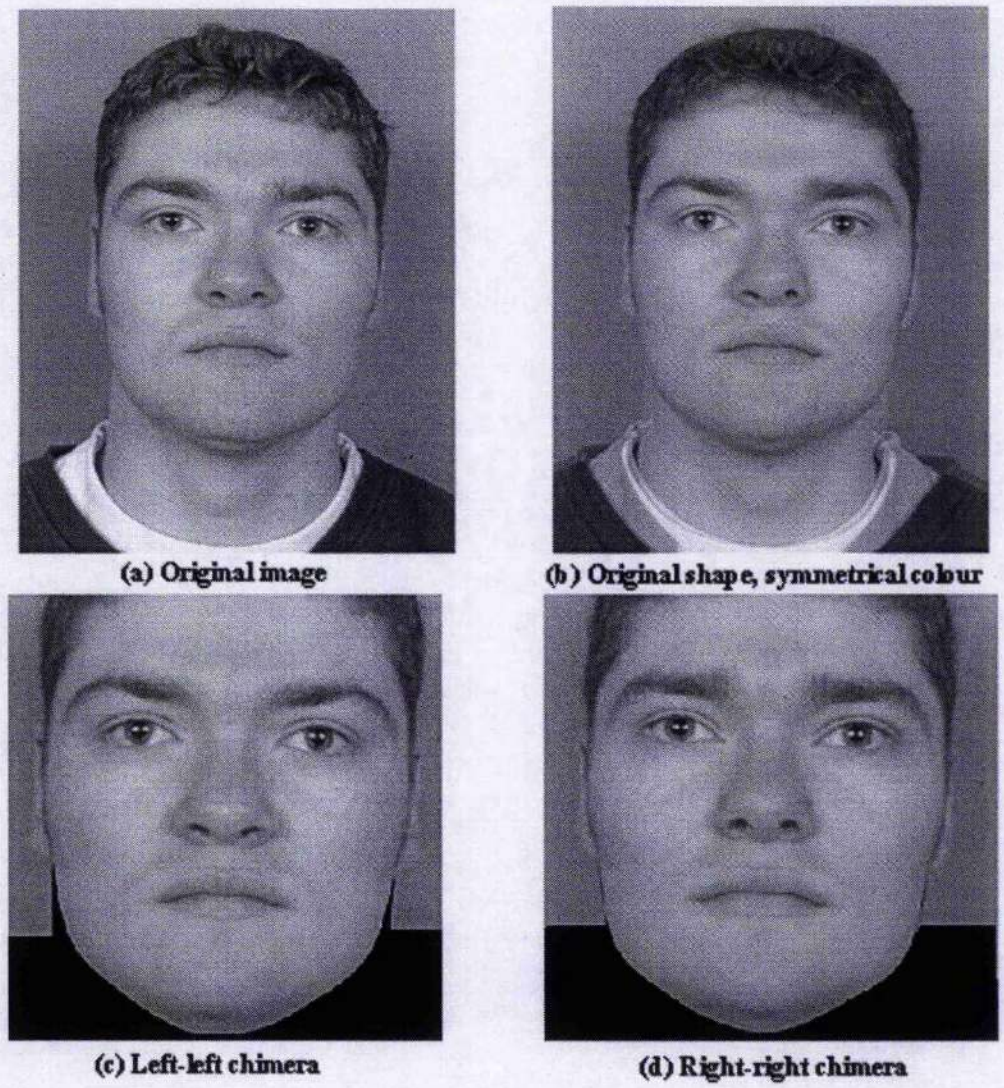

Figure 10. Assessing facial symmetry in Study 3 using chimeric faces. Facial symmetry was assessed from the degree of perceived similarity between left-left and right-right chimeric faces generated from each individual face. Chimeric faces were created in the following stages: (a) An original full-face photograph. (b) The manipulated version from which chimeric faces were derived. Note that this image is in the same shape as the original image but possesses equivalent colour and texture information on the left and

right sides of the face. Chimeric faces were generated from these images. (c) A left-left chimeric face. (d) A right-right chimeric face.

22 female participants (mean age = 24.13, standard deviation = 3.83) rated the 113 paired chimeric faces (each pairing consisting of a left-left and right-right chimeric face derived from a photograph of one male) for "similarity" (1 = very dissimilar, 7 = very similar). The same female participants also rated the 113 *original* faces for "healthiness of facial skin" (1 = very unhealthy, 4 = neutral, 7 = very healthy) and "attractiveness" (1 = very unattractive, 4 = neutral, 7 = very attractive). For ratings of "similarity", "healthiness of facial skin" and "attractiveness" full-colour images were presented on-screen in a fully randomised order. The order in which participants performed "similarity", "healthiness of facial skin" and "attractiveness" ratings was randomised across participants. All images were cropped to minimise the influence of clothing, neck and hairstyle.

7.2 Results

As inter-rater agreement for ratings of "similarity" (Cronbach's Alpha > 0.93), "healthiness of facial skin" (Cronbach's Alpha > 0.86) and "attractiveness" (Cronbach's Alpha > 0.88) was high, mean ratings for each face were calculated across all participants for use in analyses. As not all of the measures were normally distributed results of non-parametric tests (Spearman's rho) are reported. Two-tailed probabilities are reported throughout. For all statistics N = 113.

Rated symmetry ("similarity") was positively correlated with ratings of the apparent healthiness of facial skin ($r_s = 0.23$, $p = 0.015$). In addition to this, a significant positive correlation between symmetry and ratings of male facial attractiveness was also observed ($r_s = 0.21$, $p = 0.025$). Ratings of the apparent healthiness of facial skin and ratings of male facial attractiveness were also significantly correlated ($r_s = 0.70$, $p < 0.0001$).

7.3 Discussion

The positive correlation between facial symmetry and judgements of male facial attractiveness (Study 3) is consistent with the findings of previous studies (Grammer and Thornhill, 1994; Mealey et al., 1998; Penton-Voak et al., 2001; Rhodes et al., 1999, 2001b; Scheib et al., 1999) and the finding of Study 1. Analyses indicated that apparent healthiness of facial skin co-varied with facial symmetry (Study 3). Although these findings suggest that males with symmetrical faces also possess healthy-looking, attractive facial skin, ratings of visible skin condition may have been influenced by a shape "halo" effect whereby the attractiveness of facial shape influenced judgements of visible skin condition. Study 4 was carried out to investigate if facial colour and texture cues were sufficient to maintain both attractiveness-symmetry and perceived health-symmetry relationships when the influence of 2D shape was minimised.

8. Study 4

The aim of study 4 was to investigate whether males' facial colour and texture cues were sufficient to maintain the attractiveness-symmetry relationship when the influence of facial shape was minimised.

8.1 Method

First, a composite male face was generated representing the mean shape, colour and texture information for all 113 faces used in Study 3 (see Rowland and Perrett, 1995; Tiddeman et al., 2001 for methods). Using the similarity ratings from Study 3, the 30 males with the most asymmetric faces (the asymmetric sample) and the 30 males with the most symmetric faces (the symmetric sample) were identified. Composite faces, again representing shape, colour and texture information, were generated that represented the asymmetric and symmetric samples. These composite faces were made perfectly symmetrical by blending each face with a mirror-reflected version. By applying the average colour and texture information for the asymmetric and symmetric samples to the average, symmetrical shape of all 113 faces (see Rowland and Perrett, 1995; Tiddeman et al., 2001 for methods), 2 faces (asymmetric and symmetric samples) were generated that differed only in colour and texture information and possessed identical symmetrical shapes (Figure 11).

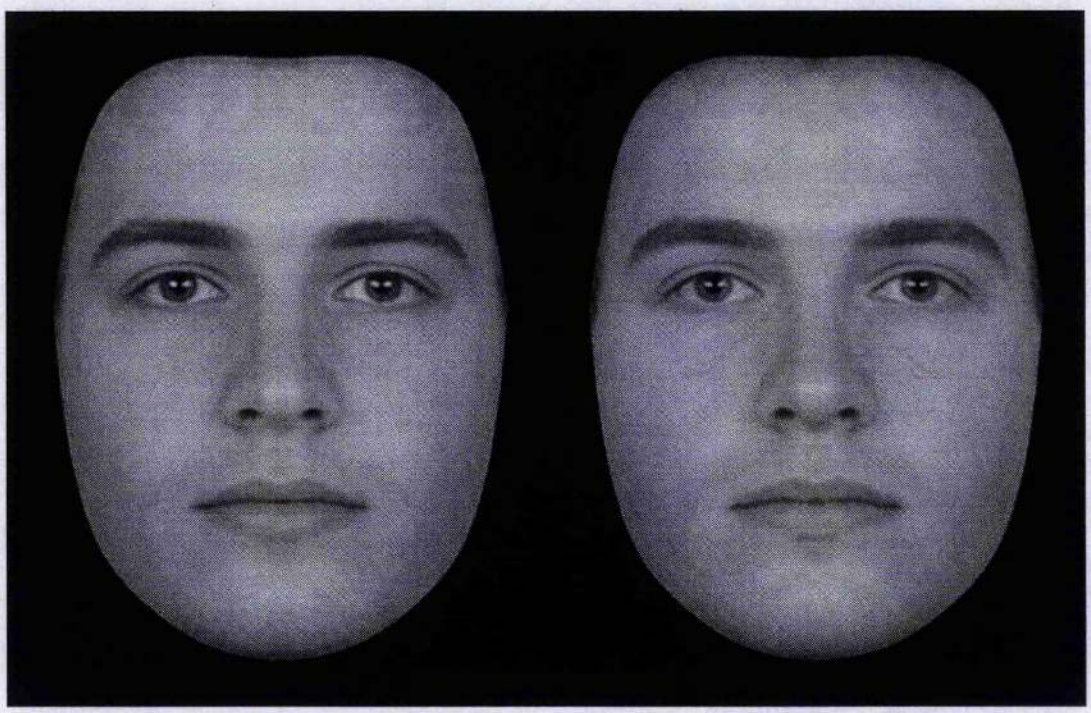

Figure 11. Stimuli used in Study 4. (a) Average face with mean colour and texture information of 30 symmetric male faces. (b) Average face with mean colour and texture information of 30 asymmetric male faces. Importantly images (a) and (b) differed only in colour and texture as they possessed equivalent symmetrical shapes.

80 female participants (mean age = 27.5, standard deviation = 4.3; none of whom had taken part in Study 1) assessed, using forced choice paradigms, either which of the 2 faces was the "most attractive" or which looked the "most healthy". 40 of the 80 females made attractiveness judgements while the remaining 40 females made health judgements. For all trials, the two composite faces were presented adjacent to one another and both trial order and the position of each face (left or right) randomised.

