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Interactions between masculinity–femininity and apparent health in face preferences

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Consistent with Getty's (2002. Signaling health versus parasites. Am Nat. 159:363–371.) proposal that cues to long-term health and cues to current condition are at least partly independent, recent research on human face preferences has found divergent effects of masculinity–femininity, a cue to long-term health, and apparent health, a cue to current condition. In light of this, we tested for interactions between these 2 cues. Participants viewed composite images of opposite-sex faces that had been manufactured in combinations of high and low apparent health and masculinity–femininity. Preferences for masculinity in men's faces and femininity in women's faces were stronger when judging the attractiveness of faces with high apparent health than when judging the attractiveness of faces with low apparent health. Similarly, preferences for high apparent health were stronger for judgments of masculine men's faces and feminine women's faces than for judgments of feminine men's faces and masculine women's faces, respectively. Interactions between apparent health and masculinity–femininity when forming face preferences may function to optimize how masculinity–femininity and apparent health are used to infer the quality of potential mates and highlight the complexity and sophistication of the perceptual mechanisms that underpin face preferences. *Key words:* apparent health, faces, integration, masculinity, mate choice, signal interactions. *[Behav Ecol]*

Physical traits that are costly to develop and maintain may signal underlying quality (i.e., long-term health) but may not necessarily signal current condition (i.e., absence of disease, Getty 2002). Because long-term health is associated with indirect benefits (e.g., heritable immunity to infectious disease; Folstad and Karter 1992), and absence of disease is associated with direct benefits (e.g., reduced likelihood of contracting illness; Welling, Conway, et al. 2007), both will be important for mate choice (Miller and Todd 1998; Johnston et al. 2001; Jones, Little, Boothroyd, DeBruine, et al. 2005). Interactions between these different signals when forming face preferences may allow individuals to better infer the quality of potential mates. Indeed, interactions among different signals of quality have been reported in studies of nonhuman mate preferences and are thought to function to provide more reliable information about the quality of potential mates (for a review, see Candolin 2003).

Among men, facial masculinity is associated with good long-term health as assessed from medical records (Rhodes et al. 2003) and incidence and duration of past illness (Thornhill and Gangestad 2006). Among women, feminine facial traits are also associated with long-term health estimated from the incidence and duration of past illness (Thornhill and Gangestad 2006) and with indices of fertility (e.g., trait hormone levels, Law Smith et al. 2006). Other facial cues, such as pallor, signal current condition (Jones, Perrett, et al. 2005). Consistent with the proposal that preferences for these different types of cues may be at least partly independent, preferences for apparent health and masculinity in male faces are unrelated among women (Boothroyd et al. 2005). Additionally, changes in women's hormonal profiles during the menstrual cycle affect preferences for apparent health and masculinity in different ways: aversions to facial cues of illness are strongest during the luteal phase of the menstrual cycle (Jones, Little, Boothroyd, DeBruine, et al. 2005; Jones, Perrett, et al. 2005), whereas preferences for masculinity are strongest around ovulation (Penton-Voak et al. 1999, Johnston et al. 2001, Jones, Little, Boothroyd, DeBruine, et al. 2005; Welling, Jones, et al. 2007). Indeed, cyclic variation in women's preferences for apparent health and masculinity in men's faces is independent (Jones, Little, Boothroyd, DeBruine, et al. 2005). Collectively, these findings suggest that preferences for cues to long-term health and current condition are at least partly independent, raising the possibility that masculinity–femininity and apparent health signal different aspects of mate quality (for discussion, e.g., Boothroyd et al. 2005 and Jones, Little, Boothroyd, DeBruine, et al. 2005).

