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Women's facial attractiveness is related to their body mass index, but not their salivary cortisol

Chengyang Han, Amanda C Hahn, Claire I Fisher, Lisa M DeBruine & Benedict C Jones

Institute of Neuroscience & Psychology, University of Glasgow, Glasgow, G12 8QB, Scotland, UK.

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Corresponding author: Benedict Jones (ben.jones@glasgow.ac.uk), Institute of Neuroscience & Psychology, University of Glasgow, Glasgow, G12 8QB, Scotland, UK.

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Abstract

Objectives: Although many theories of human facial attractiveness propose positive correlations between facial attractiveness and measures of actual health, evidence for such correlations is somewhat mixed. Here we sought to replicate a recent study reporting that women’s facial attractiveness is independently related to both their adiposity and cortisol.

Methods: Ninety-six women provided saliva samples, which were analyzed for cortisol level, and their height and weight, which were used to calculate their body mass index (BMI). A digital face image of each woman was also taken under standardized photographic conditions and rated for attractiveness.

Results: There was a significant negative correlation between women’s facial attractiveness and BMI. By contrast, salivary cortisol and facial attractiveness were not significantly correlated.

Conclusions: Our results suggest that the types of health information reflected in women's faces include qualities that are indexed by BMI, but do not necessarily include qualities that are indexed by cortisol.

Introduction

Theories of human mate choice often propose that judgments of others' facial attractiveness are psychological adaptations that identify healthy individuals (see Gangestad & Simpson, 2000 and Little et al., 2011 for comprehensive reviews of these theories). Links between health and facial attractiveness might also be expected because distinguishing between healthy and unhealthy individuals is important for both reducing exposure to infectious diseases (e.g., Tybur & Gangestad, 2011) and identifying social partners who will be able to reciprocate investment of resources (e.g., Krupp et al., 2011).

Although many different theories predict correlations between facial attractiveness and measures of actual health, evidence for such correlations is mixed. For example, although some studies have reported that people with more attractive faces report fewer past health problems (e.g., Hume & Montgomerie, 2001; Shackelford & Larson, 1999), other studies have not observed significant correlations between facial attractiveness and reported health problems (Kalick et al.1998; Thornhill & Gangestad, 2006). Evidence that facial characteristics that are perceived to be healthy (e.g., facial symmetry and prototypicality) are negatively correlated with reported incidence of past health problems is similarly mixed (Rhodes et al., 2001; Shackelford & Larson, 1997; Thornhill & Gangestad, 2006; Zebrowitz & Rhodes, 2004), as is evidence for correlations between sexually dimorphic facial characteristics and past health problems (Gray & Boothroyd, 2012; Rhodes et al., 2003; Thornhill & Gangestad, 2006). Although it has been reported that men with more masculine or attractive faces showed stronger immune responses to hepatitis B vaccinations, no such link between facial attractiveness and immune response was found for women (Rantala et al., 2012, 2013a, 2013b).

While evidence for correlations between most facial cues and measures of actual health is rather mixed, recent work on facial cues of adiposity is more consistent; people whose faces are perceived to be relatively slim report fewer past health problems, score higher on measures of cardiovascular health, and tend to live longer (Coetzee et al., 2009; Tinlin et al., 2013; Reither et al., 2009). Some work also suggests that facial cues of adiposity predict some aspects of health even when controlling for the role of BMI (Tinlin et al., 2013), suggesting that facial cues of adiposity are not necessarily redundant with other adiposity markers (e.g., body size and/or shape). Men whose faces are perceived to be relatively slim also show stronger immune responses to hepatitis B vaccinations, even when controlling for the effects of facial masculinity (Rantala et al., 2013a). These findings for health measures and facial cues of adiposity are consistent with research suggesting that measures of adiposity, such as body mass index (BMI), are good predictors of long-term health outcomes (reviewed in Calle et al., 1999).

Cortisol plays an important, but complex, role in regulating the immune system (see Martin, 2009 and Sapolsky et al., 2000 for comprehensive reviews). For example, the first wave of glucocorticoids produced in stress responses have both stimulating and inhibitory effects on immunity (Chrousos, 1995; Reichlin, 1993) and both infectious and noninfectious stressors can trigger immune activation (Harbuz & Lightman, 1992; Morrow et al., 1993). However, this activation is typically relatively short-lived (Sapolsky et al., 2000). Where levels of glucocorticoids are elevated for relatively long periods of time, such as days or even weeks, they tend to have immunosuppressive effects, such as inhibition of the synthesis, release, and efficacy of mediators that promote immune reactions (see Martin, 2009 and Sapolsky et al., 2000). Thus, high trait (i.e., average) levels of salivary cortisol may be a biomarker for poor health.