8.2 Results

All probabilities are 2-tailed. The symmetric sample average was judged more attractive than the asymmetric sample average significantly more often than would be predicted by chance (33 out of 40 participants choosing the symmetric average, Binomial distribution: $p = .0001$). The symmetric sample average was judged healthier-looking than the asymmetric sample average significantly more often than would be predicted by chance (36 out of 40 participants choosing the symmetric average, Binomial distribution: $p = .0001$).

8.3 Discussion of Study 4

When considered together, the findings of Studies 3 and 4 suggest that apparent health of facial skin is (1) a correlate of symmetry and (2) is attractive independent of facial shape. The attractiveness of symmetrical real faces appears to be due, at least partly, to the influence of surface information. That correlates of symmetry that appear healthy influence the attractiveness-symmetry relationship is consistent with the good genes account of the attractiveness of symmetric faces.

9. General Discussion

A feature of 3 of the 4 studies conducted is strong attraction to faces that have a healthy appearance. For example, in Studies 1 and 3 strong correlations were evident between health attributions and attractiveness judgements of faces. In study 4, manipulating facial appearance to increase apparent health also increased the attractiveness of the face. This strong attraction to apparent health is consistent with the good genes view of attractiveness that emphasises the role of health cues in attractiveness.

The findings from all 4 studies also indicate that symmetric faces are attractive. Positive correlations were observed between both facial attractiveness and health ratings and symmetry estimated using facial metric (Study 1) and perceptual techniques (Study 3). These findings compliment those of previous studies (Grammer and Thornhill, 1994; Rhodes et al., 2001; Mealey et al., 1999; Penton-Voak et al., 1999). While these findings used ratings of real faces, Study 2 demonstrated that increasing shape symmetry alone was sufficient to increase judgments of apparent health, replicating Rhodes et al. (2001). Study 1 demonstrated that symmetrical faces are judged attractive *because* they appear healthy (i.e. the link between attractiveness and symmetry appears to be mediated by judgements of apparent health). This supports the good genes view of the attractiveness-symmetry relationship and is problematic for the view that symmetrical faces are attractive because they are processed most efficiently by the visual system. This latter view would predict that the health-symmetry relationship is due to an attractiveness halo effect. Further evidence that the analysis of facial symmetry is an adaptation to the problem of identifying healthy mates (the good genes view) comes from the opposite-sex bias in sensitivity to symmetry observed in Study 2.

Studies 3 and 4 suggest that correlates of symmetry are visible in the face and influence attraction independent of shape symmetry itself. For example, males with symmetric faces are perceived as having healthier-looking facial skin than males with relatively asymmetric faces and visible skin condition alone is sufficient for an attractiveness-symmetry relationship to occur. Thus, visible skin condition may be a critical component

in the link between attractiveness and symmetry. Moreover, symmetric males have more attractive voices (Feinberg and Jacobson, 2001; Hughes et al., 2002) and body odours (Rikowski and Grammer, 1999; Thornhill and Gangestad, 1999b) than asymmetric males. Additionally, the findings of the studies 3 and 4 suggest that symmetric males also possess healthy-looking, attractive facial skin. The influence of these correlates of symmetry may explain why preferences for symmetrical males are evident in female mate choice (Thornhill and Gangestad, 1997), even though variations in symmetry are often so subtle they may not be easily visible during social interactions.

Both the perceptual (Study 3) and facial metric techniques (Study 1) for assessing facial symmetry measure symmetry relative to a facial mid-line that is defined as bisecting the interpupillary distance. As the midline of the face is identified from a single pair of facial locations it may not reflect the true mid-line of the face (Swaddle, 1999). This may somewhat distort the measure of symmetry that is calculated (Swaddle, 1999). Recently, however, techniques have been developed that measure facial symmetry using edge detection algorithims (e.g. Scognamillo et al., 2001, see also Morrone and Burr, 1995). These algorithims do not rely on a facial midline defined as bisecting the interpupillary distance. Whilst assessments of facial symmetry using edge detection alogorithims and perceptual techniques yield positively correlated measures (Scognamillo et al., 2001), the attractiveness-symmetry relationship has not yet been investigated using these new techniques. The development of 3D scanning techniques (see O'Toole et al., 1999) also potentially allows 3D asymmetry and attractiveness to be investigated.

10. Conclusions

These findings confirm that health attributions play a central role in facial attractiveness generally and the attractiveness-symmetry relationship more specifically. This supports the good genes account of the attractiveness-symmetry relationship but is not a prediction of perceptual bias accounts. A feature of these 4 studies was the high agreement between judges on what faces appeared healthy and the strong attraction evident for such faces. While few studies have investigated attraction to apparent health, these studies demonstrated that investigation of attraction to apparent health allows some important assumptions of accounts of face attractiveness to be tested.

Intriguingly, in Studies 1 and 3 the correlations between attractiveness and apparent health were strong but not perfect. While people express strong attraction to face with a healthy appearance there is variation in the strength of this preference. The following 3 chapters review studies reporting individual differences in human mate preferences and outline novel studies that investigated possible reasons for systematic variation in attraction to apparent health. Chapters 3 describes studies that investigated the role of hormonal profile in female attraction to apparent health and Chapter 4 describes a study that investigated a possible link between women's waist-to-hip ratio (an indicator of their attractiveness, health and fertility) and their attraction to apparent health in faces. Chapter 5 describes a study that tested for a change in attraction to apparent health in faces during puberty.

Chapter 3

Do menstrual cycle, pregnancy and oral contraceptive use alter attraction to apparent health in faces?

1. Abstract

Previous studies demonstrating changes in women's face preferences have emphasised increased attraction to cues to possible indirect benefits (e.g. heritable immunity to infection) that coincides with periods of high fertility (e.g. the late follicular phase of the menstrual cycle). By contrast, the studies reported in this chapter showed that women's preferences for faces that are perceived as healthy are (1) stronger during the luteal phase of the menstrual cycle than during the late follicular, fertile phase, (2) stronger in pregnant women than in non-pregnant women and (3) stronger in women using oral contraceptives than in women with natural menstrual cycles. These findings indicate raised progesterone level is associated with increased attraction to facial cues associated with possible direct benefits (e.g. low risk of infection) and suggest that women's face preferences are influenced by adaptations that compensate for weakened immune system responses during pregnancy and reduce the risk of infection disrupting foetal development.

2. Introduction

Masculine physical traits in males are thought to advertise immunity to infection because only males with strong immune systems can overcome the immunosuppressive effects of high levels of testosterone and be able to develop masculine characteristics (Folsatd and Karter, 1992; Zahavi, 1975). Studies have reported that women's preferences for men's faces with masculine proportions change across the menstrual cycle (Johnston et al., 2001; Penton-Voak and Perrett, 2000; Penton-Voak et al., 1999). At times that are characterised by high fertility (i.e. the late follicular phase), attraction to men's faces with masculine proportions is stronger than during less fertile phases of the cycle (e.g. the luteal and early follicular phases). Attraction to masculine males is thought to increase during periods of high fertility because it is only at these times that genetic indirect benefits can be obtained for future offspring (Johnston et al., 2001; Penton-Voak and Perrett, 2000; Penton-Voak et al., 1999). The effect of menstrual cycle phase on attraction to facial masculinity occurs when male faces are judged, but not when female faces are judged (Johnston et al., 2001), and when males are judged for possible short-term relationships, but not long-term relationships (Johnston et al., 2001; Penton-Voak et al., 1999). These latter findings are consistent with the hypothesis that attraction to masculine men is stronger for short-term than long-term matings, as there are costs (in terms of low investment) associated with choosing a masculine long-term partner (Mazur and Booth, 1998; Perrett et al., 1998). Although demonstrations of cyclic shifts in women not using oral contraceptives have been observed, these effects may not generalize to hormonal changes in women using oral contraceptives (who may differ from women with natural cycles in other important ways, e.g. lifestyle, Little et al., 2001). Indeed, Feinberg

et al. (under review) recently found that women with high (on average) levels of oestrogen demonstrated small cyclic shifts in their preferences for masculine male voices than women with relatively low (on average) levels of oestrogen. While this finding does not relate to the problem of self-selection for non-use of oral contraceptive use directly, it demonstrates that individual differences in the magnitude of cyclic shifts in social preferences do occur (see also Penton-Voak et al., 1999).

Women agree when attributing health to faces and express strong attraction to male faces that are perceived as healthy (e.g. Chapter 1). While facial characteristics associated with acute illness (e.g. pallor) contribute to an unhealthy appearance (Roujeau, 2001), apparent facial health might also be a cue to the strength of men's immune systems. If apparent health in male faces is associated with possible indirect benefits (heritable immunity to infection), women's preferences for apparent health might be expected to exhibit the same pattern across the menstrual cycle that has been reported for attraction to masculine face shapes (i.e. increased during the late follicular phase of the menstrual cycle). Furthermore, attraction to apparent health in male faces might be expected to increase during the late follicular phase when male faces are judged for short-term relationships, but not when male faces are judged for long-term relationships (Johnston et al., 2001; Penton-Voak et al., 2001), or when female faces are judged (Johnston et al., 2001). If attraction to putative cues to the strength of men's immune systems is strongest during periods of high fertility, non-pregnant women with natural cycles might express stronger attraction to apparent health in male faces than pregnant women or women using oral contraceptives.

A different set of predictions about the possible effects of menstrual cycle phase, pregnancy and oral contraceptive use on attraction to apparent health in faces is suggested by studies reporting changes in food preferences during pregnancy. During pregnancy, aversion to foods likely to be contaminated with infectious bacteria increases (Flaxman and Sherman, 2000; Fessler, 2002). This is thought to compensate for weakened immune system responses and protect the developing foetus (Flaxman and Sherman, 2000; Fessler, 2002). The increased progesterone levels that appear to trigger these aversions are also a characteristic of the luteal phase of the menstrual cycle (Gilbert, 2000; Burkit et al., 1993;Johnson and Everitt, 1995). Strategies that minimise risk of infection might be elicited during the luteal phase of the menstrual cycle in women with natural cycles (Fessler, 2001). As cues to acute illness are visible in faces and contribute to attributions of poor health (Roujeau, 2001), attraction to apparent health in faces might increase during the luteal phase of the menstrual cycle or during pregnancy, due to possible direct benefits (e.g. low risk of infection). Furthermore, because oral contraceptives raise progesterone levels (Gilbert, 2000), women using oral contraceptives might also express stronger preferences for apparent health in faces than women with natural cycles. If changes in attraction to apparent health across the menstrual cycle, during pregnancy or associated with oral contraceptive use reflect strategies to reduce risk of infection during social interactions, these effects would be expected to be unaffected by the sex of the face judged.

