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Facial masculinity and fluctuating asymmetry

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Abstract

Recently, women have been found to prefer the scent of symmetrical men and relatively masculine male faces more during the fertile (late follicular and ovulatory) phases of their menstrual cycles than during their infertile (e.g., luteal) phases. These findings make most theoretical sense if men's symmetry is associated with the masculinity of their faces and, therefore, men's symmetry and facial masculinity tap a shared underlying quality. This study examined associations between masculine facial features and nonfacial body symmetry as well as facial symmetry in samples of 141 men and 154 women. As predicted, a component of facial features that discriminates the sexes and reflects masculinization of the face significantly covaried with symmetry in men. No significant correlation was observed for women. These findings suggest that men's facial masculinity partly advertises underlying developmental stability.

Keywords: Developmental instability; Facial masculinity; Physical attractiveness; Sexual selection; Menstrual cycle

1. Introduction

Recently, Perrett, Penton-Voak, and colleagues have reported two surprising findings regarding male facial attractiveness. They digitized male and female faces, composited these images to create average sex-specific faces, and then blended or exaggerated differences between the composites to create male faces varying in masculinity. First, they found that

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women in the UK and Japan generally prefer male faces that are slightly feminized, not hypermasculinized (Perrett et al., 1998). Perrett et al. speculated that feminized faces are perceived to promise willingness to invest exclusively in a mate (Berry & Wero, 1993; Cunningham, Druen, & Barbee, 1997; Graziano, Jensen-Campbell, Todd, & Finch, 1997; Johnston, Hagel, Franklin, Fink, & Grammer, 2001), which may be traded off when women select a mate who possesses a masculine face perhaps indicative of other valuable traits (e.g., social dominance; Mazur & Booth, 1998; Mueller & Mazur, 1997; Swaddle & Reierson, 2002). The literature is not consistent in this regard, however; other studies have found that women find masculine faces more attractive (e.g., Johnston et al., 2001; Keating, 1985) or that they prefer neither masculinized nor feminized faces over average faces (e.g., Swaddle & Reierson, 2002).

Secondly, Penton-Voak et al. (1999) found that women's attraction to men's facial masculinity–femininity shifts across the cycle. Gangestad and Thornhill (1998a) reported that women prefer the scent of men who possess low fluctuating asymmetry (FA), but only during the fertile phase of their cycle. FA is a marker of developmental instability: imprecise expression of developmental design due to developmental perturbations (e.g., mutations, pathogens, toxins) or inability to deal with these perturbations (Gangestad & Thornhill, 1999; Møller 1999; Møller & Swaddle, 1997). This pattern has been replicated in three additional studies (Rikowski & Grammer, 1999; Thornhill & Gangestad, 1999a; Thornhill et al., in press). Gangestad and Thornhill conjectured that the value that women have evolved to place on indicators of good investment on the one hand and genetic benefits on the other hand shifts across the menstrual cycle. Women should have evolved to place greater value on genetic benefits when they are fertile and hence can obtain those benefits for their offspring than when nonfertile, particularly when extrapair sex is a possibility. Penton-Voak et al. reasoned that if, as they previously speculated, feminine features in a man advertise willingness to invest in a mate whereas masculinity advertises allocation to intrasexual competition (which may be condition dependent and partly heritable), women might prefer greater masculinity near ovulation. This prediction has now been supported in four published studies in four different countries (UK, Japan, US, and Austria) (Johnston et al., 2001; Penton-Voak & Perrett, 2000; Penton-Voak et al., 1999 [two studies]). Although the notion that genetic benefits (in ancestral populations) account for these preference shifts remains speculative (e.g., Gangestad & Simpson, 2000; Kirkpatrick, 1996; Thornhill & Gangestad, in press), systematic shifts of preferences are well established.

