Adaptive Human Behavior and Physiology (2020) 6:143–169
https://doi.org/10.1007/s40750-020-00128-2

ORIGINAL ARTICLE

Multivariate Intra-Sexual Selection on Men's Perceptions of Male Facial Morphology

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Received: 23 December 2019 / Revised: 13 February 2020 / Accepted: 17 February 2020 /
Published online: 17 March 2020

Abstract

Objectives Intra-sexual selection has shaped the evolution of sexually dimorphic traits in males of many primates, including humans. In men, sexual dimorphism in craniofacial shape (i.e. facial masculinity) and facial hair have both been shown to communicate aspects of social and physical dominance intra-sexually. However, less attention has been given to how variation in physical and social dominance among receivers impacts on perceptions of facial masculinity and beards as intra-sexual signals of formidability.

Methods In the current study, male participants ($N = 951$) rated male faces varying in masculinity and beardedness when judging masculinity, dominance and aggressiveness. These participants also responded to scales measuring their psychological dominance, sexual jealousy, status seeking, and masculine morphology (facial masculinity, facial hair, and height).

Results Beardedness exerted strong effects over clean-shaven faces on ratings of masculinity, dominance, and aggressiveness. Trait ratings of masculinity, dominance, and aggressiveness rose linearly with increasing craniofacial masculinity. The significant facial masculinity × facial hair interaction suggests that beardedness caused strong effects on all trait ratings over clean-shaven faces at every level of facial masculinity. Participants with full beards also reported higher scores on dominance and assertiveness scales. Participants high in dominance and assertiveness also gave higher ratings for dominance, but not masculinity or aggressiveness, to bearded over clean-shaven faces. Participants low in intra-sexual jealousy rated clean-shaven and/or feminised faces as less dominant, less masculine, and less aggressive.

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Conclusions These findings demonstrate that facial hair enhances perceptions of masculinity, dominance, and aggressiveness above ratings of facial masculinity, potentially by augmenting masculine craniofacial features. Individual differences in intra-sexual dominance showed associations with judgments of facial hair but not facial masculinity. Our study demonstrates that when two sexually dimorphic androgen dependent facial traits are judged in concert, ornamental rather than structural masculine facial features underpin men's intra-sexual judgments of formidability.

Keywords Sexual selection · Intra-sexual competition · Facial hair · Facial masculinity

Introduction

Intra-sexual selection has shaped the evolution of weapons, dominance displays, and signals of social status employed in male-male competition in many species (Emlen 2008; Rico-Guevara and Hurme 2019), including humans (Archer 2009; Puts 2010; Puts et al. 2015). Androgens shape sex differences in bodily, facial, and vocal secondary sexual characters (Randall 2008). Compared to women, men have a more v-shaped physique (Dixson et al. 2014), are taller (Stulp and Barrett 2016), have greater upper body musculature (Lassek and Gaulin 2009) and deeper voices (Puts 2010). One of the most researched sexually dimorphic androgen dependent characters is facial masculinity, which refers to a suite of features including jaw size, the midface, and brow ridge that are more pronounced in men compared to women (Whitehouse et al. 2015). Androgens exert organizational effects on facial masculinity in utero (Whitehouse et al. 2015), during pubertal surges of androgens (Marečková et al. 2011), and early adulthood (Roosenboom et al. 2018). Although facial masculinity was suggested to be associated with men's circulating androgens (Penton-Voak and Chen 2004), recent studies have not reproduced this association (Kordsmeyer et al. 2019). Similarly, some studies reported men's facial masculinity was associated with greater long-term health (Rhodes et al. 2003; Thornhill and Gangestad 2006) and more rapid immune response (Rantala et al. 2012), while others have not (Boothroyd et al. 2013; Zaidi et al. 2019). Associations between facial masculinity and immune response may be mediated by adiposity (Rantala et al. 2013), whereby a combination of facial masculinity and facial muscularity better reflect male immune response than facial masculinity alone (Phalane et al. 2017). Thus, facial masculinity may provide some information regarding health that influences mate choices among women, while associations between facial sexual dimorphisms and genetic immunity require further exploration.

