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Original Article

Male Facial Masculinity as a Cue to Health Outcomes

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Abstract: Evolutionary theories of human attraction draw heavily upon nonhuman literature, and currently the Immunocompetence Handicap Hypothesis dominates research into female attraction to male facial masculinity. Although some studies have shown links between masculinity and some measures of health, other data have failed to support the Immunocompetence Hypothesis as applied to human face preferences. Here we summarize that literature and present new data regarding links between masculinity and multiple measures of health condition in human males. Undergraduate males were photographed and their faces were assessed for sexual dimorphism using multiple methods and rated for apparent healthiness and attractiveness. Participants also reported recent health experiences both prior to being photographed and then again 10 weeks later. Although both attractiveness and rated health were associated with better actual health in the past and future (mainly indexed by lower antibiotic use), results were mixed for masculinity. With respect to respiratory illnesses, facial masculinity (assessed using morphometric techniques) was associated with better past health but with worse future health. Possible reasons for the complex and inconsistent findings are discussed and some potentially fruitful avenues of future research are outlined.

Keywords: dimorphism, facial masculinity, immunocompetence, health, attractiveness

Introduction

The Immunocompetence Handicap Hypothesis (ICHH; Folstad and Karter, 1992) lies at the core of current theories regarding female preferences for male masculinity. The ICHH arises from Zahavi's notion of an honest signal (Zahavi, 1975; Zahavi and Zahavi, 1997), wherein an individual organism "signals" some underlying quality by demonstrating the ability to withstand a serious handicap. Under the ICHH as commonly interpreted, androgen-dependent secondary sexual characteristics may signal an individual's superior immune functioning insofar as they indicate an ability to withstand the immunosuppressive effects of the sex hormones responsible for their development. Human facial dimorphism (masculinity), then, is theorized to signal immunocompetence in the face of high levels of testosterone (T), and females at peak fertility are believed to prefer more masculine faces because, despite the apparent or perceived costs of masculine mates in terms of paternal investment and prosociality (e.g., Boothroyd, Jones, Burt, and Perrett, 2007; Johnston, Hagel, Franklin, Fink, and Grammer, 2001; Perrett et al., 1998), they can acquire "good" genes conferring heritable immunity for their offspring, and increase their long term inclusive fitness.