These results make most theoretical sense if, in fact, men who possess low FA also have more masculine facial features on average, such that male symmetry and facial masculinity tap a shared underlying quality (Thornhill & Gangestad, 1993), but little work has systematically examined this association. Penton-Voak et al. (2001) found no significant correlation between male facial symmetry and masculinity; interestingly, however, a composite of the most symmetrical faces in their study was rated as more masculine than a composite of the least symmetrical faces. Scheib, Gangestad, and Thornhill (1999) found significant positive associations between male facial symmetry and features that may be related to facial masculinity (e.g., lower face length). The current study examined the association between facial masculinity and bodily FA, as measured in studies by Gangestad and Thornhill (1998a), Thornhill and Gangestad (1999a), and Thornhill et al. (in press) that have found a female preference for the scent of symmetrical men prior to ovulation, in addition to an association between facial masculinity and facial FA. (Rikowski & Grammer, 1999 measured facial and body FA.) As a comparison, we examined the association between FA and female facial masculinity. Our sample was considerably larger than those of Penton-Voak et al. (2001) or Scheib et al. (1999) and, hence, we had greater power to detect associations, should they exist.

2. Methods

Participants were 295 college students at the University of New Mexico (141 men and 154 women) who participated in a larger study on FA and romantic relationships (see Gangestad & Thornhill, 1997 for a fuller description of the sample). All individuals identified themselves as Caucasian or Hispanic; other ethnicities were poorly represented in the larger sample in this study (Asian: 3%; African American: 2%; Native American: 4%). Men's ages averaged 20.91 (S.D. = 3.02; range = 7–37); women's ages averaged 20.06 (S.D. = 3.42; range = 17–39). Because men were significantly, albeit only slightly, older [$t(293) = 2.27$, $P < .05$], age was controlled in subsequent analyses.

2.1. Bodily FA

Data were collected in two waves in different academic semesters. As part of the study, FA was measured on seven and nine body traits for the first and second waves, respectively: ear length, ear width, elbow width, wrist width, length of the small finger, ankle width, and foot width were measured in both waves, with lengths of the middle and ring fingers added in the second wave. Because measurers could at best remember their previous measurements only with great difficulty even if they tried (and they were instructed not to try), and because multiple measures intervened between bilateral measurements of any specific trait, the right and left sides were presumably measured blind to one another. As has been reported elsewhere (Gangestad & Thornhill, 1999), unsigned asymmetries on these traits tend to be slightly leptokurtic, as expected for asymmetry associated with variation in developmental instability. Directional asymmetry on the traits is minor; in a sample of about 700 (which included the current sample), only asymmetry of the foot was found to possess a small but significant directional bias (about 0.2 S.D. separating the unsigned mean asymmetry and zero), correction of which makes little difference to the measurement (see Furlow, Armijo-Perwitt, Gangestad, & Thornhill, 1997). Relative FA (absolute asymmetry divided by average trait size) was summed across the traits to create a composite FA index, although both a composite measure of absolute FA and one correcting for the minor directional asymmetry in foot width yielded the same results as those reported. Because the composites contained different numbers of traits in the two samples, they were converted to standard normal deviates (*z* scores) within each sample. Multiple studies show the repeatabilities of these composites to be 0.7–0.8 (e.g., Furlow et al., 1997; Gangestad & Thornhill, 1998a; Thornhill & Gangestad, 1999a).

2.2. Facial masculinity

A straight-on black-and-white facial photograph of each participant was taken from a distance of about 0.8 m. Participants were instructed to maintain a neutral expression while being photographed. Other instructions for the two data collection waves were slightly different. The first sample was instructed to sit straight and look straight into the camera, whereas the second was instructed to sit back with their heads against the wall and look straight into the camera. Although variation on measurements within each sample should be meaningful, these instructions resulted in somewhat different mean face measures and, hence, the sample was statistically controlled in the analyses. Each facial image was digitized and, if necessary, rotated using Adobe Photoshop so that the two pupils lay on the same horizontal axis. In Image 1.59, 25 standard points were placed on the face, from which 10 facial measures were computed: (1) Face length: length of the face from the hairline (or estimated location of the hairline) to the bottom of the chin. (2) Face width: maximum face width at the cheekbones divided by face length. (3) Chin length: the lip crease to the bottom of the chin. (4) Eye height: the top of the eye white at the pupil to the bottom of the eye white at the pupil, averaged across the two eyes. (5) Eye width: the horizontal distance from the inner corner of the eye to the outer corner, averaged across the two eyes. (6). Interpupil distance: the horizontal distance between the two pupils. (7) Lip height: the top of the upper lip to the bottom of the lower lip. (8) Lip width: the horizontal distance between the corners of the mouth. (9) Jaw width: the width of the face at the mouthline. (10) Face length minus chin length: the distance from the hairline to the crease of the lips. These dimensions were not meant to exhaust all possible variations across faces. Rather, they were deliberately chosen to tap major variations that previous research has shown to discriminate the sexes or to be influenced by sex hormones (most notably, testosterone) during development [chin length, jaw breadth, eye features (as influenced by development of the brow ridge), lip fullness] (see Penton-Voak et al., 2001; Swaddle & Reierson, 2002; Thornhill & Gangestad, 1993). They did prove useful in discriminating male from female faces in our sample.

