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When facial attractiveness is only skin deep

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Abs rac . Whilst the relationship between aspects of facial shape and attractiveness has been extensively studied, few studies have investigated which characteristics of the surface of faces positively influence attractiveness judgments. As many researchers have proposed a link between attractiveness and traits that appear healthy, apparent health of facial skin might be a property of the surface of faces that positively influences attractiveness judgments. In experiment 1 we tested for a positive correlation between ratings of the apparent health of small skin patches (extracted from the left and right cheeks of digital face images) and ratings of the attractiveness of male faces. By using computer-graphics faces, in experiment 2 we aimed to establish if apparent health of skin influences male facial attractiveness independently of shape information. Results suggest that apparent health of facial skin is correlated both with ratings of male facial attractiveness (experiment 1) and with being a visual cue for judgments of the attractiveness of male faces (experiment 2). These findings underline the importance of controlling for the influence of visible skin condition in studies of facial attractiveness and are consistent with the proposal that attractive physical traits are those that positively influence others' perceptions of an individual's health.

1 In rod c ion

As physical attractiveness influences human social interactions (for a review, see Feingold 1995), many empirical studies have been carried out in an effort to identify characteristics that determine attractiveness judgments. Although the attractiveness of bodies has also been investigated (eg 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 claim that the face plays a central role in human social interactions (Bruce and Young 1986; Enquist et al 2002). Although there is some evidence that the face is more important for judgments of the attractiveness of the 'whole person' (ie the face and body presented together) than body attractiveness (Furnham et al 2001), attractiveness ratings of faces and bodies presented separately are positively correlated (Thornhill and Grammer 1999). This latter finding suggests that faces and bodies are a single, not fragmented, cue to attractiveness.

Studies of facial attractiveness have predominantly investigated the attractiveness of aspects of facial *shape*. For example, both symmetry (Grammer and Thornhill 1994; Jones et al 2001; Perrett et al 1999; Rhodes et al 1999, 2001) and averageness (Little and Hancock 2002; Rhodes et al 1999, 2001; but see also Grammer and Thornhill 1994; Perrett et al 1994) of shape have been found to positively influence judgments of the attractiveness of male and female faces. Furthermore, female faces with a feminine shape, typified by large eyes and pronounced cheekbones (Penton-Voak et al 2001), are judged highly attractive (Perrett et al 1998; Rhodes et al 2000). Whilst some studies have found that male faces with a masculine shape, typified by a wide lower face and pronounced brow (Penton-Voak et al 2001), are judged highly attractive (eg Johnston et al 2001); the findings of other studies suggest that male faces with a slightly feminine shape are preferred (Little and Hancock 2002; Perrett et al 1998; Rhodes et al 2000). It would appear that the link between masculinity and male facial attractiveness is somewhat complex (for a review, see Penton-Voak and Perrett 2001).

Compared with the number of existing studies investigating the relationship between shape information and judgments of facial attractiveness (at least one hundred), few studies have tested for potential links between attractiveness judgments and characteristics of the surface of faces. Whilst skin texture and colouration have been found to influence judgments of the attractiveness of both male (Frost 1994; Little and Hancock 2002) and female faces (Fink et al 2001; Penton-Voak and Perrett 2001), the link between surface cues and facial attractiveness remains an understudied area (Little and Hancock 2002). As many researchers have proposed a link between attractiveness and traits that appear healthy (eg Grammer and Thornhill 1994; Jones et al 2001), apparent health of skin might be a property of the surface of faces that positively influences attractiveness judgments. Indeed, many researchers have suggested that healthy-looking skin might be an important determinant of human physical attractiveness (Morris 1967; Symons 1979). To our knowledge, however, the link between attractiveness and apparent health of facial skin has not been formally tested in a normal population.

Here we tested for a potential relationship between apparent health of skin and judgments of male facial attractiveness using both real (experiment 1) and computer-graphics (experiment 2) faces. While a potential correlation between apparent health of skin and judgments of male facial attractiveness was tested for in experiment 1, the aim of experiment 2 was to establish if apparent health of facial skin can act as a *visual cue* for judgments of facial attractiveness (ie influence attractiveness judgments independently of cues to facial shape).