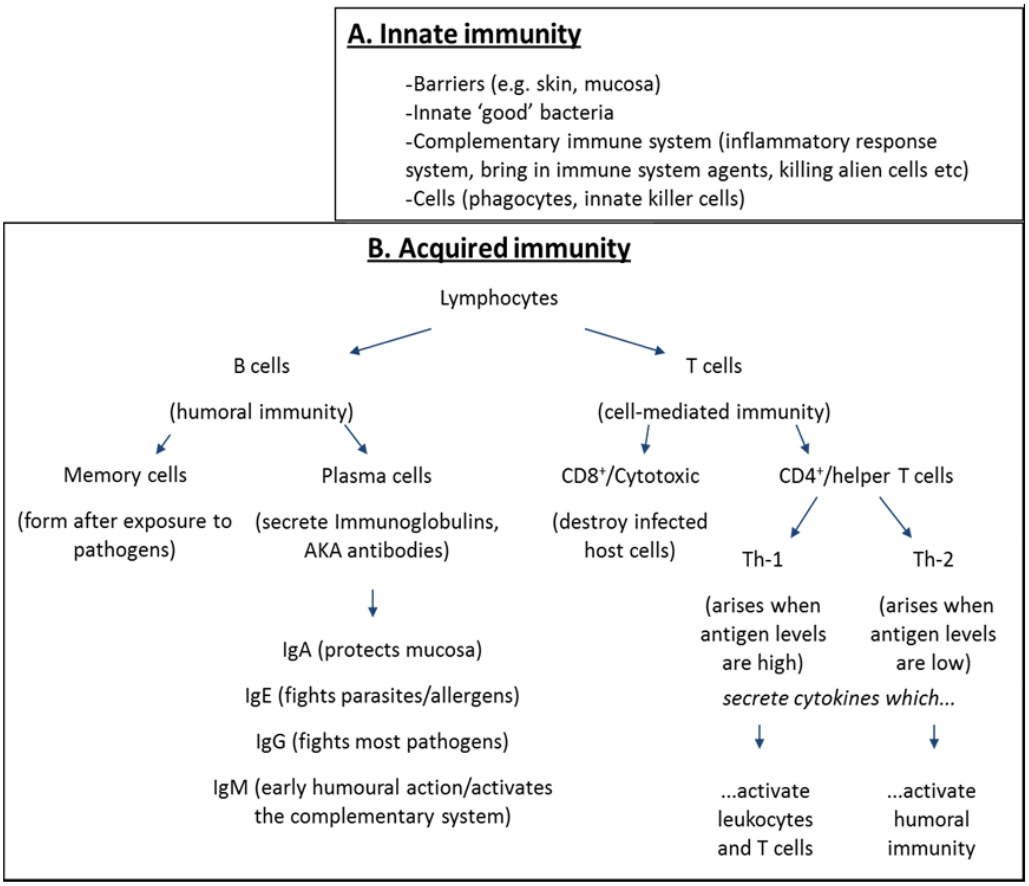
In order for this hypothesized chain of causality to be supported, at least three key lines of evidence are required (Bussière, Tinsley, and Laugen, 2013; Scott, Clark, Boothroyd, and Penton-Voak, 2013). Firstly, testosterone must be immunosuppressive in humans, secondly, an association between facial masculinity and circulating testosterone levels must exist, and thirdly, it should be possible to link, empirically, masculinity with some measure of immune functioning. There is some evidence that facial masculinity in men is associated with circulating testosterone levels (Penton-Voak and Chen, 2004; Pound, Penton-Voak, and Surridge, 2009; Roney, Hanson, Durante, and Maestripieri, 2006) and consequently the current paper will focus on the first and third of these questions, and will report the results of an empirical study addressing the third question specifically.

Although the evolutionary psychology literature has sometimes treated immunocompetence as a unitary, linear trait, and testosterone as a positive cue of immunity, in recent years more complex perspectives have emerged (Muehlenbein and Bribiescas, 2005; see Scott et al., 2013 for review). These propose that testosterone levels may reflect a strategic *reorganization* of resources, rather than (or in addition to) reflecting an abundance of them (due to heritable disease resistance). Resources may be reorganized either across stages of the lifespan or across immune functions, and individual variation in testosterone profile may reflect multiple factors, some of which may be related to genetic quality, but others at least partially independent of it. These latter factors may include (developmental) exposure to conflict, aggression, and other exogenous sources of mortality risk (Archer, 2006; Mazur and Booth, 1998; Qvarnstrom and Forsgren, 1998). Indeed, there is now a fairly substantial body of literature linking factors such as social conflict and deprivation with higher testosterone, early reproduction, and increased senescence (Archer, 2006; Daly and Wilson, 1988, 2001; Mazur and Booth, 1998).

The view of testosterone-immunity link as a complex one is further supported by an increasing acknowledgement of the distinct and sometimes independent components of the

immune system (Muehlenbein and Bribiescas, 2005). The two broad systems of innate immunity (a rapid, non-specific system) and acquired immunity (involving recognition of and responses to specific pathogens) each break down into a vast array of different subcomponents (see Figure 1 for a basic schematic summary, and Muehlenbein and Bribiescas, 2005, for further description). These different subcomponents, however, are often not correlated with each other across individuals (see Adamo, 2004, for a review), and reductions in activity within one component of the immune system may be associated with increased activity in another component (e.g., Keil, Luebke, and Pruett, 2001). Indeed, some aspects of the immune system, such as the Th-1 and Th-2 morphs of helper T lymphocytes, are mutually antagonistic. It is perhaps not surprising, then, that empirical tests of how testosterone levels relate to disease susceptibility and immune parameters have yielded varied and, at times, contradictory results.