Most previous studies of facial attractiveness have manipulated faces along only single dimensions (e.g., Perrett et al. 1998; Penton-Voak et al. 1999; Rhodes et al. 2001; Jones, Little, Boothroyd, DeBruine, et al. 2005; DeBruine et al. 2006). However, recent research on face perception has demonstrated that different types of facial cues can have effects on attractiveness that interact. For example, fearful expressions are perceived as more intense with averted gaze than direct gaze (Adams and Kleck 2003), and preferences for physically attractive faces are stronger for faces that are smiling at the viewer than for faces that are smiling away from the viewer (Jones et al. 2006). Although these studies demonstrate interactions between social cues (e.g., gaze direction) and either physical cues (e.g., physical attractiveness) or other social cues (e.g., emotional expressions), we know of no studies of face preferences that have investigated interactions between different physical cues. If cues to current health modulate preferences for masculinity–femininity and vice versa, this would suggest that interactions between information from different physical signals may function to optimize inferences about the quality of potential mates.

In light of the above, we tested if women's preferences for masculinity are stronger when judging the attractiveness of male faces displaying cues associated with good current condition (i.e., high apparent health) than when judging the

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attractiveness of male faces displaying cues associated with current illness (i.e., low apparent health). We also tested if women's preferences for apparent health are stronger when judging the attractiveness of masculine male faces than when judging the attractiveness of feminine male faces. Additionally, we carried out equivalent tests for men's preferences for femininity and apparent health in female faces. Following previous studies of preferences for masculinity–femininity (e.g., Perrett et al. 1998), cues of apparent health (Jones, Little, Boothroyd, DeBruine, et al. 2005; Jones, Perrett, et al. 2005), and interactions between physical attractiveness and facial expressions (Jones et al. 2006), participants judged the attractiveness of composite (i.e., prototype) faces that had been systematically manipulated using computer graphic methods.

METHODS

Stimuli

Masculine and feminine versions of healthy and unhealthy male and female composite faces were manufactured using well-established and validated computer graphic methods for systematically varying the appearance of face images (Perrett et al. 1998; Jones, Perrett, et al. 2005). First, 60 male and 60 female full-color face images (19–24 years old) were rated for apparent health on a scale of 1 (low health)—7 (high health) by 20 raters (17–26 years old; 10 male, interrater agreement: Cronbach's $\alpha = 0.82$). Next, a "high apparent health" female composite face was manufactured by averaging the shape, color, and texture information from the 15 female face images with the highest rated health. To do this, 179 facial landmarks were placed on each face image. The computer algorithm then calculates the mean x and y coordinates for each point (to calculate the average face shape) and the mean red-green-blue value for each pixel (to calculate the average color information). A wavelet-based algorithm was then used to apply representative realistic texture details to the image. For technical details about this process, see Tiddeman et al. (2001). A "low apparent health" female composite face was then manufactured by averaging the shape, color, and texture information from the 15 female face images with the lowest rated health. High and low apparent health male composite faces were then constructed using the same methods that were used to manufacture female composites. Previous studies have shown that high and low apparent health composites manufactured in this way differ reliably in apparent health (Jones et al. 2004; Jones, Perrett, et al. 2005).

Masculine versions of each of these high and low apparent health composites were then manufactured by applying +50% of the vector differences in 2D shape between a male and female prototype face. Feminine versions of each of these high and low apparent health composites were then manufactured by applying −50% of the differences in 2D shape between a male and female prototype face. Altering sexual dimorphism of 2D face shape in this way does not alter other aspects of facial appearance (e.g., identity). This method for manipulating sexual dimorphism of 2D shape in face images has been widely used in studies of face preferences (e.g., Perrett et al. 1998; Penton-Voak et al. 1999; Jones et al. 2007). Previous studies have also shown that faces masculinized and feminized in this way differ reliably in perceived masculinity (DeBruine et al. 2006; Welling et al. 2008) and produce preferences equivalent to those from faces manipulated in masculinity using other methods (DeBruine et al. 2006).

Finally, all images were scaled and rotated to a standard interpupillary distance. Masculine and feminine versions of both male and female high and low apparent health composites are shown in Figure 1.