2 E perimen 1

The aim of experiment 1 was to test for a positive correlation between apparent health of facial skin and judgments of male facial attractiveness. Apparent health of facial skin was assessed by ratings of the health of skin patches (extracted from the cheeks of face images), rather than ratings of the whole face. This ensured that judgments of the apparent health of facial skin were not influenced by shape information.

2.1 *Method*

Full-face colour photographs of 97 Caucasian males (20 – 25 years of age, all undergraduate students at the University of St Andrews) were taken with a digital camera (resolution set at 1200×1000 pixels) under standardised diffuse-lighting conditions. Facial expression was neutral and hair pulled back from the face. Although not all males were clean shaven, none of the 97 males had full beards. Each digital face image was first scaled and rotated to a standard interpupillary distance (320 pixels). This controlled for variations in camera-to-head distance. All males photographed were unfamiliar to those taking part in the ratings phase of the study. Left and right cheek skin patches (95×85 pixels) were extracted from each image and enlarged by 300%. These patches were extracted from the same locations on each face. This was achieved by placing the innermost top corner of each patch a fixed distance (95 pixels) vertically below the left or right pupil centre. Indeed, close inspection of the cheek patches indicated that facial hair and cues to facial shape were not visible in these patches (see figure 1). Although each skin patch was enlarged to make rating the patches easier for participants, a process that blurred the images slightly, the original patches were of a constant size and enlarged by a constant amount. This ensured that the degree of blurring was constant across all images.

Only opposite-sex ratings of faces and skin patches were used, controlling for reported opposite-sex biases in both judgments of facial attractiveness (Little et al 2001) and health-related judgments of faces (Jones et al 2001). Twenty female participants rated the 97 original faces for 'attractiveness' ($1 =$ very unattractive, $4 =$ neutral, $7 =$ very attractive). Full-colour images were presented on-screen in a fully randomised

order. In all instances clothing and hairstyles were masked (see figure 2 for examples of face images masked using an identical technique). A different twenty-four female participants rated the left and right skin patches for 'apparent healthiness of skin' (1 = very unhealthy, 4 = neutral, 7 = very healthy). Full-colour images were presented on-screen in a fully randomised order. Participants were told that skin patches had been enlarged by 300% and were from the cheeks of Caucasian males. Examples of these skin patches are shown in figure 1.

2.2 *Results*

As inter-rater agreement for ratings of attractiveness and both left and right skin-patch ratings were high (all Cronbach's alphas > 0.9), mean attractiveness, left skin-patch apparent-health, and right skin-patch apparent-health scores were calculated for each face across all raters. Nonparametric tests for associations (Spearman's rho) are reported as not all variables were normally distributed. For all correlations $N = 97$ and two-tailed p-values are reported.

In line with previous studies of attractiveness, in which composite measures of biological properties were preferred to single measures to minimise noise in the data (eg Hughes et al 2002; Leung et al 2000; Rikowski and Grammer 1999; Thornhill and Gangestad 1994, 1999), and because ratings of the apparent health of left and right skin patches were positively and significantly correlated (Spearman's rho $= 0.52$, $p < 0.0001$), an overall mean skin-health score was calculated by averaging ratings for left and right skin patches. This overall mean value was significantly and positively correlated with facial attractiveness (Spearman's rho $= 0.27$, $p = 0.008$). This suggests that males with highly attractive faces also possess facial skin that appears particularly healthy. Age of individuals photographed was unrelated to both skin-patch ratings (Spearman's rho $= 0.06$, $p = 0.56$) and whole-face attractiveness (Spearman's rho $= 0.11$, $p = 0.29$).

3 E perimen 2

In experiment 2 participants rated the attractiveness of versions of the 97 male faces under two conditions. In one condition the colour and texture information of each face was moved towards that of a composite male face with the mean colour and texture of a sample of males with high apparent skin health. In the second condition the colour and texture information of each face was moved towards that of a composite male face with the mean colour and texture of a sample of males with relatively poor apparent skin health. As facial shape was constant and only texture and colour information varied, experiment 2 was intended to establish if colour and texture cues were sufficient to maintain the relationship between apparent health of skin and facial attractiveness, when the influence of facial shape was removed.

We employed novel image-processing techniques that enable skin-texture information to be extracted from a sample of faces (Tiddeman et al 2001). Previous image-processing techniques for generating composite faces (Rowland and Perrett 1995) were unable to maintain texture and were limited to the extraction of shape and colour information. As a consequence, only composite faces with unnaturally smooth skin textures could be generated by using these older image-processing techniques (for criticism of these older digital blending techniques, see Alley and Cunningham 1991). By contrast with these older image-processing techniques, the novel method we used in experiment 2 allows the effects of realistic skin texture to be assessed independently of face shape.