Some recent studies have reported that men with lower average cortisol have more attractive faces (Moore et al., 2011a, 2011b). Additionally, a recent study reported that women with lower average cortisol have more attractive faces, even when controlling for the effects of adiposity (Rantala et al., 2013a). These results for women's attractiveness suggest that women's facial attractiveness may contain at least two different types of health information; information that is indexed by cortisol and information that is indexed by adiposity. However, that another recent study (Gonzalez-Santoyo et al., 2015) observed no significant correlation between women's cortisol and ratings of their facial attractiveness suggests that the association between attractiveness and cortisol reported by Rantala et al. (2013a) may not be robust. Consequently, the current study attempted to replicate Rantala et al's (2013a) results for cortisol, adiposity, and women's facial attractiveness.

Methods

Ninety-six white women (mean age=21.42 years, SD=3.02 years) at the University of Glasgow (UK) came into the lab once a week for five weeks (i.e., each participant completed five test sessions in total). Participants were recruited to the study only if they were not currently using any hormonal supplements (e.g., oral contraceptives) and had not used any form of hormonal supplements in the 90 days prior to their participation. None of the participants reported being pregnant, having been pregnant recently, or breastfeeding. All aspects of the study had been approved by our local ethics committee and all participants provided written consent prior to participating.

In each of the five test sessions, each woman first cleaned her face with hypoallergenic face wipes to remove any make up. A full-face digital photograph was taken a minimum of 10 minutes later. Photographs were taken against a constant background, under standardized lighting conditions, and participants were instructed to pose with a neutral expression and looking directly at the camera. Participants wore a white smock covering their clothing when photographed. Photographs were taken using a Nikon D300S digital camera and a GretagMacbeth 24-square ColorChecker chart was included in each image for use in color calibration. Following other recent studies (e.g., Jones et al., 2015), face images were color calibrated using a least-squares transform from an 11-expression polynomial expansion developed to standardize color information across images (Hong et al., 2001). Images were aligned on pupil position and masked so that hairstyle and clothing were not visible. Only the face photograph from each participant’s first test session was used in the current study.

In each test session, participants provided a saliva sample via passive drool (Papacosta & Nassis, 2011). Participants were instructed to avoid consuming alcohol and coffee in the 12 hours prior to participation and avoid eating, smoking, drinking, chewing gum, or brushing their teeth in the 60 minutes prior to participation. Each individual woman's test sessions took place at approximately the same time of day. Twenty-nine of the women were tested between 10am and 11am each time, 14 of the women were tested between 12pm and 1pm each time, 13 of the women were tested between 1pm and 2pm each time, 14 of the women were tested between 2pm and 3pm each time, and 15 of the women were tested between 3pm and 4pm each time. Saliva samples were frozen immediately and stored at -32°C until being shipped, on dry ice, to the Salimetrics Lab (Suffolk, UK) for analysis, where they were assayed using the Salivary Cortisol Enzyme Immunoassay Kit 1-3002. All assays passed Salimetrics' quality control. The average cortisol level for each participant was calculated for use in analyses by averaging cortisol values for each woman from all five of her test sessions (M=0.23 μg/dL, SD=0.12 μg/dL).

Each participant's height (M=166.22 cm, SD=5.30 cm) and weight (M=65.23 kg, SD=12.61 kg) was measured and used to calculate their BMI (M=23.53 kg/m^2, SD=3.92 kg/m^2). According to the World Health Organization's (WHO) classifications (WHO, 2000), 5 of the women were in the underweight BMI category (<18.5 kg/m^2), 65 of the women were in the normal category (18.5–

24.99 kg/m^2), 19 of the women were in the overweight category (25–29.99 kg/m^2) and 7 of the women were in the obese category (>30 kg/m^2).