In total, this method created 4 male composite faces (a healthy-looking masculine male composite, a healthy-looking feminine male composite, an unhealthy-looking masculine male composite, and an unhealthy-looking feminine male composite) and 4 corresponding female composite faces (a healthy-looking masculine female composite, a healthy-looking feminine female composite, an unhealthy-looking masculine female composite, and an unhealthy-looking feminine female composite).

Participants

Participants in the laboratory sample were 354 women (mean age = 21.1, standard deviation [SD] = 5.8) and 144 men (mean age = 21.1, SD = 4.6). All participants in the laboratory sample were undergraduate students at the University of Aberdeen who completed the experiment on individual computers in the laboratory in groups of 4–40.

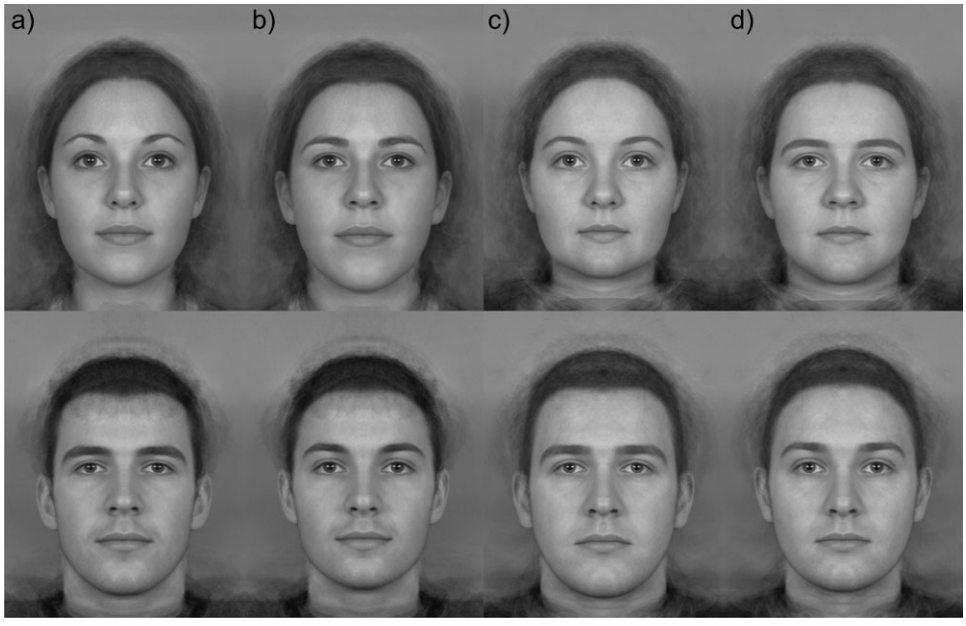

Figure 1
Face stimuli used in the experiment. Masculine male and feminine female faces with high apparent health (a), feminine male and masculine female faces with high apparent health (b), masculine male and feminine female faces with low apparent health (c), and feminine male and masculine female faces with low apparent health (d) were presented in combinations such that each face pair differed on only one aspect (health or masculinity–femininity).

Additionally, 5564 women (mean age = 20.4, SD = 2.7) and 3632 men (mean age = 21.2, SD = 2.7) completed the experiment through an online interface. Previous studies have shown that online and laboratory studies of face preferences have produced consistent results (Wilson and Daly 2004; Jones, Perrett, et al. 2005; Jones et al. 2007; Welling et al. 2008). Responses from duplicate Internet protocol addresses from the online tests were not analyzed.

Procedure

In both the laboratory and Web samples, participants were presented with 4 pairs of opposite-sex faces that differed in either masculinity–femininity or apparent health but that were matched in other regards and were asked to indicate which face was more attractive in each image pair. Participants were also asked to indicate the strength of their preference by choosing from the options "much more attractive," "more attractive," "somewhat more attractive," and "slightly more attractive." Thus, preferences for masculinity versus femininity were assessed under 2 conditions: on one trial where masculinized and feminized versions of a healthy-looking face were presented and on another trial where masculinized and feminized versions of an unhealthy-looking face were presented. Similarly, preferences for apparent health were also assessed under 2 conditions: on one trial where high and low apparent health versions of a masculinized face were presented and on another trial where high and low apparent health versions of a feminized face were presented. Trial order and the side of the screen on which any particular image was shown were fully randomized.