3.1 *Methods*

To generate the average male facial shape, the same 179 landmark points were first marked on each of the 97 faces used in experiment 1. Mean xy positions were calculated for each of these landmark points. The 'poor apparent-skin-health-sample' composite

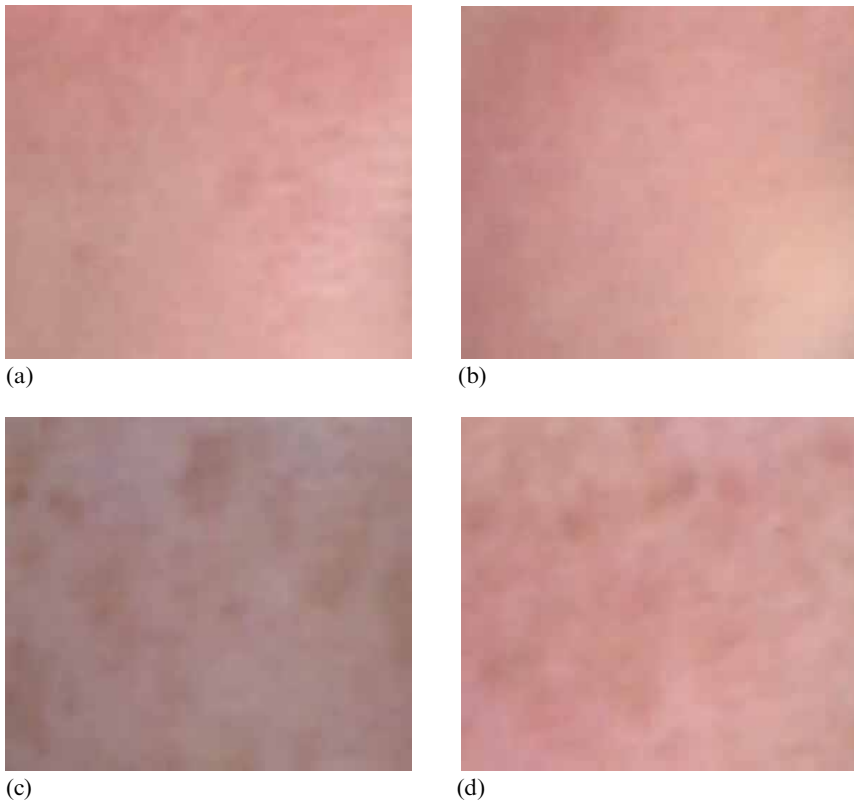
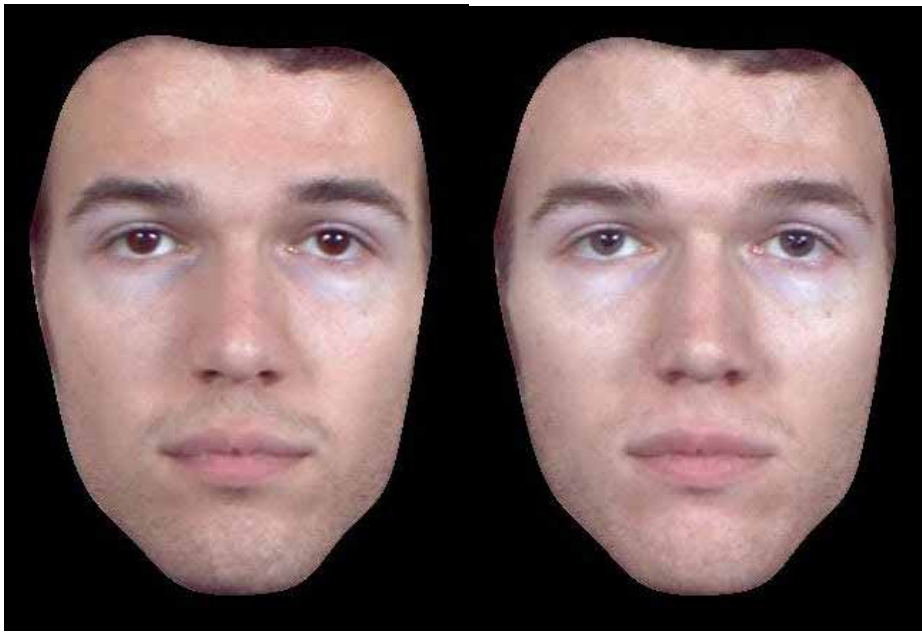