207 men and 266 women (mean age=24.14 years, SD=6.03 years) rated the faces for attractiveness, health, femininity, or weight in an online study using 1 (low) to 7 (high) scales. Each participant rated the faces on only one of these dimensions and the dimension that any participant was allocated to rate the faces on was randomly determined. Each participant rated only a randomly selected subset of 40 of the 96 faces. Trial order was fully randomized. Using the same paradigm, a different group of 52 men and 67 women (mean age=24.97 years, SD=10.89 years) rated the faces for dominance. Of the participants in the face rating part of the study, 73% reported they were White, 5% reported they were East Asian, 4% reported they were West Asian, and 2% reported they were Black. The remaining participants either reported their ethnicity as “other” or chose not to report their ethnicity.

Inter-rater reliability for all ratings was estimated using bootstrapping. This technique computed the average correlation between ratings for each face (derived from randomly selected subsamples of participants over ten thousand iterations) separately for each dimension. The average correlation was high for each of the five dimensions (all r>.87, all SD<.02). This bootstrapping procedure was used because each participant had rated only a random subset of the full image set. We then calculated the average attractiveness, health, femininity, dominance, and weight rating for each face. These average ratings were used in our analyses.

Results

To control for possible effects of diurnal shifts in hormone levels (Papacosta & Nassis, 2011), average cortisol values were standardized for time of day prior to analyses. This was done by grouping participants by hour of testing (between 10am and 11am, between 12pm and 1pm, between 1pm and 2pm, between 2pm and 3pm, or between 3pm and 4pm) and converting average cortisol values within each group to z-scores. Women's cortisol levels from the first test session (i.e., the test session in which the photograph presented in the face rating part of the study had been taken) were also standardized in this way. This method for controlling for possible effects of diurnal shifts in cortisol is similar to that used in other studies, in which salivary cortisol levels were standardized for time since waking via conversion to z-scores (e.g., Flinn, 2009).

Table 1 shows the simple (i.e., zero-order) correlations among all variables. BMI was negatively and significantly correlated with facial attractiveness (r=–.43, N=96, p<.001), facial health (r=–.41, N=96, p<.001), and facial femininity (r=–.32, N=96, p=.002). BMI was positively and significantly correlated with facial adiposity (r=.67, N=96, p<.001). BMI was not significantly related to facial dominance (r=–.09, N=96, p=.39). No significant correlations were observed between average cortisol (all |r|<.16, all N=96, all p>.14) or first test session cortisol (all |r|<.15, all N=96, all p>.17) and any of the face ratings. Figures showing the relationships between face ratings and BMI, average cortisol, and first test session cortisol are given in our Supporting Information.

INSERT TABLE 1 HERE

Repeating all of the analyses described above with average face ratings derived from either heterosexual male raters' responses only or heterosexual female raters' responses only showed the same pattern of results in all cases (i.e., showed significant relationships between face ratings and BMI, but not between face ratings and either of the cortisol measures). These patterns of results were also seen when non-parametric correlational tests (Spearman's rho) were used.

Finally, we tested whether the relationships between BMI and facial appearance were best characterized by linear or quadratic relationships using the same method reported in Rantala et al. (2013a). BMI was first centered on its mean. A regression analysis in which face ratings were the dependent variable and the centered BMI and the square of the centered BMI were simultaneously entered as predictors was then carried out separately for each of the five facial dimensions considered in our study (facial attractiveness, health, femininity, dominance, and adiposity). For attractiveness ratings, this analysis showed a significant negative linear relationship between BMI and attractiveness (t=–3.60, standardized beta=–.41, p=.001). The quadratic relationship was not significant (t=–0.31, standardized beta=–.04, p=.76). Similar patterns of results were observed for the analyses of health (linear: t=–3.55, standardized beta=–.41, p=.001; quadratic: t=–0.03, standardized beta=–.003, p=.98) and femininity (linear: t=–2.24, standardized beta=–.27, p=.027; quadratic: t=–0.73, standardized beta=–.09, p=.47) ratings. The analysis of adiposity ratings showed a significant positive linear relationship between BMI and adiposity ratings (t=7.48, standardized beta=.70, p<.001). The quadratic relationship was not significant (t=–0.45, standardized beta=–.04, p=.65). For dominance ratings, neither the linear (t=–1.66, standardized beta=–.21, p=.10) nor quadratic relationships were significant (t=–1.66, standardized beta=–.21, p=.10).