Initial processing of data

Following previous studies of face preferences (e.g., Jones, Perrett, et al. 2005; Jones, Little, Boothroyd, Feinberg, et al. 2005; Buckingham et al. 2006; Jones et al. 2007), responses on the face preference tests were coded on the following 0–7 scale:

0 = feminine male, masculine female, or low apparent health was judged much more attractive
1 = feminine male, masculine female, or low apparent health was judged more attractive
2 = feminine male, masculine female, or low apparent health was judged somewhat more attractive
3 = feminine male, masculine female, or low apparent health was judged slightly more attractive
4 = masculine male, feminine female, or high apparent health was judged slightly more attractive
5 = masculine male, feminine female, or high apparent health was judged somewhat more attractive
6 = masculine male, feminine female, or high apparent health was judged more attractive
7 = masculine male, feminine female, or high apparent health was judged much more attractive

Thus, participants provided 4 preference scores: 1) preference for masculinity versus femininity in faces with high apparent health, 2) preference for masculinity versus femininity in faces with low apparent health, 3) preference for high versus low apparent health in masculinized faces, and 4) preference for high versus low apparent health in feminized faces.

RESULTS

Following many previous studies that have used composite images to investigate face preferences (e.g., Perrett et al. 1994, 1998; Jones et al. 2006), individual raters served as the unit of analysis in all analyses. Paired-samples *t*-tests were used to compare preferences for high versus low apparent health in masculinized and feminized faces and to compare preferences for masculinity versus femininity in faces with high and low apparent health.

Health preferences

In both the laboratory and Web samples, preferences for high apparent health were stronger when judging masculinized male faces than when judging feminized male faces (laboratory: $t_{353} = 2.73$, $P = 0.007$; Web: $t_{5563} = 11.28$, $P < 0.001$) and when judging feminized female faces than when judging masculinized female faces (laboratory: $t_{143} = 4.42$, $P < 0.001$; Web: $t_{3631} = 26.25$, $P < 0.001$). These data are summarized in Figure 2.

Next, health preference scores were compared with the chance value of 3.5 (indicating no preference for either face in a pair) using one-sample *t*-tests. In both samples, male and female participants preferred high apparent health in both masculinized and feminized opposite-sex faces (laboratory: all $t > 23$, $P < 0.001$; Web: all $t > 87$, $P < 0.001$).

Masculinity–femininity preferences

In both the laboratory and Web samples, preferences for masculinity were stronger when judging male faces with high apparent health than when judging male faces with low apparent health (laboratory: $t_{353} = 4.87$, $P < 0.001$; Web: $t_{5563} = 13.92$, $P < 0.001$). Preferences for femininity were stronger when judging female faces with high apparent health than when