5 studies are reported here that tested these different predictions. Studies 5 - 7 tested for effects of menstrual cycle phase on attraction to apparent health in faces (Study 5, between groups design; Studies 6 and 7, within subject design). Study 8 compared pregnant women's preferences for apparent health in faces with the preferences of non-pregnant women with natural cycles, while Study 9 compared preferences for apparent health in faces between women with natural cycles and women using oral contraceptives.

3. Study 5 "Does menstrual cycle alter attraction to apparent health in faces?"

The aim of Study 5 was to test for an effect of menstrual cycle phase on attraction to male faces manipulated in apparent health. Attraction to apparent health in male faces during the late follicular (15-21 days until onset of menses) phase of the menstrual cycle was compared with that during the luteal (0-14 days until onset of menses) phase of the menstrual cycle (Johnston et al., 2001).

3.1 Methods

Stimuli manufacture

Four pairs of male faces varying in apparent health were manufactured for use in Study 5.

First, colour images (1200x1000 pixels) of 80 Caucasian male faces (age: M=20.8, SD=1.3, range=18-30 years) were captured under diffuse flash lighting with neutral expression and hair off the face. These face images, with hairstyle and clothing masked, were rated for health by 8 men and 7 women (age: M=23.3, SD=2.7, range=19-30 years) using a 1 (low health) – 7 (high health) point integer scale. Faces were presented in a

random order. As inter-rater agreement for these ratings was high (Cronbach's Alpha, α= .81), ratings for each face were averaged across all participants. Two composite images ('healthy' and 'unhealthy') were generated by marking the same 179 facial landmarks on each face and averaging shape, colour and texture of the 25 face images with highest and lowest health ratings using image manipulation software (see Benson and Perrett, 1991; Tiddeman et al., 2001 for methods). These composites were made symmetric by averaging each composite with a mirror-reflected version of itself.

Next, 4 'base faces' were created by averaging the shape, colour and texture of 4 random sets of 3 of the 80 male faces. 'Base faces' refer to the face images which were subsequently transformed along a linear continuum of apparent health. The 4 'base faces' were transformed in shape, colour and texture (see Tiddeman et al., 2001, for methods) by +/-50% of the difference between the 'healthy' and 'unhealthy' composites. This resulted in 4 pairs of male faces that varied in apparent health but were matched in other respects. These 4 face pairs were presented to participants in the study. Figure 12 shows an example face pair used in the study.

Figure 12. Example stimuli used in Study 5. Male 'base face' with raised (right) and lowered (left) apparent health. 'Base faces' were manipulated in 2D shape, colour and texture.

Participants

The participants in the study were 660 heterosexual women (age: M=22.56, SD=1.69, range=20-25 years) who reported regular cycles when asked if their cycle was regular or irregular, cycle lengths of 26-32 days (M=28.9 days, SD=1.17), 0-21 days until next onset of menses and no hormonal contraceptive use. All women were resident in the UK.

Procedure

The 4 face pairs varying in apparent health were presented on-screen in a fully randomised order and interspersed with filler trials. Participants indicated the extent to which they preferred a particular face by choosing from the options "guess", "slight preference", "preference" and "strong preference". All participants reported their age, sexual orientation, hormonal contraceptive use, pregnancy status, whether cycle was

reported regular, usual cycle length, date of onset of menstrual period prior to testing, residency and partnership status. In common with previous studies of individual differences in face preferences (Little et al., 2002) and cyclic changes in behaviour (Fessler and Navertete, 2003) the experiment was run across the web. Participants were recruited through the BBC website by following links to an on-line study of face preferences. Duplicate entries were removed using computer ip address and similarity on an independent 16-item questionnaire (see Kraut et al., 2004).

Initial processing of data

Reported cycle length and date of onset of menstrual period prior to testing were used to assign participants to luteal (N=386, 0-14 days calculated until onset of next period, M=7.9, SD=4.2) or late follicular (N=274, 15-21 days calculated until onset of next period, M =18.1, SD=2.1) groups. Responses were recoded using the following scale: 1=strong preference for low health to 8=strong preference for high health. For each participant, the mean preference strength for apparent health was calculated (across 4 face pairs) and converted to a percentage of maximum preference for apparent health.

3.2 Results

Univariate ANOVA [dependent variable: percentage of maximum preference; random factor: cycle phase (late follicular, luteal); covariate: age] indicated a significant effect of cycle phase ($F(1,657)=10.597$, $p<.001$, partial Eta squared=.023) and no effect of age ($F(1,657)=1.112$, $p=.292$). Attraction to apparent health was significantly stronger during

the luteal phase of the cycle (M=75.88%, SE=0.61) than during the late follicular phase of the cycle (M=72.64%, SE=0.79).

4. Study 6 "Does relationship context interact with the effect of menstrual cycle on attraction to apparent health in male faces?"

Findings from Study 5 indicated women in the luteal phase of the menstrual cycle expressed stronger attraction to apparent health in male faces than did women in the late follicular phase of the menstrual cycle. Study 6 was carried out to establish if this finding generalised to a within-subject comparison of preferences for apparent health in male faces. Women judged the attractiveness of male faces for short-term and long-term relationships. As reporting of cycle data is prone to error (e.g. Gangestad and Thornhill, 1998), the method used in Study 6 to allocate test days to cycle phases confirmed that measured pregnanediol / creatinine ratios were high on test days assigned to the luteal phase and also ensured test days assigned to the late follicular phase were characterised by both low measured pregnanediol / creatinine ratios and high predicted fertility.

4.1 Methods

Stimuli manufacture

Six pairs of faces varying in apparent health were used in the study. These face pairs were manufactured in the same way as those used in Study 5.

Six 'base faces' were manufactured by combining 6 different sets of 10 male faces. These sets of faces were randomly selected from the sample of 80 male faces used to manufacture stimuli in Study 5, but were different to those used to make 'base faces' in Study 5. Three of the 6 new 'base faces' were transformed in apparent health using the 'healthy' and 'unhealthy' composites manufactured in Study 5. The 3 remaining 'base faces' were transformed using 'healthy' and 'unhealthy' composites manufactured from an independent sample of Caucasian male faces (N=58, age: M=21.2, SD=2.8, range=18-27 years). First, masked versions of the 58 faces were rated for health by 12 female and 2 male participants (age: M=25.4, SD=5.6, range=21-27 years; Inter-rater agreement, α=.75) using a 1 (low) – 7 (high) scale. 'Healthy' and 'unhealthy' composites were then manufactured by averaging the shape, colour and texture information from the 20 male faces that were rated most or least healthy (using the same techniques used in Study 5).

Participants

Participants included here were 24 heterosexual female University undergraduates (age: M=21.17, SD=1.04, range=18-24 years; cycle length: M=30.42, SD=2.31, range=28-34 days) reporting no hormonal contraceptive use, regular cycles when asked if their cycle was regular or irregular, not being pregnant and not having used hormonal contraceptives in the last 3 months.

Procedure

Participants were tested at 4 weekly intervals. On each test day, the procedure was identical to that used in Study 5, except that 6 pairs of faces were presented and

participants saw each pair twice – once in a block where faces were judged for short-term relationships and once in a block where judgements were for long-term relationships. The order of these blocks was randomised. In both blocks, health pairs were interspersed with filler trials. Long- and short-term relationships were defined as in (Perrett et al., 2002). Participants were given a sample bottle prior to each test day and were asked to provide a sample of mid-stream urine collected from 1st urination of the morning of testing.

Initial processing of data

As the luteal phase of the menstrual cycle is characterised by pregnanediol / creatinine ratios of 0.5 or greater (Bonello and Norman, 2002; Joseph-Horne et al., 2002), all test days when ratios exceeded 0.5 were assigned to the luteal phase. From the remaining test days, reported cycle lengths and days until onset of next menses were then used to identify test days suspected to be in the late follicular phase of the menstrual cycle, as in Study 5. Following this procedure, preferences for both luteal and late follicular phases were available for 17 heterosexual women. A potential order confound was examined by comparing the mean order of test days assigned to luteal and late follicular phases using a paired-samples t-test. This analysis indicated that assigning test days to late follicular and luteal phases did not confound cycle phase and order of testing ($p=.64$). For the short-term condition, mean preference strengths on luteal and late follicular test days were calculated separately and converted to percentages of maximum health preference as in Study 5. Corresponding values were also calculated for the long-term condition.

4.2 Results

Preferences were analysed using a repeated measures ANOVA [dependent variable: percentage of maximum preference; within-subject factors: relationship context (long-term, short-term), phase (late follicular, luteal)]. This analysis showed no significant main effects of relationship context (F=0.29, df=1,16, p=.871) or cycle phase (F=0.571, df=1,16, p=.461). There was, however, a weak interaction between cycle phase and relationship context (F=3.401, df=1,16, p=.084).

A paired samples t-test indicated that attraction to apparent health was significantly stronger in the luteal phase of the cycle than in the late follicular phase when faces were judged for a short-term relationship (t=2.270, df=16, p=.037). By contrast, when faces were judged for a long-term relationship, a paired samples t-test showed no significant difference between the late follicular and luteal cycle phases (t=-0.425, df=16, p=.667). For the short-term condition, the mean preference for apparent health on luteal test days was 75.69% (SE=1.88) and 72.11% on late follicular test days (SE=2.10). For the long-term condition, the mean preference for apparent health on luteal test days was 75% (SE=2.28) and 74.19% on late follicular test days (SE=2.19).

5. Study 7 "Does sex of face interact with the effect of menstrual cyle phase on attraction to apparent health?"

Both within-subject and between-groups tests for an effect of menstrual cycle on attraction to apparent health in faces indicated that the attraction to apparent health in faces was stronger during the luteal phase of the menstrual cycle than during the late follicular phase. Study 7 (within-subject design), compared the effect of menstrual cycle

phase (luteal, late follicular) on attraction to apparent health in male and female faces. New stimuli were manufactured with more subtle cues to apparent health defined by colour and texture.

5.1 Methods

Stimuli manufacture

Twelve new pairs of faces (6 female, 6 male) were manufactured. Six new pairs of female faces varying in apparent health were manufactured by transforming 6 female 'base faces' (made by averaging the shape, colour and texture of 6 random sets of 3 female faces) using composites of the 20 faces judged the least and most healthy from a sample of 60 photographs of female faces (age range of faces=19-24 years; 4 male and 4 female raters, age range of raters=17-26 years; Inter-rater agreement, α=.82). These female photographs were taken under identical conditions to the male faces rated for health in Study 5. Face rating and computer graphic procedures were identical to those used in the previous studies, except faces were transformed by +/- 30% of the colour and texture differences between the healthy and unhealthy composites. By contrast with stimuli in Studies 5 and 6, 2D shape was not altered.