Facial images varied in size (partly due to lack of a perfectly standardized lens to face distance) and, hence, we created derived scores to control for face size. We regressed each of the vertical measures of eye height and lip height on total face length and computed unstandardized residual scores. Because chin length is a sizable component of total face length, to control for length of face *other than* chin, we regressed chin length on total face length minus chin length (measure 10 above) and computed residuals. [The converse — residuals of total face length regressed on chin length — should, of course, be redundant with (inversely associated with) these residuals and hence we did not compute them. Controlling for total face length rather than total face length minus chin length yielded nearly identical results.] We then computed residuals of the horizontal measures of interpupil distance, lip width, jaw width, and eye width regressed on face width (measure 2 above). To obtain a measure reflective of the overall breadth of the face, controlling for face length, we regressed face width on face length and calculated residuals. In doing these regressions, we also checked to see whether the sample (first vs. second wave of data collection) predicted variation. For eye height, eye width, lip height, and lip width, the sample did predict and, for these variables, we also removed variation due to the sample. (Two different measurers placed the points for the two samples and appear to have placed points on the edge of the eyes and the lips slightly differently; these regressions hence removed intermeasurer differences.)

We examined sex differences (controlling for age, sample, and ethnicity) by conducting a series of general linear models [SPSS: general linear modeling (GLM)] with sex, sample, and ethnicity as fixed factors and age and age squared as covariates. Of the eight residual variables, five significantly discriminated the sexes. Previous research (e.g., Penton-Voak et al., 2001) shows that the major sex differences in facial structure are found in the size of the jaw/chin and the development of the brow ridge. Controlling for face size, men had longer chins than women [$F(1,285)=171.89$, $P<.001$], wider jaws [$F(1,285)=4.88$, $P<.05$], and eye whites of lower height (e.g., eyes less "open" [$F(1,285)=14.34$, $P<.001$]). (The latter effect probably reflects development of the brow ridge, which creates the appearance of "narrower" eyes.) In addition, men had wider lips than women [$F(1,285)=11.09$, $P<.001$], but eyes with less horizontal breadth [$F(1,285)=8.29$, $P<.005$]. The sexes did not differ significantly with respect to interpupil distance [$F(1,285)=2.32$, NS], lip height [$F(1,285)= 1.65$, NS], or face width [$F(1,285)=0.00$, NS].

A principal axis factor analysis was performed on the five sex-differentiating variables to identify major sources of variation. A scree test revealed two major factors (the first four eigenvalues = 1.75, 1.23, 0.85, and 0.62), which were extracted and oblimin rotated (the rotated factors correlated just $-.09$ and, hence, a varimax rotation was nearly identical). One component was primarily defined by chin length (pattern matrix loading=.64) and jaw width (.62), with modest loadings by two other variables distinguishing the sexes: eye height (negatively; $-.26$) and lip width (.26). This component appears to capture the major expected differences between the sexes, including that due to the effects of testosterone during pubertal development (a longer, broader jaw; see Penton-Voak et al., 2001; Swaddle & Reierson, 2002). The second factor was defined by eye width (.82) and eye height (.42) and appears to tap residual variation in eye size not reflected in the first component (which captures some variation in eye height).