Figure 1. The immune system as described by Muehlenbein and Bribiescas (2005)



Empirical research findings for humans are summarized in Table 1 and show that higher levels of endogenous testosterone are associated in different studies with both greater and lesser likelihood of contracting sometimes closely related diseases, and with higher levels of T cells and lower levels of C-reactive protein (a general marker of inflammation), with mixed or null results for several other parameters. At the time of

writing, the only correlational study to have looked at acute responses to a particular immune challenge (rather than baseline immunological parameters) found that men with higher testosterone showed a larger antibody response to immunization with a particular antigen (Rantala et al., 2012). There is, however, some intriguing evidence suggesting that in chronic viral infection (hepatitis B), increased testosterone levels arising during puberty are associated with reductions in viral load (Wu et al., 2010) – that is to say, testosterone may facilitate rather than suppress immune function in this instance. Only two experimental studies (Bhasin et al., 2000, Singh et al., 2002) have investigated the impact of exogenous testosterone administration on immunological parameters, and neither found any effect, despite one of those parameters showing a correlational relationship with circulating testosterone in one study (although not another). However, it is notable that with the exception of the Rantala study, effect sizes in correlational studies of associations between testosterone and immune parameters have been extremely small, with no *r* value reaching .1.

Overall, then, the extant literature shows a pattern of male testosterone potentially being both a positive and a negative factor in immune functioning, or perhaps having no causal role at all (as per the experimental data) but rather sharing one or more antecedents with some different elements of the system.

The findings summarized above then raise the question of whether male facial masculinity is a consistent predictor of male health outcomes across different disease measures and research designs. Surprisingly, however, little published data exists to address this issue. Rhodes, Chan, Zebrowitz, and Simmons (2003) used a prospective design with archival data and found that males whose photographs (taken in adolescence) were rated as more masculine had medical records which were independently rated as showing better health between ages 11 and 18 than those males rated as less masculine. More masculine looking faces were also rated as looking healthier. However, this composite medical health score is as much a reflection of what individuals will report to their doctor as it is an objective measure of health; furthermore, the composite nature of the general health score may mask any more variable relationships as seen in the testosterone studies above. Finally, it should be noted that the purpose of the Rhodes study was to examine associations between sexually dimorphic aspects of face *shape* and health. Consequently, black and white photographs were used, meaning shape and some skin texture cues were available to raters, but not skin color, which may be important for perception of health in faces (see, e.g., Stephen, Coetzee, and Perrett, 2011).

Thornhill and Gangestad (2006) used a retrospective design and found that undergraduate men with more anatomically masculine faces (i.e., assessed through measurements of sexually dimorphic facial proportions rather than rated by observers) tended to report less respiratory illness and less use of antibiotics in the preceding 3 years, but showed no differences in the incidence of stomach illness. Although the images in this study and the measure of masculinity were superior to those utilized by Rhodes et al., the purely retrospective design remains a shortcoming.

Finally, Rantala et al. (2013) examined the physical masculinity of the same men (mean age = 23, *SD* = 3.9) from whom they had gathered the immune response data discussed above. They found that although some indices of dimorphism did correlate with

immune response strength to the vaccine, this could not explain anything female observers found attractive about those men. Thus, although the data offers partial support for the ICHH, it falls short of providing evidence that any immune function superiority inherent in more masculine men is utilized in mate choice.