Six new pairs of male faces varying in apparent health were manufactured in the same way by transforming 6 male 'base faces' using healthy and unhealthy male composites. 'Healthy' and 'unhealthy' composites and the 6 'base faces' used were made from a sample of 60 male faces that were rated for health by the same 8 raters who rated the

female faces (Inter-rater agreement, α=0.79). These 60 male faces were selected at random from the 80 male faces used to manufacture stimuli for Study 5.

Examples of male and female stimuli used in Study 7 are shown in Figure 13.

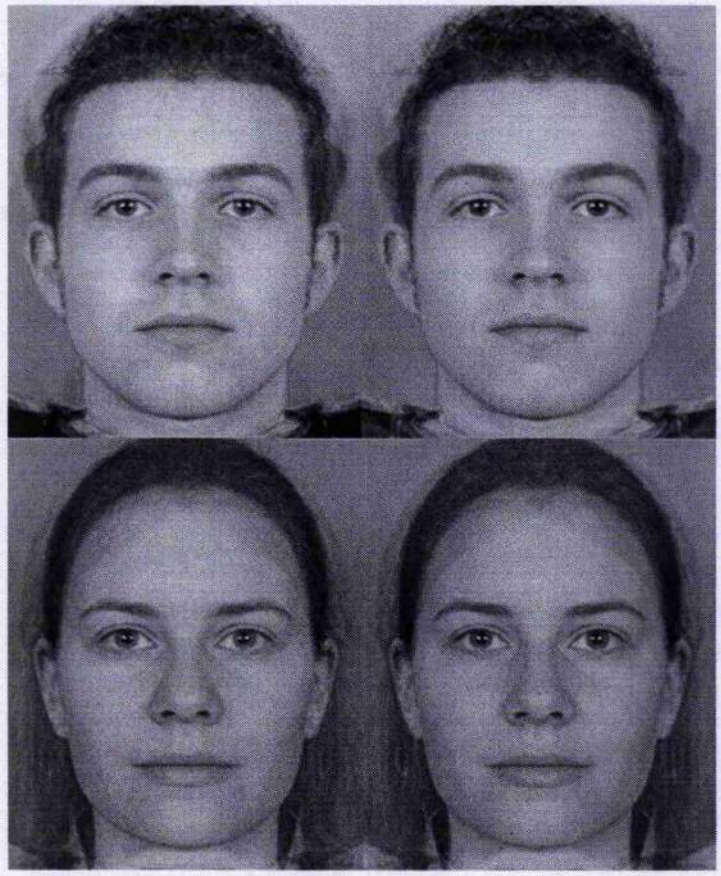

Figure 13. Example stimuli used in Study 7. Male (top row) and female (bottom row) 'base faces' with raised (right) and lowered (left) apparent health. 'Base faces' were manipulated in colour and texture.

Participants

Participants in the study were 25 heterosexual female University undergraduates (age: M=19.66, SD=1.35, range=18-23 years, cycle length: M=29.19, SD=2.5, range=23-35 days) reporting no hormonal contraceptive use, regular cycles when asked if their cycle was regular or irregular, not being pregnant and not having used hormonal contraceptives in the last 3 months.

Procedure

Women were tested at 6 weekly intervals. On each test day, the 12 pairs of health stimuli were presented on-screen using a forced-choice paradigm, in a random order, and interspersed with filler trials. Participants responded to the instruction "choose the face which is most attractive". On each test day, participants provided a urine sample collected on the morning of testing and reported cycle data as in Studies 5 and 6.

Initial processing of data

Test days were assigned to late follicular and luteal phases using the same criteria as Study 6. After this process, preferences during both luteal and late follicular phases were available for 16 women. Assigning test days to the late follicular and luteal phases did not confound cycle phase and order of testing (p=.72). The percentage of trials (out of 12 possible) on which faces with increased apparent health were chosen was calculated as a measure of preference for apparent health in Study 7. For male faces, the percentage of trials on which apparent health was preferred in luteal and late follicular phases were calculated separately. Corresponding values were also calculated for female faces.

5.2 Results

Repeated measures ANOVA [dependent variable: percentage of trials on which apparent health preferred; within-subject factors: sex of face presented (male, female), phase (late follicular, luteal)] indicated no significant main effect of sex of face presented (F=0.125, df=1,15, p=.728) and sex of face did not interact with cycle phase (F=0.166, df=1,15, p=.689). There was, however, a significant main effect of cycle phase (F=4.706, df=1,15, p=.047). Attraction to apparent health in faces was stronger during the luteal phase (M=71.3%, SE=4.91) than during the late follicular phase of the menstrual cycle (M=62.7%, SE=4.02).

6. Study 8

Findings from Studies 5 – 7 suggest that increased attraction to apparent health in faces is associated with raised progesterone levels. As increased progesterone levels are also a characteristic of pregnancy (Gilbert, 2000; Burkit and Young, 1993), Study 8 compared pregnant and non-pregnant women's preferences for apparent health in male faces. Stimuli and testing procedure were the same as in Study 5.

6.1 Methods

115 heterosexual women reporting pregnancy (age: M=26.51, SD=3.0, range=20-30 years, 87% from UK, 98% with a partner; days since onset of last period of menstrual bleeding: M=111, SD=64, range=20-240) were matched in terms of age, partnership and country of residency to 857 control non-pregnant heterosexual women reporting regular

cycles when asked if their cycle were regular or irregular, and no use of hormonal contraceptives (age: M=26.58, SD=2.9, range=20-30 years, 86% from UK, 98% with a partner). Non-pregnant women were selected to represent an even sample through the entire menstrual cycle (cycle length: M=28.9, SD=1.3 days, days until next period: M=14.7, SD=8.2, range=-4 to 32 days). As in Studies 5 and 6, responses were converted to percentages of maximum preference for apparent health.

6.2 Results

Attraction to apparent health of pregnant women and the control group was examined with an independent samples t-test. This analysis indicated pregnant women expressed greater attraction to apparent health than women with natural cycles did ($t(1,970)=2.776$, $p=.042$). Pregnant women expressed a mean preference for apparent health of 76.8% (SE=1.003) while women with natural cycles expressed a mean preference of 74.39% (SE=0.419).

7. Study 9

Findings from Studies 5 – 8 suggest increased attraction to apparent health coincides with conditions that are characterised by high progesterone levels (i.e. the luteal phase of the menstrual cycle, pregnancy). As most oral contraceptives also raise progesterone levels (Gilbert, 2000), Study 9 compared attraction to apparent health in male faces between women with natural menstrual cycles and women using oral contraceptives. Women using oral contraceptives are more likely to be in long-term relationships than women not using oral contraceptives, and partnership status (i.e. having a partner or not) has been

found to influence preferences for masculine proportions in male faces (Little et al., 2002). In Study 9, possible effect of partnership status on preferences for apparent health were therefore considered. Stimuli and testing procedure were the same as in Studies 5 and 8.

7.1 Methods

Participants in the study were 1600 heterosexual women reporting oral contraceptive use (age: M=22.58, SD=1.66, range=20-25 years, 83% from UK, 74.9% with a partner) and 1330 women reporting no oral contraceptive use and regular cycles (age: M=22.58, SD=1.68, range=20-25 years, 71.3% from UK, 44.5% with a partner; days since last period of menstrual bleeding: M=13.749, SD=8.214, range=0-31 days; cycle length: M=28.89, SD=1.249, range=25-32 days). As in Studies 5 and 8, responses were converted to percentages of maximum preference for apparent health.

7.2 Results

Univariate ANOVA [dependent variable: percentage maximum health preference; between-subject factors: oral contraceptive use (yes, no), partnership status (partnered, single), UK residence (yes, no); covariate: age] revealed significant main effects of oral contraceptive use ($F(1,2921)=6.652$, $p=.010$, partial Eta squared=.003) and UK residence ($F(1,2921)=5.348$, $p=.021$) but no main effects of partnership status ($F(1,2921)=0.008$, $p=.929$) or age ($F(1,2921)=.021$, $p=.885$). There were no significant interactions (all $F<1.259$, all $p>.262$). Women using oral contraceptives expressed stronger attraction to apparent health (M=75.22%, SE=0.462) than women not using oral contraceptives

(M=73.38%, SE=0.375) and UK residents expressed stronger attraction to apparent health (M=74.90%, SE=0.50) than non-UK residents (M=73.51%, SE=0.25).

8. Discussion

In Studies 5, 6 and 7, attraction to apparent health in faces was stronger during the luteal phase of the menstrual cycle than during the late follicular phase of the cycle. Although the sex of the face presented did not alter the effect of menstrual cycle phase on health preferences (Study 7), attraction to apparent health in male faces was stronger during the luteal phase of the menstrual cycle than during the late follicular phase when male faces were judged for possible short-term, but not long-term relationships (Study 6). Previous studies examining the effect of menstrual cycle on face preferences have employed self-report diaries to estimate cycle phase. By contrast, Studies 6 and 7 confirmed high progesterone metabolite for test days assigned to the luteal phase and low progesterone metabolite for test days assigned to the late follicular phase. In Studies 8 and 9, attraction to apparent health in male faces was stronger in pregnant women and women using oral contraceptives (high progesterone levels) than in women with natural cycles (relatively low progesterone levels). Collectively, these findings suggest that increased attraction to apparent health in faces coincides with conditions that are characterised by raised progesterone levels, rather than conditions that are characterised by high fertility.

Increased attraction to faces with a healthy appearance during the luteal phase of the menstrual cycle, pregnancy and in oral contraceptive users supports the claim that strategies to reduce the risk of infection are elicited by increased progesterone levels

(Flaxman and Sherman, 2000; Fessler, 2001, 2002). This is potentially adaptive as it may compensate for weakened immune system responses and reduce the risk of infection disrupting foetal development (Flaxman and Sherman, 2000; Fessler, 2002). Although apparent health in faces may be a cue to both underlying long-term health condition and current absence of illness, the findings reported in this chapter suggest it is the latter of these qualities that is important for hormone-mediated variation in women's preferences for faces.