Factor scores were estimated (using regression based scores) and entered into a discriminant analysis predicting sex. The first factor significantly discriminated the sexes [$F(1,293)=82.67$, $P<.00001$]; the second added marginally significant predictive value [$F(1,292)=3.21$, $p=.074$] and was also retained. Discriminant function scores, used as a measure of facial masculinity, could correctly classify the sex of 75.3% of the faces. (These scores correlated .98 with the first factor and $-.32$ with the second. Results were nearly identical when only the first factor was used as a measure of facial masculinity.)

2.3. Facial FA

Using procedures described by Scheib et al. (1999), we measured facial FA. First, we calculated the midpoints of seven lines running horizontally across the face [at the outer and inner eye corners, the eye pupils, the cheekbones, the outer edges of the nose and mouth, the jaws (at the mouth line)] and computed the sum of the x axis absolute differences between these points (in pixels; see Grammer & Thornhill, 1994). Second, we calculated the sum of the y axis absolute differences (in pixels) in placement of six pairs of bilateral points (at the inner and outer eye corners, the cheekbones, the nose, the corners of the mouth, and the jaws). Because these "horizontal" and "vertical" components have different standard deviations, we z scored them before summing them into a composite measure of facial FA. The facial FA measures of three women and two men were excluded because their faces were not oriented straight at the camera. (The Sex × Facial FA effect on facial masculinity reported below was stronger when these faces were included.)

3. Results

We analyzed predictors of facial masculinity through GLM (SPSS-PC 11.0). Sex, bodily FA, facial FA, the Bodily FA × Sex interaction, and the Facial FA × Sex interaction were the main predictors. We expected that bodily and facial FA would be negatively associated with facial masculinity for men, but not for women (and, hence, Predicted FA × Sex interactions). Because relative FA may correlate with overall body size (Palmer, 1994), body weight was included as a control factor, as were sample, ethnicity, age, age squared, and interactions of sex with body weight, age, and sample.

Naturally, sex had an effect on facial masculinity [$F(1,274) = 11.20$, $P = .001$], as did body weight [$F(1,274) = 19.49$, $P < .001$]. Bodily FA had an independent effect on facial masculinity [$F(1,274) = 6.48$, $P = .011$]. Importantly, and as predicted, this association differed by sex [$F(1,274) = 10.66$, $P = .001$], as did the association between facial FA and facial masculinity [$F(1,274) = 4.74$, $P = .030$]. In addition, the effects of age and age squared were moderated by sex [$F(1,274) = 8.21$ and 9.27, respectively, both $P < .005$); the sex difference in facial masculinity between the sexes tended to increase with age. Ethnicity, age, age squared, and the Sex × Body Weight interaction had no significant effects.

Separate correlational analyses on men and women revealed that, for men, bodily FA was negatively associated with facial masculinity ($r = -.268$, $P = .001$; see Fig. 1). For women, no association emerged ($r = .043$, NS). Partialling out sample, body weight, ethnicity, age, and age squared did not affect these results: for men, $r = -.264$, $P = .003$; for women, $r = .007$, *NS*. (See Gangestad & Thornhill, 1998b on the robustness of parametric tests on FA.)

Similarly, facial FA significantly predicted facial masculinity for men ($r = -.195$, $P = .021$), but not for women ($r = .033$, NS). Partialling out sample, body weight, ethnicity, age, and age squared reduced the correlation for men to marginally significant [$r = -.159$,