Table 1. Summary of empirical findings regarding testosterone and immune function

Correlational Studies

Study	Sample	Measure	Tests	DV	Result	Notes
Muehlenbein et al. (2005)	Honduras. (n = 8 with malaria)	Serum T	DS	Malaria (*P vivax*) parasitemia from blood smears	+ve correlation	For four consecutive samples taken during convalescence, higher T levels were associated with higher parasitemia (F = 22.36, p = 0.0002)
Campbell, Lukas, and Campbell (2001)	Settled Turkana pastoralists, Kenya (n = 64)	Blood spot T	DS	Chest infection or pain reports[1]	Marginal +ve correlation	T was significant predictor (p = 0.036) in multivariate linear model with age and BMI
				"Spleen pain" reports[2]	Marginal +ve correlation	T was marginally significant predictor (p = 0.06) in multivariate linear model with age and BMI
	Nomadic Turkana pastoralists, Kenya (n = 91)	Blood spot T	DS	Chest infection or pain reports[1]	+ve correlation	T was marginally significant predictor (p = 0.086)in multivariate linear model with age and BMI
				"Spleen pain" reports[2]	No link	
Kurtis, Mtalib, Onyango, and Duffy (2001)	Western Kenya (n = 140)	Plasma T	DS	Malaria (*P. falcip*) parasitemia from blood smears	-ve correlation	In a multivariate linear model, T was a significant negative predictor (p = 0.02) of mean parasitemia after accounting for age
Granger, Booth, and Johnson (2000)	US Army (n = 4415)	Plasma T	DS	STD infections (ever had gonorrhea or syphilis)		r = 0.08; p < 0.01
			DS	Number of colds	No link	
			IF	T lymphocytes (total)	+ve correlation	r = 0.05; p < 0.01
			IF	$CD4^+$ cell counts	+ve correlation	r = 0.05; p < 0.01
			IF	$CD8^+$ cell counts	+ve correlation	r = 0.04; p < 0.01
			IF	IgM	+ve correlation	r = 0.03; p < 0.01
			IF	B lymphocytes, monocytes, IgA, IgG	No link	
Lassek and Gaulin (2009)	US 862 males from NHANES III		IF	C-reactive protein	-ve correlation	Controlling for age, T negatively related to CRP (r = −0.083, p < 0.05)
			IF	WBC (leukocyte) count	No link	
van Anders (2010)	US college (n =91)	Salivary T	IF	IgA	No link	
Rantala et al. (2012)	Latvia college (n = 74)		IF	Antibody response to a hepatitis B vaccine (Anti-HBsAg)	+ve correlation	In multivariate linear regression model, T was a significant predictor of Anti-HBsAg (Adj R^2 = 0.45, F(1, 73) = 61.21, p < .001)

Experimental Studies

Study	Sample	Measure	Tests	DV	Result	Notes
Singh et al. (2002)	US men (n = 61)	20 x weekly IM injections of 25-600 mg of testosterone enanthate	IF	C-reactive protein	No link	Circulating levels of C-reactive protein were not correlated with T concentrations and did not change with treatment in any group
Bhasin et al. (2000)	HIV-infected men 32 T, 29 placebo	16 x weekly IM injections of 100 mg of testosterone enanthate	IF	$CD4^+$ and $CD8^+$cell counts	No link	No significant differences vs. placebo

Notes: DS = Disease Susceptibility; IF = Immune Function; [1]Participants reported *Erarum* which translates to "chest infection" or "chest pain" typically associated with TB and pneumonia in the population; [2]Participants reported *Etid* which translates to discomfort or sharp pains in the left abdomen – typically associated with actual splenomegaly in malaria.