Intriguingly, increased attraction to apparent health during conditions characterised by high progesterone levels appears to be relevant for avoiding infection during social interactions with men and women (Study 7) but does not influence preferences when choosing between potential long-term partners (Study 6). Changes in preferences for apparent health in men's faces are therefore unlikely to pose a significant threat to the stability of long-term relationships. In Study 9, women residing in the UK expressed stronger attraction to apparent health than did women who were not UK residents. This suggests differences in experience with faces of the type judged (white British males) contribute to variation in health preferences. The absence of an interaction between oral contraceptive use and UK residence, however, suggests experiential and hormonal effects on preferences for apparent health are independent.

Previous studies (Johnston et al., 2001; Penton-Voak and Perrett, 2000; Penton-Voak et al., 1999), demonstrating that attraction to masculine proportions in male faces is strongest during the late follicular phase of the menstrual cycle have emphasised indirect

benefits of such preferences (e.g. offspring inheriting immunity to infection). By contrast, attraction to apparent health in faces, in the luteal phase of the menstrual cycle, in pregnancy and during oral contraceptive use, suggest hormonal profile alters preferences for individuals offering direct benefits (e.g. low risk of infection). While hormone-mediated variation in preferences for masculine proportions and apparent health in faces show very different patterns, both evince adaptive design in women's face preferences.

Chapter 4. Do psychological and physical condition influence female preferences for apparent health in faces?

1. Abstract

Estimates of female condition predict individual differences in female mate preference in many species. Although studies have demonstrated effects of physical condition on female mate preferences, both physical factors (e.g. health, fertility) and psychological factors (e.g. stress, anxiety, depression) may reflect condition of human females. Study 10 investigated the relationships between women's preferences for composite faces varying in colour and texture cues associated with apparent health and estimates of their physical condition (waist-to-hip ratio) and psychological condition (a composite score of stress, anxiety and depression measures). Women with low waist-to-hip ratios (indicating health and fertility) or that scored low on the anxiety, depression and stress measures expressed greater attraction to apparent health in male faces (but not female faces) than women with relatively high waist-to-hip ratios or that scored relatively high on the anxiety, depression and stress measures. The effects of waist-to-hip ratio and psychological condition were independent and were not mediated by women's perceptions of their own attractiveness. These findings indicate women's physical and psychological condition both contribute to individual differences in face preferences.

2. Background to Study 10

One of the most robust findings in studies of human attractiveness is the high level of agreement among individuals on what is an attractive face (see Langlois et al., 2000 for a meta-analytic review). In many species, however, individual differences in mate preferences are evident. For example, female sticklebacks (*Gasterosteus aculeatus*) and guppies (*Poecilia reticulata*) in good physical condition are more likely to prefer cues to immunocompetence in males than are relatively poor condition females (Bakker et al., 1999; Lopez, 1999). Condition dependent preferences such as these are potentially adaptive if only females in good physical condition are able to obtain the healthiest mates. As the face plays an important role in human mate choice (Miller and Todd, 1998; Thornhill and Gangestad, 1999), women's own condition may influence their preferences for male faces with characteristics that are thought to be indices of immune system strength and health (e.g. symmetry and masculinity, Gangestad and Simpson, 2000; Thornhill and Gangestad, 1999).

Consistent with this proposal, Little et al. (2001) reported positive relationships between women's ratings of their own attractiveness and the extent to which they preferred male faces with symmetric and masculine shapes. Penton-Voak et al. (2003) replicated Little et al.'s finding regarding female preferences for sexual dimorphism in male face shape using independent measures of female physical condition (waist-to-hip ratio and other-rated facial attractiveness, see Miller and Todd, 1998). Although psychological factors (e.g. anxiety, depression, stress) might also reflect female condition, and psychological factors are known to influence physical health (for a review see Brunner and Marmot,

1999), possible relationships between estimates of women's psychological condition and their face preferences have not yet been investigated.

Visible skin condition is positively associated with indices of men's genotypic health (e.g. MHC heterozygosity, Roberts et al., 2003), phenotypic health (e.g. pallor during illness, Roujeau, 2001) and facial attractiveness (Jones et al., 2004; Roberts et al., 2003). In women, a low waist-to-hip ratio is associated with an attractive body shape (Singh, 1993), medical health (Singh, 1993 for a review) and fertility (Janieski et al., 2004). Given the above, Study 10 was carried out to investigate if women with low waist-to-hip ratios expressed stronger attraction to apparent health in faces than women with relatively high waist-to-hip ratios. The possibility that women who scored low on assessments of anxiety, depression and stress might express stronger attraction to apparent health in faces than women who scored relatively high on these measures was also tested. Possible effects of self-rated attractiveness on preference were also investigated, as effects of psychological and physical condition on face preferences could be mediated by women's beliefs about their own attractiveness. Stimuli (composite male and female faces) were manipulated in colour and texture cues associated with apparent health and did not differ in symmetry or masculinity of 2D shape.

3. Methods

Stimuli

Stimuli were the same as those used in Study X (i.e. 6 male and 6 female faces varying in visible skin condition)

Participants

69 heterosexual women (age: M=19.76, SD=1.365, range=17-23 years; all Undergraduate students at the University of St Andrews) participated in the study in return for payment (£4 per hour pro rata).

Procedure

The 12 face pairs varying in apparent health were presented on-screen using a forced choice paradigm, in a fully randomised order and interspersed with filler trials. Faces were presented in full colour. Women responded to the question, "Which of these individuals is more attractive?" Participants reported their age, completed the Hospital Anxiety and Depression Scale (a 14-item questionnaire with anxiety and depression subscales, Johnston et al., 1995; Zigmond and Snaith, 1983), and responded to the questions "How would you rate your current level of stress?" and "Please rate yourself in terms of attractiveness" (1=very low - 7=very high). Waist and hip circumferences were also measured.

Initial data processing

The proportion of trials on which the faces with raised apparent health were preferred was calculated separately for male and female faces. Self-rated current stress, the anxiety subscale of the Hospital Anxiety and Depression Scale and the depression subscale of the Hospital Anxiety and Depression Scale were positively interrelated (all $r>.418$, $N=69$, all $p<.001$). Factor analysis was used to reduce these 3 variables to a single component that

explained 62.389% of the total variance in stress, anxiety and depression scores (stress: r=.758, anxiety: r=0.815, depression: r=.796). This component was reverse-scaled and labelled "psychological condition" (high score = low stress, anxiety and depression). Waist-to-hip ratios were also calculated (M=0.80, SD=0.057, range=0.67-0.92).

4. Results

One sample t-tests (comparing preferences with chance) indicated that women generally preferred faces with raised apparent health (male faces: t=5.509, df=68, p<.001; female faces: t=5.741, df=68, p<.001).

Preferences for apparent health in male faces was analysed with linear regression [dependent variable = proportion of trials on which health was preferred for male faces; independent variables entered using the enter method = waist-to-hip ratio, age, psychological condition, self-rated attractiveness]. The overall model was significant and explained approximately 10% of the variance in preference for apparent health in male faces (adjusted R^2=.100, F=2.890, df=68, p=.029). Waist-to-hip ratio (β=-0.238, t=-2.059, p=.044) and psychological condition (β=0.256, t=2.173, p=.044) were independently related to preference for apparent health in male faces. Women with low waist-to-hip ratios or who were in good psychological condition expressed stronger attraction to apparent health in male faces than women with high waist-to-hip ratios or who were in relatively poor psychological condition. There were no effects of age (β=0.090, t=0.776, p=.441) or self-rated attractiveness (β=0.128, t=1.090, p=.280).

Preferences for apparent health in female faces were analysed in the same way. By contrast with our findings for male faces, the overall model was not significant (adjusted R^2=.002, F=1.036, df=68, p=.396) and there were no independent effects of any of the independent variables (all absolute β values <.184, all absolute t values <1.516, all p>.135).

There were no significant relationships between the independent variables themselves (all p>.328).

5. Discussion

Although women generally preferred faces with raised apparent health to faces with lowered apparent health, systematic variation in women's preference for apparent health in male faces was also observed. Women with low waist-to-hip ratios expressed stronger attraction to apparent health in male faces, but not female faces, than women with relatively high waist-to-hip ratios. This finding complements those from earlier studies in which positive relationships between estimates of women's physical condition and their preferences for male faces with masculine and symmetric shapes were observed (e.g. Little et al., 2001; Penton-Voak et al., 2003). Independent of the effect of waist-to-hip ratio, women who scored low on the anxiety, depression and stress measures demonstrated stronger preferences for apparent health in male faces, but not female faces, than women who scored relatively high on the anxiety, depression and stress measures. In addition to the effect of physical condition, psychological condition also appears to contribute to individual differences in women's preferences for male faces. Both the

effect of waist-to-hip ratio and that of psychological condition were independent of women's beliefs about their own attractiveness.

Colour and texture cues to apparent health in male faces (e.g. skin tone, evenness of complexion, Jones et al., 2004) signal both genotypic (Roberts et al., under review) and phenotypic (Roujeau et al., 2001) health. Findings from Study 10 therefore suggest that women's physical and psychological conditions are positively related to their preference for healthy potential mates. This systematic variation in health preference is potentially adaptive if only women who are in good condition (physically and psychologically) are able to obtain the healthiest mates. Condition dependent preferences for healthy males could yield reproductive benefits by reducing wasted mating effort while simultaneously allowing for pursuit of the healthiest mate that is attainable, and may contribute to similarity in the attractiveness of partners (see Feingold, 1988).

The mechanisms and processes that produce condition dependent preferences for potential mates who are perceived as healthy are not currently known. One possibility is that women learn the facial characteristics that are common to the men who express sexual interest in them (or who do not reject their own interest) and that this implicit knowledge constrains what might otherwise be a stronger preference. Imprinting-like phenomena might also account for condition dependent face preferences, if healthy-looking fathers have daughters who are in good physical and psychological condition (see Little et al., 2003 and Perrett et al., 2002 for discussions of why women might imprint on paternal traits). Further research is needed to investigate these issues.

Chapter 5.

Does attraction to apparent health in faces increase during puberty?

1. Abstract

It has been suggested that attraction to cues to apparent health in faces might either emerge or increase during puberty. No previous studies have investigated the effects of pubertal maturation on preferences for apparent health in faces, however. This chapter describes a study that tested for a change in attraction to apparent health in faces during pubertal development. As menarche (first menses) is an indicator of pubertal maturation in females, a study was carried out that compared preferences for apparent health between pre- and post-menarche females (12 - 13 years). Although both the post-menarche and pre-menarche groups expressed attraction to apparent health in faces that was stronger than would be expected by chance alone, attraction to apparent health in faces was stronger in the post-menarche group than in the pre-menarche group. This finding suggests that attraction to apparent health in faces increases during puberty but emerges at an earlier stage of development.