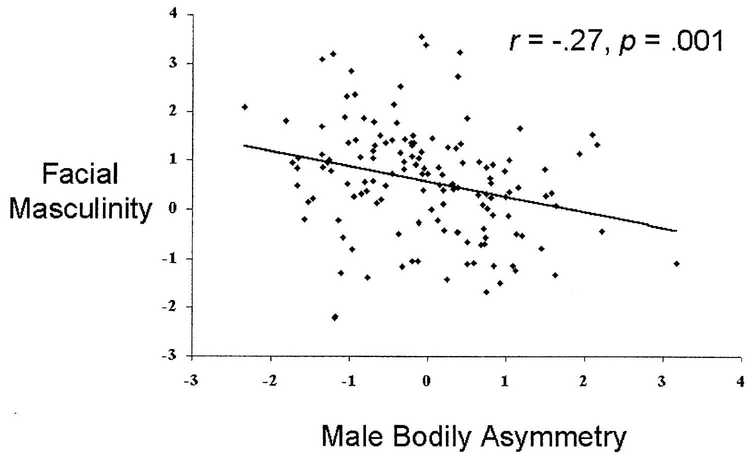

Fig. 1. Scatterplot of the association between bodily FA and facial masculinity in men, showing a significant linear association. $N = 141$. Variables on both axes have been standardized (converted to z scores).

$P = .066$, which is significant by a directed test (Rice & Gaines 1994), $P = .041$, appropriate here because of the a priori prediction] and did not substantially alter the correlation for women ($r = .038$, NS).

GLM analyses of individual measures revealed three significant Bodily FA × Sex interactions: for jaw width [$F(1,274) = 6.74$, $P < .010$], chin length [$F(1,274) = 3.95$, $P = .048$], and eye height [$F(1,274) = 5.71$, $P = .018$]. For men, bodily FA predicted jaw width ($r = -.230$, $P = .006$), chin length ($r = -.181$, $P = .031$), and at a marginally significant level, eye height ($r = .165$, $P = .051$). For women, none of these correlations exceeded ± 0.08, all NS. In addition, two significant Facial FA × Sex interactions emerged: for eye height [$F(1,274) = 7.21$, $P = .008$] and eye width [$F(1,274) = 3.87$, $P = .050$]. For men, facial FA significantly predicted eye height ($r = .192$, $P = .024$) and chin length ($r = -.179$, $P = .032$) but not eye width ($r = .101$, NS) or chin width ($r = -.137$, NS). For women, none of these correlations exceeded ± 0.09, all NS.

Additional regression analyses did not reveal any curvilinear associations between facial masculinity and bodily FA; with facial masculinity controlled, facial masculinity squared did not significantly covary with bodily or facial FA (F's < 1 for both sexes). Interestingly, however, curvilinear associations between facial masculinity and facial FA did emerge for both sexes [$F(1,136) = 23.70$, $P < .001$ for men; $F(1,148) = 8.21$, $P = .005$ for women]. (These remained significant after controlling for additional variables such as age, weight, and sample.) In both sexes, extreme values on facial masculinity were associated with greater FA, possibly owing to an association between facial nonaverageness and developmental instability of facial structures (see Fig. 2).

In this sample, facial FA and bodily FA were not correlated: for men, $r = -.087$, NS; for women, $r = .014$, NS. In general, FA of individual traits is only weakly correlated with underlying developmental instability (Gangestad & Thornhill, 1999) and, hence, it not

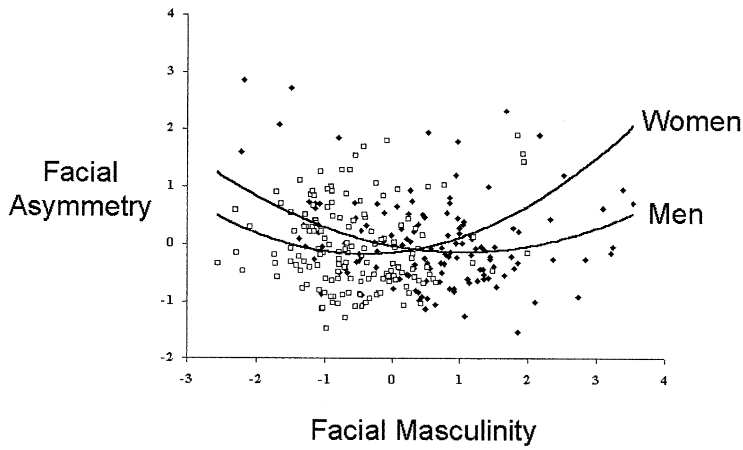

Fig. 2. Scatterplot of the associations between facial masculinity and facial FA in men (filled diamonds) and women (open squares). For men, there is a significant linear association as well as a significant curvilinear association. $N = 139$. Linear $r = -.20$, $P < .05$. Quadratic r (with linear effect partialled out) $= .39$, $P < .001$. For women, there is a significant curvilinear association. $N = 151$. Linear $r = .03$, NS. Quadratic r (with linear effect partialled out) $= .23$, $P < .01$. Note that, as facial masculinity increases, men tend to have greater facial symmetry than women; as facial masculinity decreases, women tend to have greater facial symmetry than men.

surprising that a measure of facial FA does not strongly covary with a multitrait composite of bodily FA (though one would expect the population correlation to be mildly positive).