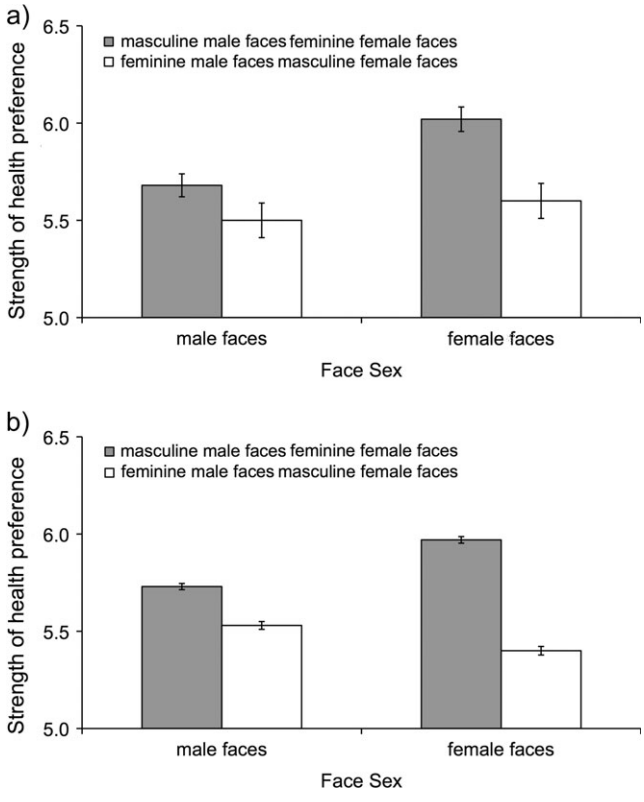

Figure 2
Preferences for apparent health when masculinity–femininity is varied in male and female faces. Bars show means and standard error of the means (SEMs). In both the laboratory (a) and Web (b) samples, preferences for high apparent health were stronger for judgments of masculine male and feminine female faces, compared with feminine male and masculine female faces. Male faces were judged by female participants, and female faces were judged by male participants. Note that SEMs for the laboratory sample are extremely small because of the large sample size.

judging female faces with low apparent health (laboratory: $t_{143} = 8.41$, $P < 0.001$; Web: $t_{3631} = 38.06$, $P < 0.001$). These data are summarized in Figure 3.

Next, these preference scores were compared with the chance value of 3.5 (indicating no preference for either face in a pair) using 1-sample *t*-tests. Male participants preferred femininity in both healthy and unhealthy female faces (laboratory: both $t > 6$, $P < 0.001$; Web: both $t > 33$, $P < 0.001$). Female participants preferred masculinity only in healthy male faces (laboratory: $t = 5.44$, $P < 0.001$; Web: $t = 13.1$, $P < 0.001$). Female participants in the laboratory study showed no significant preference for masculinity or femininity in unhealthy male faces ($t = 0.19$, $P = 0.853$), although female participants in the Web sample tended to prefer masculinity in unhealthy male faces ($t = 1.91$, $P = 0.056$).

Note that all significant effects reported in our Results would be robust to Bonferroni correction for multiple comparisons.

DISCUSSION

In both the laboratory and Web samples, preferences for masculinity in men's faces and femininity in women's faces were stronger when judging the attractiveness of faces with high apparent health than when judging the attractiveness of faces with low apparent health. Similarly, in both samples, preferences for high apparent health were stronger when judging the attractiveness of masculine male faces and feminine female faces than when judging the attractiveness of feminine male faces and masculine female faces, respectively. Consistent with our hypotheses, these findings show that apparent health modulates preferences for exaggerated sex-typical features in opposite-sex faces (and vice versa). Previous studies of face preferences have shown interactions between information from changeable social cues, such as gaze direction and expression, and physical characteristics, such as physical attractiveness (Jones et al. 2006) and sex of face (Conway et al. 2008). Complementing these findings, here we show interactions between information from different physical cues when forming face preferences.