The above research designs varied not only in terms of the health and disease variables measured, but also on a number of other dimensions, including whether they were prospective or retrospective, and whether masculinity was assessed through ratings or objective measurements. The prospective/retrospective distinction may be important given that, as described above, testosterone may be involved in the reallocation of resources over the life course. The distinction between rated and objectively measured masculinity may also have important implications given that rated masculinity has been proposed to be more closely linked to male attractiveness than measured masculinity, and possibly even attributed to faces on that basis (Scott, Pound, Stephen, Clark, and Penton-Voak, 2010). Thus, the purpose of the current study was to add to this small group of studies and consider further whether there is any link between masculinity and indices of health in Western men, as measured via a range of illnesses, using both prospective and retrospective methods, and with both rated and measured masculinity. We photographed a group of men at the start of their university careers and examined both contemporaneous and prospective health outcomes with follow-up data collected at the end of their first term. The choice of this particular time window was specifically to try and capture a period of time in which individuals may be exposed to a range of novel pathogens, and thus when variation between individuals might be most consequential, particularly given the fact that Western medicine may be a great "leveler" of health outcomes. Durham University students are rarely locals, and come from across the UK and the world. The start of a new university term provides an opportunity for the mixing of individuals from a wide geographical area carrying a range of pathogens. Thus, illness during this period could arguably be considered a window into how the immune system copes with new challenges.

Materials and Methods

Participants

Fifty-seven male and 129 female undergraduates (male mean age = 18.8 years, *SD* = 1.6, range = 18-31; female mean age = 18.9, *SD* = 2.5, range = 18-46) across three academic cohorts were photographed during first year course registration at Durham

University. The large majority of students described their ethnicity as white (males 92%; females 91%) and their nationality as British (males 90%; females 89%). All students on three academic programs were photographed by two different photographers; subsequently participants were recruited by email advertisement and gave permission for their photographs to be used at the same time as completing the questionnaire section of the study. Data on the first two cohorts of female participants has been published elsewhere (Gray and Boothroyd, 2012) and they are included here only for morphometric masculinity analyses below.

Questionnaire measures

Participants in the first cohort reported on "past health" within 2 weeks of course registration, and on "future health" at the end of the autumn term; due to poor retention, however, subsequent cohorts were recruited at the end of the autumn term and completed the questions on past health with a 2 month delay.

Past health. As in Thornhill and Gangestad (2006), participants reported (i) the number of bouts of colds and influenza, (ii) the number of stomach bugs and (iii) the number of occasions on which they had used antibiotics in the preceding 36 months to being photographed. Note that in Thornhill and Gangestad the second question was regarding "stomach flu" which is an American term for gastroenteritis, but we used "bug" as this is standard UK parlance for the same complaint.

Future health. A subgroup (47 men) completed the questionnaire in December and reported the number of days over the preceding academic term they had experienced (i) colds, (ii) flu, (iii) "stomach bugs," and (iv) the number of days they had taken antibiotics. As at least one major health factor had affected one cohort and not others (swine flu was prevalent during the "future health" period for only the first cohort, although all three cohorts had experienced it in the "past health" period), scores were standardized separately for the first vs. the latter cohorts.

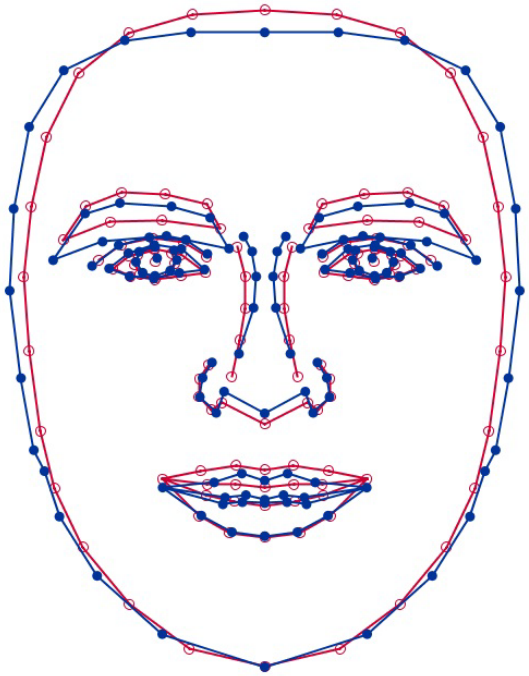
Photograph measures

Ratings. Faces were masked to obscure hair and clothes, and each cohort was separately rated for attractiveness, masculinity, and health on 1-7 Likert scales. Cohort one was rated by 11 raters (five male, six female, mean age = 20.4), cohort two by 15 raters (four male, 11 female, mean age = 23.7), and cohort three by 25 raters (10 male, 15 female, mean age = 20.2). One face was not rated for masculinity due to an error in sex classification during test construction. Because expressions were not controlled in the photographs, images were also rated for mood, again on a Likert scale (from 1 = "very unhappy" to 7 = "very happy"). As the pictures were rated by different observers, all scores were standardized within cohort using *z* scores.