Fig re 1. Examples of facial skin patches (not shown as actual size at presentation) rated for apparent health by male and female participants in experiment 1. Skin patches (95×85 pixels) were extracted from the left and right cheeks of Caucasian males and were enlarged by 300% prior to rating. Patches (a) and (b) were judged as looking particularly healthy while patches (c) and (d) were judged as looking particularly unhealthy. When presented for rating on-screen, all patches were presented in full colour.

was then constructed by calculating the mean RGB colour values at each pixel for the 20 males with the poorest apparent skin health in experiment 1 and applying these to the average male facial shape (ie the average facial shape for all 97 faces). The 'high apparent skin health sample' composite was constructed by calculating the mean RGB colour values at each pixel for the 20 males with the highest apparent skin health in experiment 1 and applying these to the average male facial shape. The ratings of apparent skin health used to identify individuals in the 2 subsamples ('poor apparent skin health sample' and 'high apparent skin health sample') were the overall mean ratings of the left and right skin patches. These 2 subsamples did not differ in age (independent samples t-test: $t_{38} = 0.22$, $p = 0.8$).

Representative texture was calculated for the 'high apparent-skin-health' and 'poor apparent-skin-health' samples and applied to the respective composites. This technique used a wavelet-based method (for a general discussion of use of wavelets in computer graphics, see Stollnitz et al 1995), similar to one previously used to apply realistic texture to non-face images (Heeger and Bergen 1995). The method used here adjusted the amplitude of edges (ie the change in pixel intensity) in the composite image so that it matched the average edge amplitudes in the sample at different locations, orientations, and spatial scales. The edges in the images can be defined by using a variety of different edge-detecting wavelet filters at different spatial scales and with different orientations. For each wavelet sub-band, the edge magnitude was calculated for each



(a) (b)

Fig re 2. Example of stimuli used in experiment 2. (a) Version of a face manipulated to possess healthy-looking facial skin by shifting the colour and texture information towards that of the average for the 20 males with the highest apparent skin health in experiment 1. (b) Version of a face manipulated to possess unhealthy-looking facial skin by shifting the colour and texture information towards that of the average for the 20 males with the poorest apparent skin health in experiment 1. Note that images for rating were presented on-screen in full colour and that both versions of the faces possessed equivalent 2-D shapes.

pixel and these values smoothed to give a measure of edge strength for the small region around that point. This information from different wavelet sub-bands was used to amplify the edges of the shape and colour prototype, resulting in a realistic texture for the composite face. For more details of the calculation of average facial shapes and RGB colour values see Rowland and Perrett (1995). For calculation of representative texture see Tiddeman et al (2001).

By shifting the colour and texture information of the 97 original faces a prescribed distance (+50% or −50%) along a healthy–unhealthy continuum, the extremes of which were defined by the 'poor apparent skin health' composite (−100%) and the 'high apparent-skin-health' composite (+100%), healthy-looking and unhealthy-looking versions of the 97 original faces were generated (for methods, see Tiddeman et al 2001). The 'healthy' version of each face possessed colour and texture information representative of male faces judged to have healthy-looking skin, while the 'unhealthy' version of each face possessed colour and texture information representative of male faces judged to have relatively unhealthy-looking skin. An example of the stimuli is shown in figure 2. It is important to note that only colour and texture information was manipulated and that the original facial shapes were unaffected. Thus, colour and texture cues were manipulated independently of facial shape.

Twenty-four female participants (18–23 years, none of whom had taken part in experiment 1) rated each of these 194 faces for attractiveness using a 1–7 scale (1 = very unattractive, 7 = very attractive). A different twenty females (18–23 years, none of whom had taken part in experiment 1) rated each of the 194 faces for apparent health of skin using a 1–7 scale (1 = very unhealthy, 7 = very healthy). Full-colour faces were presented on-screen in a fully randomised order and were masked to control

for the influence of hairstyle and clothing. For both attractiveness and skin-health judgments, faces were presented in 2 blocks each consisting of 97 faces. In no block were subjects asked to judge the attractiveness or skin health of both versions of an individual face.