Discussion

Consistent with other recent studies (e.g., Coetzee et al., 2009; Tinlin et al., 2014), we found that ratings of women's facial adiposity were strongly correlated with their actual BMI. These results indicate the existence of cues of BMI in women's faces (see also Windhager et al., 2013 for corresponding evidence from studies of percentage body fat, rather than BMI). We also found that women with lower BMIs tended to have more attractive, healthier-looking faces. A similar relationship was observed for femininity ratings of women's faces (i.e., women with lower BMIs were rated as looking more feminine), which is a novel result not previously reported in the literature. These results suggest that cues of adiposity are important for social judgments of women’s faces.

We observed no significant correlations between ratings of women's faces and their cortisol levels. This pattern was seen both when average cortisol levels (i.e., cortisol levels collapsed across test sessions) were analyzed and when only cortisol levels from the same test session as the photograph were analyzed. These null results contrast with Rantala et al. (2013a), who recently reported a significant negative relationship between women's facial attractiveness and cortisol. Like our study, Gonzalez-Santoyo et al. (2015) also reported no significant correlations between women’s cortisol and facial attractiveness and femininity. However, and unlike our study, Gonzalez-Santoyo et al. (2015) observed a significant negative correlation between cortisol and women’s facial dominance.

There are several possible explanations for these inconsistent results. For example, effects of changes in women’s facial appearance over the menstrual cycle (e.g., Puts et al., 2013), which were controlled for only in Rantala et al. (2013a), may have obscured relationships between attractiveness and cortisol in the current study and Gonzalez-Santoyo et al’s (2015) study. It is also possible that the inconsistent results reflect cross-cultural differences in social judgments of faces and/or the nature of the relationships between hormones and appearance, since the studies were conducted using different populations. Differences in the visibility of hairstyle, hair-quality, and clothing across studies, whether plasma or salivary cortisol levels were investigated, and differences in how researchers controlled for possible effects of diurnal shifts in cortisol levels may also have contributed to the inconsistencies. Future research exploring these, and other, possibilities may help clarify the reasons for the inconsistent results across studies.

Some previous research on the relationship between women’s facial appearance and measures of their adiposity reported that overweight and underweight women were less attractive and healthier-looking than women with normal adiposity levels and that these quadratic relationships explained variation in facial appearance better than simple linear relationships did (e.g., Coetzee et al., 2009; Rantala et al., 2013). By contrast with these results, here we found that linear relationships between BMI and facial appearance explained more of the variation in attractiveness, health, and femininity than did the corresponding quadratic relationships. Importantly, we emphasize here that these results do not indicate that very thin women have particularly attractive, healthy, or feminine faces; according to the World Health Organization’s classifications (WHO, 2000) only 5 of the 96 women in our study were underweight.

Our results linking perceptions of women's facial attractiveness, health and femininity to their BMI present further evidence for the existence of health cues in women's faces and the importance of adiposity cues for social judgments of women's faces. That no relationships were observed between ratings of women's faces and cortisol suggests that the associations reported in two recent studies might not necessarily be robust (Gonzalez-Santoyo et al., 2015; Rantala et al., 2013a). Our results for perceptions of women’s facial attractiveness, health, and femininity then raise the possibility that the types of health information reflected in women's faces include qualities that are indexed by BMI, but do not necessarily include qualities that are indexed by cortisol. That facial adiposity appears to be a particularly important health cue for judgments of *women's* attractiveness is consistent with other recent work suggesting that facial adiposity is a particularly important health cue for judgments of *men's* attractiveness (Rantala et al., 2013b).

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Table 1. r values (and 2-tailed p values) for linear relationships among all variables in our study.

	average cortisol	first session cortisol	attractiveness	health	femininity	adiposity	dominance	age
BMI	–.03 (.76)	–.09 (.38)	–.43 (<.001)	–.41 (<.001)	–.32 (.002)	.67 (<.001)	–.09 (.39)	.09 (.38)
average cortisol		.67 (<.001)	–.11 (.28)	–.10 (.34)	–.08 (.43)	.05 (.60)	.15 (.15)	.18 (.08)
first session cortisol			.09 (.40)	.07 (.48)	.09 (.37)	–.09 (.36)	.14 (.17)	.16 (.13)
attractiveness				.85 (<.001)	.89 (<.001)	–.59 (<.001)	.26 (.010)	–.07 (.49)
health					.76 (<.001)	–.52 (<.001)	.17 (.11)	–.10 (.33)
femininity						–.44 (<.001)	.20 (.053)	–.12 (.23)
adiposity							–.08 (.43)	–.05 (.63)
dominance								.24 (.02)