2. Background to Study 11

Social cues to health status influence our treatment of others (Porter et al., 2003). As faces play an important role in social interaction (Bruce and Young, 1986), studies have investigated attributions to faces varying in health of appearance. Adults show high levels of agreement when judging the health of faces and express strong attraction to faces with a healthy appearance (Chapters 2 and 3, see also Grammer and Thornhill, 1994; Kalick et al., 1998; Rhodes et al., 2001). The focus of other work has been to identify the mechanisms underpinning variation in adults' preferences for cues to apparent health (Chapter 3; Koehler et al., 2002) and the developmental profile of these preferences (Rhodes et al., 2002).

Rhodes et al. (2002) reported that adult women and infants varied in their preferences for facial cues to apparent health (symmetry and averageness, Rhodes et al., 2001) and suggested attraction to health cues might emerge or increase during puberty as a consequence of rising hormone levels. Indeed, variation in adult women's attraction to apparent health in male faces appears to be hormone-mediated: this attraction is stronger during the luteal phase of the menstrual cycle than during the follicular phase and stronger in pregnant women and women using oral contraceptives than in women with natural menstrual cycles (Chapter 3).

Menarche (onset of first period of menstrual bleeding) is an indicator of pubertal maturation that reflects increasing levels of sex hormones (Nottelman et al., 1987). Most females in western Europe experience menarche around the age of 13 (Cole, 2000). If

rising levels of sex hormones cause an increase in attraction to apparent health in faces (Rhodes et al., 2002), females who have experienced menarche might be expected to express stronger attraction to apparent health in faces than females who have not experienced menarche. This hypothesis was tested by comparing attraction to apparent health in adult male faces among pre-menarche and post-menarche women aged 12 - 13 years. Possible effects of age on preferences were also tested for.

3. Methods

Stimuli

Stimuli were the same as those used in Studies 5, 8 and 9 (i.e. 4 pairs of male faces, each pair being one base face with lowered and raised apparent health)

Participants

207 females aged 12 and 457 females aged 13 (all UK residents) participated in the study. Participants were recruited through the BBC Science On-Line website.

Procedure

The 4 face pairs were presented on-screen in a fully randomised order and interspersed with filler trials. Participants indicated the extent to which they preferred a particular face by choosing from the options "guess", "slight preference", "preference" and "strong preference". They also reported their age, residency and menstrual cycle data (choosing from the options: not applicable, regular cycles, irregular cycles). The experiment was run across the web. Participants followed links from the BBC web page to a study labeled

'Face Perception' if they wished to participate in the study. They were then told that they would be shown pairs of faces and would be asked to choose the face that they preferred. They were also told there would be a short questionnaire to complete before judging the faces. The interface used and full instructions can be seen in Appendix B or at the link below.

http://www.bbc.co.uk/science/humanbody/mind/surveys/faceperception1/

Duplicate entries were removed using computer ip address and similarity on an independent 16 item personality questionnaire.

Initial data processing

Attraction to apparent health was estimated by calculating percentage of maximum preference for apparent health as in studies 5, 8 and 9. Women who reported regular or irregular menstrual cycles were assigned to the post-menarche group (N=344). The remaining participants were assigned to the pre-menarche group (N=320).

4. Results

Both the pre-menarche (One-sample t-test comparing proportion of healthy faces preferred to chance: $t=27.63$, $df=319$, $p<.001$) and post-menarche ($t=34.97$, $df=343$, $p<.001$) groups demonstrated attraction to apparent health.

Univariate ANOVA (between subject factors: menarche-status (pre-menarche, post-menarche), age (12, 13 years); dependent variable: % maximum preference strength)

revealed a significant main effect of menarche-status ($F=6.242$, $df=1,660$ $p=.013$). There was no main effect of age ($F=0.15$, $df=1,660$ $p=.69$) or interaction between menarche-status and age ($F=0.001$, $df=1,660$ $p=.974$). Women in the post-menarche group reported greater attraction to apparent health ($M=74.5\%$, $SE=0.89$) than women in the pre-menarche group ($M=71.54\%$, $SE=0.76$).

5. Discussion

Circum-pubertal females who were in the post-menarche group expressed stronger attraction to apparent health than those in the pre-menarche group. This supports the proposal that attraction to apparent health in faces increases during pubertal development (Rhodes et al., 2002). It remains unclear, however, if this reflects 1) rising levels of sex-hormones during puberty, 2) previously reported increases in face preferences during the luteal phase of menstrual cycles (see Chapter 3), or 3) changes in social experience during puberty.

Intriguingly, although analyses indicated that attraction to apparent health was slightly increased in the post-menarche group, a strong attraction to faces with a healthy appearance was also evident in the pre-menarche group. This indicates that preferences for apparent health increase, rather than emerge, during puberty. Further work is needed to establish why preferences for facial cues to apparent health increase during puberty and at what stage of development preferences for facial cues to apparent health emerge.

Chapter 6.

Does apparent facial health communicate accurate information regarding lifestyle health?

1. Abstract

The studies described in the previous chapters demonstrate that attributions of health play an important role in face preferences. Faces with a healthy appearance are more attractive than faces with a relatively unhealthy appearance. Where variation in attraction to apparent health was observed (e.g. studies in Chapters 3 – 5), this variation occurred in the *strength*, rather than the *direction* (pro-health), of preferences. There have, however, been relatively few tests for a potential association between apparent facial health and measures of long-term health. In other words, although apparent health plays an important role in face preferences, it remains unclear if apparent facial health communicates any accurate information regarding long-term health. This chapter reviews findings from previous tests for associations between apparent facial health and measures of long-term physical health (e.g. good genes for immunocompetence, incidence and severity of illnesses from medical records, longevity) and describes a new study in which the relationship between women's apparent facial health and a measure of their lifestyle health (the Alameda County Questionnaire which has been found to predict longevity and general health at 6 year and >6 year follow ups; Berkman and Breslow, 1983) was investigated. A significant positive relationship was observed between rated health of

facial appearance and health of lifestyle, suggesting apparent facial health communicates some accurate information about long-term physical health.

2. Is there evidence for a positive relationship between apparent facial health and long-term health?

Although empirical studies have tended to investigate possible relationships between facial attractiveness and long-term health (see Chapter 1 for a review of these studies) and between facial symmetry and apparent health (see Chapter 2 for a review of these studies), some studies have also tested for possible relationships between apparent facial health and indices of long-term health. Roberts et al. (2003) reported that men with healthy-looking faces were more likely to possess a genetic profile associated with a strong immune system (and presumably long-term health) than men with relatively unhealthy faces. Hetrozygosity at the major histocompatibilty complex, found to be associated with apparent health of male faces, correlates negatively ith severity of contracted AIDS, psorisis and salmonella poisoning (see Roberts et al., 2003). It is important to note, however, that Thornhill et al. (2003) found no links between the same measure of genetic-based immunocompetence (MHC heterozygosity) and attractiveness of facial appearance. This latter finding is perhaps surprising given the findings of Roberts et al. (2003) and the positive associations reported between facial attractiveness and apparent health (see Chapter 2, for example; see also Grammer and Thornhill, 1994; Rhodes et al., 2001). The sample studied by Thornhill et al. (2003) was diverse in terms of age and ethnicity, which may explain the null finding. By contrast, the sample studied by Roberts et al. was a narrow age range and all white European.

By contrast with the studies described above, which have considered genetic measures of long-term health, other studies have considered incidence and severity of illnesses

reported in medical records. For example, Kalick et al. (1998) tested for relationships between men and women's long-term health and apparent facial health using medical records to estimate long-term health. Although Kalick et al. found no significant relationships between apparent facial health and long-term health, these relationships strengthened considerably when the influence of attractiveness was controlled using partial correlations. This latter finding suggests attractive aspects of facial appearance may mask cues to long-term health in faces (Kalick et al., 1998). Although Rhodes et al. (2001) did not report analyses for associations between apparent facial health and long-term health (again assessed from medical records), facial averageness was found to be associated with both apparent facial health and medical history in women. Similarly, ratings of men's facial masculinity have been found to be positively associated with ratings of their facial health and their long-term health (although the relationship between apparent health and medical health was not reported, Rhodes et al., 2003). Only one study has tested for an association between longevity and apparent facial health. Henderson and Anglin (2003) tested for links between longevity and apparent facial health in men and women and found no significant relationships. It would appear that evidence for a relationship between apparent facial health and long-term health is equivocal, at best.

3. Rationale for Study 12

Although evidence that facial appearance generally, and the perceived health of faces specifically, is related to long-term health is equivocal, we know of no studies that have tested for a possible link between health of lifestyle and apparent facial health (or any aspect of physical appearance). The Alameda County Questionnaire (Berkman and

Breslow, 1983) assesses lifestyle health and contains items that assess 7 health-related behaviours: typical alcohol consumption, smoking, sleeping behaviour, exercise behaviour, obesity (as estimated from weight relative to height), breakfasting and snacking behaviour. These health behaviour items independently predict longevity and general medical health at a 6 year follow up (i.e. long-term health). The questionnaire method for assessing lifestyle health relies on self-report data. This approach has been criticised when used by other researchers (Shakelford and Larson, 1999; Hume and Montgomerie, 2001) to test for possible links between facial appearance and long-term health (see Rhodes et al., 2001 for a discussion of this issue and Chapter 2). It is important to note that in the case of the Alameda County Questionnaire, these self-report items have been found to predict measures of actual health. While there may be methods that more accurately reflect incidence of health-related behaviours (e.g. time line follow back procedures to assess alcohol consumption; Jones et al., 2003), these alternative measures have not necessarily been shown to relate to long-term health.

The following section describes a study that tested for positive relationships between lifestyle health (as estimated using Alameda County Questionnaire items) and apparent health of neutral and smiling faces in a sample of undergraduate women. Both neutral and smiling faces were considered as previous findings suggest that facial expression may modify the relationship between long-term health and facial appearance (Shackelford and Larson, 1999). Positive expressions may mask (or perhaps shift attention away from) cues to long-term health in faces (Shackelford and Larson, 1999). By contrast with many studies that have found little evidence for stable relationships

between facial appearance and long-term health (e.g. Kalick et al., 1998; Rhodes et al., 2001, 2003), high resolution, full colour face photographs were used in Study 16.

4. Method

Two full-face photographs were taken of each of the 51 female participants (age: mean=19.5, SD=1.12, range=18-21 years, all undergraduate students at the University of St Andrews). For one photograph, participants were asked to pose with a neutral expression while for the other participants were asked top pose with a smiling expression. Participants were pre-selected to be within the normal, healthy range for body-mass-index (mean=22.01, SD=1.5, range=18-25, Porter, 2003). This was done to ensure women with an unusually high or low body-mass-index could not have driven any relationships observed. All participants were white.