4. Discussion

This study found reliable associations of facial masculinity with bodily FA and facial FA for men but not women. As predicted, more symmetrical men tended to have more masculine features, including wider jaws, longer chins, and narrower (less open) eyes (the latter presumably due to development of the brow ridge). These features are purportedly the main ones affected by testosterone during pubertal development (see Swaddle & Reierson, 2002). Although the FA–facial masculinity correlations in men are not large, FA is only a moderately valid measure of underlying developmental instability. The validity of the seven- to nine-trait bodily FA composite used here appears to approach 0.5 (Gangestad & Thornhill, 1999). Hence, the correlation of about $-.25$ is expected to underestimate the correlation between facial masculinity and underlying developmental instability by about half, suggesting a true value close to -0.5. Because facial FA taps developmental instability in developmentally related traits, its validity as a measure of organism-wide FA is probably lower than 0.5.

Our results contrast with those of Penton-Voak et al. (2001), who found no association between measured facial masculinity and facial FA (though our results extend the findings of Scheib et al., 1999). There are several possible reasons for the different results. One is that our strongest results came from a composite of seven to nine different body traits, whereas Penton-Voak et al. measured only facial symmetry. An individual trait's FA is a poor marker of underlying developmental instability. As noted, our composite measure of FA has been estimated to have a correlation of about .5 with underlying trait-general developmental instability (Gangestad, Bennett, & Thornhill, 2001; Gangestad & Thornhill, 1999). Facial FA (as measured by Penton-Voak et al.) no doubt reflects asymmetry of multiple traits. Because many of these traits are developmentally integrated, however, they may provide less independent information about underlying general developmental instability than do the multiple traits in our composite. Hence, our index of body FA may be superior to a measure of facial FA as a measure of developmental instability. Secondly, our empirically derived measure of facial masculinity differed somewhat from Penton-Voak et al.'s empirically derived measure (e.g., their index included eyebrow height whereas ours did not; ours had individual measures of eye height). As noted earlier, Penton-Voak et al. found that a composite of symmetrical faces was rated as more masculine than a composite of asymmetrical faces. Possibly, our index picked up on aspects of facial masculinity that Penton-Voak et al.'s measure did not. As the differences between our measures were subtle (we suspect that eye height and eyebrow height pick up on similar variations, with lower eyebrows associated with narrower eyes), we suspect that this is not a primary reason for differing results. Thirdly, we had a substantially greater sample size (141 vs. 66) and, hence, greater power to detect an association. It is noteworthy that the correlation they report is not significantly different from the ones we report ($z=1.78$, $P=.074$ for bodily FA; $z=1.21$, NS, for facial FA); the differences between the findings could be due to sampling variability.

Although bodily FA was not curvilinearly associated with facial masculinity, we did find curvilinear associations between facial masculinity and facial FA, such that extremely masculine and extremely feminine faces exhibited greater asymmetry. Facial averageness may hence provide some information about the developmental stability of the facial region (including, perhaps, of the brain; e.g., Thoma, Yeo, Gangestad, Lewine, & Davis, 2002), which could be one reason why averageness is found attractive (e.g., Rhodes et al., 2001).

These results tie together findings that relatively masculine facial appearance and the scent of symmetrical men are both preferred by women in the late follicular and ovulatory phases. More fundamentally, these results suggest that facial masculinity advertises developmental stability in men. The proximate and functional processes involved are topics for future work (see Bardin & Catterall, 1981; Thornhill & Gangestad, 1999b).

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