3.2 *Results*

3.2.1 *Attractiveness judgments.* For each of the twenty-four participants who judged the attractiveness of the male faces, mean attractiveness ratings were calculated separately for the unhealthy-looking and healthy-looking versions of the faces. A comparison of these means, with the use of a matched-pairs t-test, revealed that the healthy-looking versions of the faces were rated significantly more attractive than the unhealthy-looking versions ($t_{23} = 6.19$, two-tailed $p < 0.0001$). The mean rating for the healthy-looking versions of the faces was 3.46 (standard deviation = 0.96) and the mean rating for the unhealthy-looking faces was 2.86 (standard deviation = 0.7). This suggests that manipulating the visible skin condition of male faces was sufficient to influence attractiveness independently of the effects of shape. Attractiveness ratings of unhealthy and healthy versions of faces were positively correlated (Spearman's rho = 0.06, $N = 97$, $p < 0.001$).

3.2.2 *Skin-health judgments.* For each of the twenty participants who judged the apparent skin health of the male faces, mean skin-health ratings were calculated separately for the unhealthy-looking and healthy-looking versions of the faces. These means were compared by using a matched-pairs t-test. This test showed that the healthy-looking versions of the faces were judged to have healthier-looking skin than the unhealthy-looking versions of the faces ($t_{19} = 12.56$, two-tailed $p < 0.0001$). The mean rating for the healthy-looking versions of the faces was 4.24 (standard deviation = 0.54) and the mean rating for the unhealthy-looking faces was 3.50 (standard deviation = 0.62). This suggests that manipulating the visible skin condition of male faces was sufficient to influence apparent health of facial skin independently of the effects of shape. Skin-health ratings of unhealthy and healthy versions of faces were positively correlated (Spearman's rho = 0.05, $N = 97$, $p < 0.001$).

4 Discussion

The positive correlation between male facial attractiveness and the health ratings of skin patches (experiment 1) is consistent with the suggestion that healthy-looking skin is an attractive physical trait (Morris 1967; Symons 1979). In experiment 1, however, the relationship between facial attractiveness and apparent health of facial skin may have been somewhat confounded by the influence of facial shape on attractiveness judgments. In other words, in addition to colour and texture cues, shape information may also have influenced the attractiveness judgments. By contrast, in experiment 2 manipulating colour and texture (but not shape) information along a continuum—the extremes of which were defined by prototypical faces representing males—with either particularly healthy-looking or unhealthy-looking skin, influenced female judgments of both the attractiveness and the visible skin condition of male faces. Thus, despite the relatively weak correlation between ratings of attractiveness and health of skin patches reported in experiment 1, it would appear that apparent skin health can act as a visual cue for judgments of male facial attractiveness as manipulating visible skin condition was sufficient to influence attractiveness judgments independent of facial shape.

In experiment 1, health ratings of left and right skin patches were highly positively correlated, indicating that apparent health of skin is relatively stable across disparate facial locations. In the same study, attractiveness and visible skin condition were unrelated to the age of those photographed. Furthermore, there was no significant difference in age between the 'poor' and 'high' apparent skin-health subsamples used

as the basis for the image manipulations in experiment 2. This suggests that the present studies were not confounded by the influence of actual age. It should be noted, however, that in a sample with a more diverse age range than that of the present studies (20 – 25 years) age might be significantly related to both facial attractiveness and visible skin condition. Indeed, the relationship between visible skin condition and facial attractiveness remains to be tested in samples of diverse ages and ethnicity. A further limitation of the present studies was that the *relative* contributions of colour and texture information to judgments of attractiveness and visible skin condition were not investigated. Thus, it is unclear if the observed relationships were driven by colour cues, texture cues, or an interaction between the two. It should be noted, however, that current computer-graphic techniques do not allow colour and texture information to be manipulated independently in face images.

In the present studies apparent health of facial skin was not only correlated with judgments of male facial attractiveness (experiment 1), but also appeared to be a visual cue for judgments of the attractiveness of male faces (experiment 2). These findings underline the importance of controlling for the influence of colour and texture information in studies of facial attractiveness and are consistent with the proposal that attractive physical traits are those that positively influence others' perceptions of an individual's health (Grammer and Thornhill 1994; Jones et al 2001).

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