Each participant also completed the Alameda County Questionnaire (see Appendix A). For each behaviour, questionnaire responses were recoded into healthy (1) or unhealthy (0) (see Berkman, Breslow & Wingard, 1983). This recoded data was converted into z-scores and averaged for each participant. Two lifestyle health scores were calculated: 1 included alcohol consumption and the other did not include alcohol consumption. This was done because undergraduate reporting of alcohol consumption is notoriously unreliabale and because drinking behaviour during undergraduate degrees is not typical of drinking behaviour at other times in adulthood (Jones, 2003).

Unmasked versions of the face images were rated for health by 26 people (age: mean=20.3, SD=1.8, range=19-23, 10 males) using a 1 (low) to 7 (high) scale. Smiling and neutral faces were rated in separate blocks. Both the block order and face order within each block were fully randomised. Participants prefaced ratings with a "K" if they recognised the individual. A small number of ratings (<5%) were excluded as they were prefaced with a K. As inter-rater agreement for both sets of ratings was high (inter-rater agreement for smiling faces: Cronbach's alpha=.85, inter-rater agreement for neutral faces: Cronbach's alpha=.87), average health ratings were calculated separately for each neutral and smiling face by averaging ratings for these faces across all participants. Ratings from male and female raters were highly correlated in each condition (all r's>.75, all p<.0001).

5. Results

Two-tailed p-values are reported throughout and N=51 in all cases. As all variables (i.e. age, both lifestyle health indices and both sets of face ratings) were normally distributed (one-sample Kolmogorov-Smirnov test for significant difference from normal distribution: all p>.08), results from parametric tests are reported.

There were significant positive correlations between apparent facial health of neutral faces and the composite lifestyle health score that *did not* include alcohol consumption (r=0.312, p=.024) and between apparent facial health of neutral faces and the composite lifestyle health score that *did* include alcohol consumption (r=0.277, p=.049). By contrast, the relationships between apparent facial health of smiling faces and the

composite lifestyle health score that *did not* include alcohol consumption and between apparent facial health of smiling faces (r=0.251, p =.073) and the composite lifestyle health score that *did* include alcohol consumption (r=229, p=.105) were not significant. Age of person photographed was not correlated with any of these 4 variables (all r<.21, all p>.123). Although ratings of the health of neutral faces were significantly lower than those of smiling faces (paired sample t-test: t=4.5, df=50, p<.001), ratings of neutral and smiling faces were significantly positively related (r=0.86, p<.001).

6. Discussion

Ratings of the health of individuals from face photographs with neutral expressions were positively correlated with the index of lifestyle health measures. This relationship was observed when alcohol consumption was included in the index and when it was excluded from the index. By contrast, the relationships between ratings of the health of individuals from face photographs with smiling expressions were not correlated with the index of lifestyle health measures. These findings suggest that while cues to health of lifestyle are visible in faces and influence attributions of health, facial expression appears to mask these cues. Strong attraction to apparent facial health observed in previous studies may reflect preferences for individuals who lead healthy lifestyles. As lifestyle health predicts longevity and general health at follow up examinations, the findings of the present study suggest women with faces that appear healthy may live longer and be generally healthier than women who look relatively unhealthy facially.

One limitation of the present study is that some of the women participants were wearing makeup and many had shaped (i.e. plucked) their eyebrows. Cues to grooming may influence health perceptions and may also co-vary with lifestyle health. For example, women who are careful to eat breakfast in the mornings may also be those women who take more time to apply make up in the mornings. Although this suggests cues to lifestyle health may not necessarily be visible in faces when cues to grooming are absent, women do wear makeup in everyday life. Therefore, if grooming cues were to solely mediate the link between facial appearance and lifestyle health this would still mean cues to lifestyle health were visible during social interactions and may be used in mate and associate choices.

Health psychologists have investigated why some individuals seek formal medical advice for illnesses while others delay, potentially reducing the efficacy of treatment (Porter, 1999). It has been suggested that lay referrals (recommendations that you consult a doctor made during social interactions) speed decisions to seek formal medical advice (Porter, 1999). Although it remains unclear what social cues elicit lay referrals, our findings here suggest facial appearance may contribute to decisions about health advice.

A number of studies have tested for links between measures of genetic health (e.g. heterozygsity of MHC) and facial appearance (Thornhill, 2003; Roberts et al., 2003). If lifestyle health is related to facial appearance, however, and either independent of genetic health or related to genetic health in a systematic manner, then such studies may have missed effects of genetic health as they were masked by cues to lifestyle health

(Thornhill, 2003) or have found links between genetic health and facial appearance that are mediated by lifestyle health (Roberts et al., 2003). Further studies are necessary that compare the effects of lifestyle health and genetic health on facial appearance. Similar issues may arise in studies of hormonal profile and facial appearance, as lifestyle factors and attractiveness may change during the menstrual cycle (Roberts et al., 2004). Given that the effects of poor lifestyle health may be cumulative, further studies are also needed to investigate the links between lifestyle health and facial appearance in older samples.

Previous test for links between facial appearance and measures of health have focused on identifying facial correlates of underlying health (e.g. incidence of serious illness, a genetic profile conducive to a strong immune system). Evidence from these studies is equivocal, however. By contrast, the present study demonstrated that cues to health of lifestyle are visible in faces.

Chapter 7

Summary and directions for future research

1. Abstract

First, this final chapter summarises findings from the previous experimental chapters. These findings suggest that studying apparent facial health can offer insight into controversial issues for attractiveness research (e.g. Chapter 2, Why are symmetric faces attractive? Chapter 6, Are the attributions we make to faces accurate?). Moreover, own hormonal profile (Chapter 3), own condition (both physical and psychological, Chapter 4) and physical maturation (Chapter 5) contribute to individual differences in attraction to apparent health in faces that occur in a systematic manner. A number of important issues emerge from the work reported in the experimental chapters (e.g. the utility of employing independent measures of attraction) and suggestions are made about how these could be investigated.

2. Summary of findings

The findings detailed in the preceding experimental chapters demonstrate that judgements of health when viewing faces play an important role in social perceptions. For example, ratings of the attractiveness and health of faces are positively associated (Chapter 2). Moreover, the health of facial appearance can be manipulated using prototype-based transformation techniques and this influences facial attractiveness (Chapters 3 - 5). Faces with increased apparent health are preferred (Chapters 3 - 5). These effects do not seem to be modified by the sex of the faces (own- or opposite-sex), the relationship context for which faces were judged (if opposite-sex faces, long- or short-term relationships) and are evident when adult women judge adult male faces (Chapter 3 and 4) and when circum-pubertal (and even pre-pubertal) females judge adult male faces (Chapter 5). These latter findings, together with the absence of effects of age within samples of adult women judges (Chapters 3 and 4), suggest apparent health may be a universal preference. Both surface and shape characteristics of faces influence judgements of apparent health (Chapter 2, see also Chapters 3 and 4). Demeanour also influences apparent facial health. Smiling faces look healthier than faces with neutral expressions (Chapter 6).

Considering the role of apparent health offered insight into a widely studied (and contested) topic in face preference research: attraction to symmetric faces. Findings from Chapter 1 suggest that symmetric faces are considered attractive because they appear healthier than asymmetric faces. Moreover, male and female faces manipulated in shape symmetry alone were perceived healthier than their relatively asymmetric counterparts. This suggests shape symmetry is a visual cue for judgements of apparent health when

viewing faces. This effect was particularly pronounced when judging opposite-sex faces, suggesting opposite-sex biases in attributing health to symmetric faces may underpin opposite-sex biases in symmetry preferences reported elsewhere (Penton-Voak et al., 2001; Little et al., 2001). Although symmetry appears to be a visual cue for judgements of facial health, findings from Studies 3 and 4 indicated correlates of facial symmetry are sufficient to maintain a link between symmetry and facial attractiveness. A composite with the mean colour and texture information for a sample of symmetric male faces was judged healthier and more attractive than a composite with the mean colour and texture information for a sample of asymmetric male faces (Study 4). As these composites possessed identical 2d shapes, this finding cannot be attributed to symmetry acting as a visual cue or shape correlates of symmetry acting as visual cues. That correlates of symmetry may contribute to symmetry preferences is evidence against the claim that sexual selection for symmetric individuals could not occur, as asymmetries are so small they cannot be easily seen. While it remains unclear if there are benefits to selecting symmetric partners in modern times (Rhodes et al., 2001), attraction to symmetric faces appears to reflect evolved preferences for cues to apparent health. These findings support the claim that attraction to symmetric faces are is an evolved behaviour that identifies healthy mates (Grammer and Thornhill, 1994) and are problematic for the claim that attraction to symmetric faces simply reflects greater efficiency in processing any symmetric stimuli (see Chapter 2).

Although consistent strong attraction to high apparent health was evident in all of the studies reported, systematic variation in the strength of this preference was observed.

Three different sources of systematic variation in attraction to apparent health were investigated – first, the effects of hormonal profile on women's preferences, second, the effects of pubertal maturation on preferences and third, the effects of own condition on preferences.

Hormonal changes across the menstrual cycle and during pregnancy were found to influence female attraction to apparent health in male faces (Chapter 3). Attraction to apparent health was stronger in women in the luteal phase of the cycle than in women in the late follicular phase of the menstrual cycle and stronger in pregnant than non-pregnant women (Chapter 3). These effect of cycle was different to that previously observed for attraction to masculine proportions in male faces (which is stronger during the late follicular phase of the cycle than the luteal phase, e.g. Penton-Voak et al., 2001). Changes in hormonal profile elicit strategies for minimising risk of infection during pregnancy (e.g. food preferences, Flaxman and Sherman, 2000), including increased aversion to facial characteristics associated with acute illness. Although symmetry is a cue to apparent health, individual differences in attraction to apparent health reported here cannot be attributed to variation in symmetry preferences as stimuli were made symmetric prior to testing. Although Koehler et al. (2002) found no difference in attraction to symmetric faces between the late and early follicular phases of the menstrual cycle, it is likely the effects of hormonal profile on apparent health do involve changes in attraction to correlates of symmetry (e.g. healthy skin condition, Chapter 2). Perhaps the most important point to emphasise about hormone-mediated variation in attraction to

apparent health is that it demonstrates face preferences are influenced by biological factors.