Morphometric masculinity. Geometric morphometric techniques were used to assess facial masculinity using the methods used in Scott et al. (2010) and Stephen et al. (2012). Using definitions from Stephan et al. (2005), the x-y coordinates of the 129 facial landmarks used in Scott et al. (2010) and Stephen et al. (2012) were delineated for each face using Psychomorph (Tiddeman, Burt, and Perrett, 2001). For 13 males, it was not possible to delineate all the required landmarks due to head position, and consequently

these participants were excluded from this analysis. For each face, geometric morphometric techniques were then used to calculate a masculinity index for each face based on the landmark configurations. Using Morphologika geometric morphometrics software (O'Higgins and Jones, 1998), Procrustes registration was used to remove scale, rotational and translational difference in configurations. Subsequently (again using Morphologika), principal components analysis of the Procrustes-registered landmark data was used to identify dimensions of shape variation in facial landmark configuration. Principal components (PCs) were selected for inclusion in subsequent analysis using a Kaiser-Guttman criterion; i.e., those with eigenvalues greater than the average eigenvalue were retained. This led to the retention of the first 23 PCs which together accounted for 87.9% of the variance in facial landmark configuration. A step-wise discriminant analysis (SPSS 18) was then used to determine which of the 23 PCs were best able to discriminate between the male and female faces. This yielded a discriminant function that incorporated 13 of the PCs (Wilks' $\lambda = 0.441$; $df = 13$; $\chi^2 = 121.6$, $p < 0.00001$) and gave correct sex classifications for 89.2% of faces. In light of the classification accuracy, the discriminant function scores were therefore used as an index of morphological masculinity, with high scores indicating a more masculine facial structure. Visual representation of the shape changes reflected by the scores is given in Figure 2.

Figure 2. Face shape change associated with moving from low (red) to high (blue) scores on the morphometric masculinity index



Notes: Shape change associated with moving from low (red) to high (blue) scores on the morphometric masculinity index; Derived from regression of the symmetric component of landmark configuration variation on morphometric masculinity scores in MorphoJ (Klingenberg, 2011) for the male sample; Scaled to represent the magnitude of the change in masculinity scores from the lowest to highest within the male sample ($n = 49$).

Results

As shown in Table 2, more masculine men were rated as looking more attractive (rated masculinity: $r = .49$, $p < .01$; morphometric masculinity: $r = .378$, $p < .05$) and more healthy (rated masculinity: $r = .43$, $p < .05$; morphometric masculinity: $r = .46$, $p < .01$). Similarly, rated attractiveness and rated health were strongly correlated ($r = .80$, $p < 0.001$). The relationship between rated and morphometric masculinity was positive but did not reach significance ($r = .25$, $p = .10$).