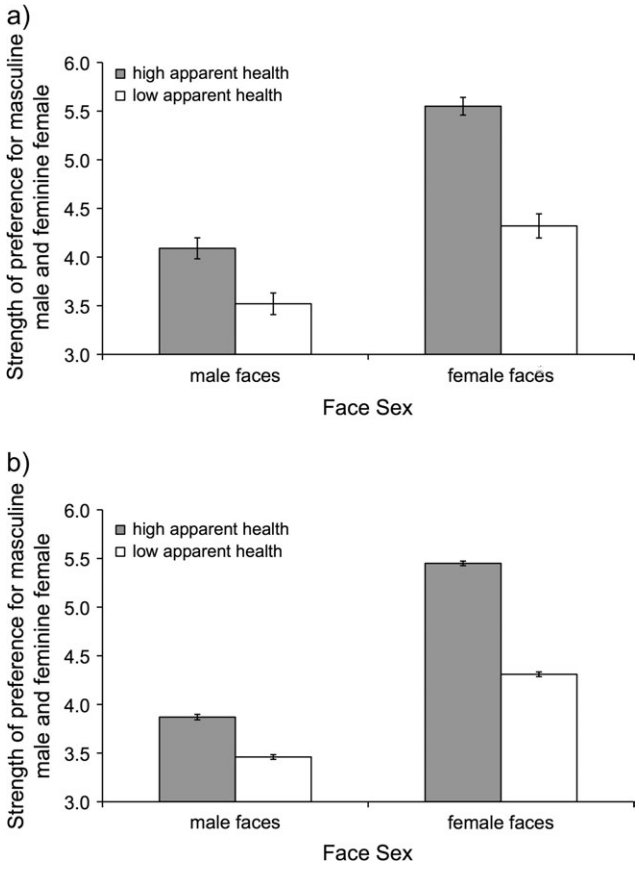

Figure 3
Preferences for masculinity–femininity when apparent health is varied in male and female faces. Bars show means and standard error of the means (SEMs). In both the laboratory (a) and Web (b) samples, preferences for masculinity in male faces and femininity in female faces were stronger for judgments of faces with high apparent health, compared with faces with low apparent health. Male faces were judged by female participants, and female faces were judged by male participants. Note that SEMs for the laboratory sample are extremely small because of the large sample size.

It is important to note that participants could not use the masculinity–femininity dimension to discriminate between faces on trials where they were choosing between healthy and unhealthy faces because the healthy and unhealthy faces were matched in terms of masculinity–femininity (i.e., were healthy and unhealthy versions of the same face image). Similarly, participants could not use apparent health to discriminate between faces on trials where they were choosing between feminine and masculine faces because the feminine and masculine faces were matched in terms of apparent health. Consequently, stronger preferences for masculinity (in men's faces) and femininity (in women's faces) on trials where the faces possessed high apparent health than on trials where the faces possessed low apparent health and stronger preferences for apparent health on trials where the faces were masculinized male faces or feminized female faces demonstrate interactions between apparent health and masculinity–femininity when forming face preferences. Furthermore, additive effects of these cues cannot explain differences in the strength of such preferences between conditions.

Getty (2002) proposed that traits signaling underlying condition (i.e., long-term health) do not necessarily signal current condition, and vice versa. Subsequent studies of face preferences have suggested that preferences for these different types of facial cues are also, at least partly, independent (Boothroyd et al. 2005; Jones, Little, Boothroyd, DeBruine, et al. 2005; Jones, Perrett, et al. 2005). Because both underlying and current condition are important for mate choice, however, interactions between information about both types of health may allow people to optimize the possible benefits of their mate choices. Indeed, our findings complement those for interactions among multiple signals of quality in nonhuman mate preferences, which are thought to function to increase the reliability of the information that is available about the quality of potential mates (for a review of this issue, see Candolin 2003). For example, the sex hormones that influence masculinity–femininity of face shape can also be immunosuppressants (Thornhill and Gangestad 1999). Thus, modulating the strength of preferences for masculinity–femininity according to the current condition of the target individual may promote mating with individuals who are able to maintain good current condition despite this immunosuppression. In other words, considering the extent to which individuals appear able to maintain good current condition despite the immunosuppressive effects of sex hormones may be important for inferring mate quality.

Previous studies have found wide variation in the strength of preferences for masculinity in male faces (for reviews, see DeBruine et al. 2006 and Rhodes 2006). Although some researchers have suggested that differences among studies can be attributed to differences in the methods used to manipulate masculinity in face images (for reviews, see DeBruine et al. 2006 and Rhodes 2006), DeBruine et al. (2006) found that different methods produce the same preferences for

masculinity in men's faces. Other researchers have attributed these differences to systematic variation among women in the extent to which masculinity is considered attractive (Little et al. 2002; DeBruine et al. 2006). The current study demonstrates that characteristics of the faces being judged, such as apparent health, can also influence the extent to which masculinity is considered attractive and highlights the complexity and sophistication of the perceptual mechanisms that underpin face preferences.

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