Attraction to apparent health in male faces also increased following menarche (Chapter 5). Although the mechanisms that cause this remain unclear, this is further evidence of systematic variation in attraction to apparent health and indicates face preferences change during puberty. As females in the pre-menarche group did express strong attraction to apparent health in faces, further work is needed to identify at what stage of development preferences for apparent health emerge (see also Rhodes et al., 2002).

Independent of the effects of hormonal profile, the physical condition of female judges (as estimated from waist-to-hip ratio) was found to influence attraction to apparent health in male faces but not female faces. Women with body shapes associated with high attractiveness, health and fertility (a low waist-to-hip ratio, Singh, 1993) expressed stronger attraction to apparent health in male faces than women with body shapes associated with low attractiveness, health and fertility (a high waist-to-hip ratio, Singh, 1993). This effect was not mediated by women's beliefs about their own attractiveness. This effect of waist-to-hip ratio is also independent of the effects of hormonal profile because, although waist-to-hip ratio varies across the menstrual cycle (Singh et al., 2001), it is lowest during the late follicular phase of the cycle (when attraction to apparent health is weakest). Because waist-to-hip ratio was negatively associated with the strength of health preferences (Chapter 4), cyclic shifts in attraction to apparent health will have weakened (rather than caused) the associations between own attractiveness and

preferences for apparent health in faces. This is an important point: by contrast, the effects of attractiveness and menstrual cycle on attraction to masculine proportions in male faces are confounded.

Independent of the effect of own physical condition, women's psychological condition (as estimated by a composite measure of stress, anxiety and depression) also appeared to influence their preferences for apparent health in faces (Chapter 4). Women who scored low on anxiety, stress and depression measures preferred apparent health to a greater extent than women who scored relatively high on these measures. This effect was not mediated by women's beliefs about their own attractiveness. In common with the effect of women's waist-to-hip ratio on preferences for apparent health in faces, psychological condition influenced only women's preferences for apparent health in male faces.

Inter-rater agreement for ratings of health when viewing faces was high (Chapters 2 and 3). In other words, people agree on what faces appear healthy and which appear unhealthy. That an index of lifestyle health measures was positively related to apparent health of faces, suggests this may be because the attributions are, to a degree, accurate. Thus, findings from Chapter 6 contribute to the ongoing debate about the extent to which attributions to faces (e.g. health, personality, intelligence) have a "kernal of truth". Macrae et al. (2002) reported that the efficiency with which women could classify the sex of faces varied across the menstrual cycle. Women were most efficient at the task during the late follicular phase when attraction to masculinity is also strongest. Macrae et al. suggested the efficiency of access to stereotypes associated with masculinity is mediated

by hormonal profile and may be the mechanism through which the potentially adaptive shift in masculinity preferences occurs. Following this logic, hormonal profile may influence classification of health in faces, underpinning changes in preferences. This issue remains to be investigated. Tests for systematic variation in the accuracy with which faces of physically healthy individuals can be classified may be necessary to discover the extent to which there is a kernel of truth in the attributions make to faces. Some people may make more accurate attributions to faces than others.

2. Suggestions for future research

A limitation of the studies reported here is their reliance on self-report measures of attraction. It is curious that while many researchers (e.g. Tarin and Gomez, 2002; Fisher, 2004) have noted a need to validate self-reported menstrual cycle data with hormonal analysis of urine samples (as we did in Chapter 3), few researchers have acknowledged that it might be necessary to validate self-reported preferences. Importantly studies of self-reported actual partner choice do not allow preferences to be considered, and may miss important associations due to the constraints on actual partner choice (Perrett et al., 2002). Thus, we are presented with a difficulty: how can preferences be studied independent of these constraints? The following paragraphs discuss some alternatives to self-report measures of preferences.

Brain imaging studies have shown that reward centres in the brain (e.g. the ventral striatum) are activated when viewing attractive faces (Aharon et al., 2001; Kampe et al., 2001; O'Doherty et al., 2003). Furthermore, activation of reward centres by attractive

faces appears to be most pronounced when viewing attractive opposite-sex faces (suggesting they may serve as "good potential mate" detectors, Aharon et al., 2001). Thus, activation in the ventral striatum may be a useful independent measures of attraction. Transforming faces in apparent health while controlling attractiveness and expression may activate regions associated with viewing positive (healthy) and negative (unhealthy) faces, above and beyond those previously reported for expression and attractiveness. Moreover, given evidence for hormone-mediated variation in female preferences for apparent health in male faces, brain imaging studies might detect changes in ventral striatum activity across the menstrual cycle, for example. Such a study would potentially strengthen the claim that biological processes (changes in hormonal profile, localised activity in reward structures) underpin our face preferences.

An alternative independent measure of attraction to faces is the time for which faces of a particular kind were viewed during free viewing. This measure is widely used where self-report preferences cannot be used such as studies of infants' preferences for faces (e.g. Rhodes et al., 2002) and non-human primates' preferences (e.g. Wait et al., 2003). In adult humans viewing times are positively associated with self-report preferences (Quinsey et al., 1996). For example, men look at feminine female faces longer than they look at older (i.e. masculine) faces. Thus, looking times might be longer when viewing faces with increased apparent health than faces with lowered apparent health. Moreover, looking times may be a sensitive measure of preferences for studies of individual differences in attraction: viewing times for healthy faces minus viewing times for

unhealthy faces might positively associated with measures of women's own condition (see Chapter 4).

While activation in the ventral striatum and viewing times are measures that are already used in studies of attractiveness (albeit not widely), visuo-cogntive paradigms for testing attentional biases towards stimuli of different kinds might also be adapted to investigate face preferences. Change-blindness paradigms and anti-saccade paradigms allow the extent to which different classes of stimuli are attended to and have been adapted to investigate attention to faces (e.g. Gilchrist et al., 2003; Ro et al., 2001). Findings from these studies suggest mandatory capture of attention by faces. Further changes could be made to these paradigms that would allow attention to different types of faces to be investigated. This may be associated with the attractiveness of the face. Thus, the extent to which attention is "grabbed" by faces varying in apparent health may shift across the menstrual cycle or as a function of own attractiveness in a way that compliments changes in *preferences* for apparent health.

Another important issue for future research is the physical qualities that influence apparent facial health. Aspects of underlying genetic health (Roberts et al., 2003), acute illness (Roujeau, 2001), and lifestyle health (Chapter 6) have been found to predict health of facial appearance. A study is needed that compares the associations between these factors and other measures of general (e.g. long-term medical health sensu Kalick et al., 1998), reproductive (e.g. hormone levels conducive to fertility sensu, Jasienska et al., 2004) and psychological (e.g. stress, anxiety) health. Investigating this issue in multiple

samples of multiple ages may provide insight into the accuracy with which people can judge a person's health from their face (or more importantly, the aspects of health they can and can't "see"). Furthermore, tests to see if apparent facial health is stable across the lifespan (i.e. do healthy-looking children become healthy-looking adults?) may offer further insight into the causes of apparent facial health and the developmental profile of facial appearance

4. Conclusions

High agreement about what faces looked healthy was evident in all of the studies reported. Moreover, faces that looked healthy were also considered very attractive. Indeed, apparent health appears to be a more important determinant of attractiveness than many characteristics previously studied (symmetry, averageness, sexual dimorphism). Although people typically expressed strong attraction to faces that look healthy, individual differences in this preference were observed. This variation was systematic: hormonal profile, physical maturation and own condition predicted preferences. Collectively these findings indicate that the health of a person's face is an important determinant of how we treat the person and suggest that preferences for apparent health in faces are influenced by biological factors.

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Appendix A

The Alameda County Study Questionnaire Items

(Berkman and Breslow, 1983)

		Responses			
Q1	How often do you participate in swimming / walking?	never	sometimes	often	
Q2	How often do you participate in physical exercise / sport?	never	sometimes	often	
Q3	How often do you drink wine?	never	less than once a week	once or twice a week	more than twice a week
Q4	When you drink wine how many drinks do you usually have at a sitting?	never	1 or 2 drinks	3 or 4 drinks	5 drinks or more
Q5	How often do you drink beer?	never	less than once a week	once or twice a week	more than twice a week
Q6	When you drink beer how many drinks do you usually have at a sitting?	never	1 or 2 drinks	3 or 4 drinks	5 drinks or more
Q7	How often do you drink spirits?	never	less than once a week	once or twice a week	more than twice a week
Q8	When you drink spirits how many drinks do you usually have at a sitting?	never	1 or 2 drinks	3 or 4 drinks	5 drinks or more
Q9	How many hours sleep do you usually get at night?	6 hours or less	7 hours	8 hours	9 hours or more
Q10	How often do you eat breakfast?	almost every day	sometimes / once in a while	rarely or never	
Q11	How often do you eat in between your regular meals?	almost every day	sometimes / once in a while	rarely or never	
Q12	Do you smoke?	yes	no		
Q13	How many cigarettes do you smoke in a typical day?				

Appendix B

Interface and instructions for studies in Chapters 3 – 5

(BBC website)

Face Perception 1

Please read each adjective pair presented below and click beside the number that best describes you or your ideal partner. Please complete all questions you can.

Question 1

Please rate yourself on the following scales - which of these characteristics would best describe you.

A) Extroversion

○	○	○	○	○	○	○
Reserved, Quiet, Retiring						Affectionate, Talkative, Sociable

B) Conscientiousness

○	○	○	○	○	○	○
Careless, Lazy, Negligent						Careful, Hardworking, Conscientious

C) Agreeableness

○	○	○	○	○	○	○
Vengeful, Callous, Cold						Forgiving, Sympathetic, Warm

D) Openness To Experience

○	○	○	○	○	○	○
Uncreative, Conventional, Conforming						Creative, Original, Independent

E) Neuroticism

At ease, Calm, Relaxed

Nervous, Worrying, Highly Strung

F) Physical Attractiveness

Not very attractive

Very attractive

Question 2

What characteristics would make up your ideal long-term partner?

A) Extroversion

Reserved, Quiet, Retiring

Affectionate, Talkative, Sociable

B) Conscientiousness

Careless, Lazy, Negligent

Careful, Hardworking, Conscientious

C) Agreeableness

Vengeful, Callous, Cold

Forgiving, Sympathetic, Warm

D) Openness To Experience

Uncreative, Conventional, Conforming

Creative, Original, Independent

E) Neuroticism

At ease,
Calm,
Relaxed

Nervous,
Worrying,
Highly Strung

F) Physical Attractiveness

Not very
attractive

Very
attractive

previous

Face Perception 1

Question 1 of 20

Strongly Prefer	Prefer	Slightly Prefer	Only Just Prefer	Only Just Prefer	Slightly Prefer	Prefer	Strongly Prefer

previous next