Table 2. Correlations between rated facial features and health outcomes

			Rated Attractiveness	Rated Healthiness	Rated Masculinity	Morphometric Masculinity
	Rated Attractiveness	*r*		.796**	.492**	.384*
		p		.000	.000	.010
		N		57	56	44
	Rated Healthiness	*r*			.426**	.461**
		p			.001	.002
		N			56	44
	Rated Masculinity	*r*				.250
		p				.101
		N				44
Past Health	Cold or Flu	*r*	-.330*	-.197	-.252†	-.338*
		p	.018	.166	.077	.025
		N	51	51	50	44
	Stomach Bugs	*r*	.193	.135	.126	-.119
		p	.167	.335	.375	.437
		N	53	53	52	44
	Antibiotics	*r*	-.248†	-.239†	-.078	-.068
		p	.076	.088	.586	.656
		N	52	52	51	44
Future Health	Colds	*r*	-.208	-.122	-.167	-.162
		p	.160	.415	.262	.294
		N	47	47	47	44
	Flu	*r*	.171	.142	.095	.318*
		p	.249	.341	.525	.036
		N	47	47	47	44
	Stomach Bugs	*r*	.019	.094	-.207	.221
		p	.899	.529	.164	.149
		N	47	47	47	44
	Antibiotics	*r*	-.350*	-.361*	-.177	-.026
		p	.016	.013	.235	.868
		N	47	47	47	44

Notes: *$p < 0.05$; ** $p < 0.01$; † $p < 0.1$

Correlations between facial features and actual past health showed relationships between attractiveness and illness such that more attractive individuals reported fewer instances of cold or flu in the last three years (r = -.28, p < .05) and a statistically non-significant tendency toward less use of antibiotics (r = -.25, p = .08). Healthier looking individuals also reported a statistically non-significant tendency toward fewer instances of antibiotic use in the last three years (r = -.24, p =.09). More masculine men reported fewer bouts of colds or flu (rated: r = -.25, p =.08; morphometric: r = -.38, p < .05) in the last three years. There were no other significant correlations (see Table 2 for details).

Correlations between facial features and future health scores showed that individuals rated as more attractive or more healthy reported less use of antibiotics (attractiveness: r = -.35, p < .05; health: r = -.36, p < .05). There was a positive correlation between morphometric masculinity and reported number of days of flu (r = .32, p < .05). There were no other significant correlations (see Table 2 for details).

Rated mood of faces did not correlate with any health or facial measure (all r < .19, all p > .1), and controlling for rated mood or participant age did not change the pattern of results.

Discussion

The aim of this study was to investigate whether masculine facial appearance and facial structure could predict not only past health experience and current health appearance but also future health outcomes in an environment in which individuals were likely to be exposed to novel pathogens.

With regard to masculinity, results were inconsistent across prospective, (rated) current, and retrospective measures. Men who looked more masculine or had more masculine facial proportions were rated as looking healthier and more attractive, and we replicated Thornhill and Gangestad's (2006) relationship between anatomical masculinity and reported past health insofar as more masculine men reported fewer colds or flu bouts (but not antibiotics) in the last 3 years. Regarding future health, however, a more masculine facial structure was associated with *greater,* not less, ill health in one domain (days suffering flu).

In contrast, rated facial health and attractiveness appeared to be valid modest cues to not only an individual's health history, but also their likely future good health on at least one measure. Men who looked healthier reported less use of antibiotics both prior to and during the university term, although rated health was not associated with reported rates of other illnesses.

Similarly, more attractive men looked healthier and reported fewer colds and less antibiotic use in the retrospective questionnaire, and fewer days using antibiotics during the prospective phase of the study. Given the sample sizes used in the present study (range = 44 to 57) we had more than adequate (96% to 99%) statistical power to detect associations with large (r > 0.5) effect sizes (G*power 3: see Faul, Erdfelder, Lang, and Buchner, 2007). However, power to detect medium-sized effects (r > 0.3) was more limited (range = 53% to 64%). Consequently, further research with larger samples may be needed to establish with more certainty whether, for example, rated masculinity is associated with indicators of past

and future health status. In contrast, even with a relatively small sample we were able to find a number of medium sized associations between morphometric masculinity and health measures.

Our mixed findings regarding the relationships between facial masculinity and measures of health and illness are consistent with more complex, nuanced perspectives on testosterone and immunity, as outlined in the introduction. Previously, Muehlenbein and Bribiescas (2005) have argued strongly against treating immunocompetence as a unitary trait and it is notable that previous studies investigating relationships between testosterone and multiple immune parameters have tended to find a mixture of null and significant results. Thus, just as susceptibility to one form of illness may be unrelated to susceptibility to another across individuals, so too physical characteristics, such as masculinity, may be indicative of better resistance to some pathogens but not to others, and perhaps greater susceptibility to still more.

Mixed and inconsistent findings with respect to associations between facial appearance and measures of health and illness may also arise because relationships between sexually selected signals and viability may be more complex than is commonly assumed by evolutionary psychologists applying "handicap" principles to human mate choice. Condition-dependent trait expression and life-history trade-offs mean that even where male traits are considered to signal "good genes," both positive and negative associations between signal quality and disease burden and/or survival are theoretically possible (Getty, 2006; Kokko, Brooks, McNamara, and Houston, 2002; Kokko, Brooks, Jennions, and Morley, 2003), and indeed positive associations between signal quality and pathogen load are found in many comparative studies (Getty, 2002).

A potential further, speculative, explanation for our findings is that the relationships between masculinity and health are variable across age groups. As noted in previous papers, masculinity is a cue to early developmental factors, and its association with health may therefore decrease, or even reverse, with age (Scott et al., 2010; Stephen et al., 2012). In our data, the relationship between health measures and masculinity was positive using past health measures, but negative using future health measures, suggesting a possible change of direction in the relationship between adolescence and adulthood. The limited time period and age range of our sample make it difficult to draw strong conclusions from these data, but our findings are broadly consistent with an account of testosterone in which high T levels are associated with earlier mating success but also earlier senescence (Muehlenbein and Bribiescas, 2005; see Scott et al., 2013 for review). Future studies could address this issue by examining links between masculinity/testosterone and disease across a wider age range, and we feel that this could be a productive avenue for further research.

More generally, our current data exemplify the problem posed by Adamo and Spiteri (2009); to paraphrase, "he may not have a cold, but will he survive the plague?" Overall mortality rates in the face of disease are likely to be determined by a wide number of factors, of which each facet of immune function is just one, and which also include other elements of broader condition such as digestive and metabolic efficiency (i.e., capacity to make good use of food energy) and cardiovascular fitness, to name just two. What is perhaps required, therefore, is not only a broadening of our conception of "good genes" in general and "immunocompetence" in particular, but also empirical consideration of

whether masculinity (or other traits of interest) are able to predict more extreme and selectively powerful health outcomes such as premature mortality or offspring mortality. Indeed, associations between paternal features and offspring mortality represent the critical test of the ICHH in regards to facial masculinity. Such studies cannot easily be carried out in western samples where, thankfully, modern medicine mitigates the morbidity associated with individual susceptibility to infectious diseases, and this is a significant limitation on both our own and previous studies of masculinity and health.

Aside from the nature of the population studied, the current research has some other significant limitations. The apparently contradictory associations between morphometric masculinity and decreased incidence of colds and flus prior to the start of the study but increased incidence of flu during the prospective phase suggest that it would have been desirable to separate these two illnesses in the past health questions. Flu is generally a considerably more severe illness than a cold (for instance, only flu carries a real mortality risk for groups such as the elderly and pregnant), despite both being respiratory infections, and indeed the correlation coefficient for future colds suggests that if anything, more masculine men suffer less with colds in the future, in contrast to their apparently greater susceptibility to flu.

Additionally, given the relatively small sample size, statistical power is only modest. Furthermore, although we sought to correct for one potential source of variance amongst the pictures (namely, expression), these images were used opportunistically, and more standardized images would be desirable where an opportunity arises to recruit a large number of men within the first 2 days of the term. Future research could attempt to reduce additional sources of variance, for example, by applying color calibration techniques (Stephen et al., 2012). The fact that significant (or borderline significant) results were found despite these potential sources of noise, however, suggests that our paradigm could be usefully replicated with such a larger and more standardized sample.

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