Although debate surrounds whether men's facial masculinity communicates genetic quality indirectly, evidence that it provides an index of male social dominance and formidability is more consistent (Scott et al. 2013; Puts 2010). Androgens influence suites of coordinated characters, and male facial masculinity is positively associated with body size, height, and physical strength (Butovskaya et al. 2018; Fink et al. 2007; Holzleitner and Perrett 2016; Windhager et al. 2011). Facial masculinity is also positively associated with men's behavioural dominance, assertiveness, and aggressiveness (Puts 2010; Scott et al. 2013; Geniole et al. 2015; Sell et al. 2012). While mothers and their offspring may benefit directly via resources and protection from partners displaying well-developed masculine morphology (Scott et al. 2013; Puts

2010), women's preferences for male facial masculinity varies across cultures (Borras-Guevara et al. 2017; Dixson et al. 2017b; Scott et al. 2014; Marcinkowska et al. 2019). Yet men with more masculine faces, bodies, and voices have higher mating success than their less masculine peers (Hill et al. 2013; Kordsmeyer et al. 2018). Some evidence supports women's preferences for facial masculinity are stronger under social and economic conditions characterised by high male-male competition (Brooks et al. 2011), when an intra-sexually competitive partner may directly benefit mothers and their offspring.

Like facial masculinity, sex differences in facial hair develop due to androgens during early adolescence and are fully developed by young adulthood (Randall 2008). Compared to clean-shaven male faces, bearded faces are judged as being older, more masculine, socially dominant (Addison 1989; Muscarella and Cunningham 1996; Neave and Shields 2008; Saxton et al. 2016; Sherlock et al. 2017), and aggressive (Geniole and McCormick 2015; Muscarella and Cunningham 1996; Neave and Shields 2008). Facial hair may augment judgments of masculinity, dominance, and threat by exaggerating masculine craniofacial traits, including facial length and jaw prominence (Dixson et al. 2017c; Sherlock et al. 2017). Beards enhance explicit aggressiveness ratings, as well as speed and accuracy in recognition of angry facial expressions over clean-shaven faces (Craig et al. 2019; Dixson and Vasey 2012). Facial hair unambiguously communicates age, sexual maturity, and masculinity (Dixson et al. 2017c; Neave and Shields 2008), which may explain why women rate men with beards as most attractive when judging long-term relationships (Neave and Shields 2008; Dixson et al. 2016) and fathering abilities (Clarkson et al. 2020; Dixson and Brooks 2013; Dixson et al. 2019b; Stower et al. 2019). Women's stated preferences for men's facial hair are reflected in mate choices (Dixson et al. 2013; Štěrbová et al. 2019; Valentova et al. 2017) and are strongest under socio-economic conditions of high male intra-sexual competition (Barber 2001; Dixson et al. 2017c, 2019a, b).

If intra-sexual selection has shaped male cognition to assess physical formidability and social dominance among their contemporaries, men should accurately assess physical strength and social status from facial, bodily, and vocal characteristics (Puts 2010; Sell et al. 2012). Assessing physical strength from masculine facial structures and expansive body postures occurs as early as age 3 (Terrizzi et al. 2019). During adolescence, positive associations between male physical strength, physical aggression, and nonphysical aggression are strongest in early and mid-adolescence, with aggressiveness becoming less physically and more socially orientated among older adolescents of 17–18 years (Isen et al. 2015; Muñoz-Reyes et al. 2012). By late adolescence, males accurately assess physical strength in faces and bodies (Gallup et al. 2010). In adulthood, physical strength is accurately judged from gait among men from Chile, Germany, and Russia (Fink et al. 2017), but possibly not among the Maasai of Tanzania (Fink et al. 2019; Durkee 2019). People also accurately assess physical strength from facial shape, bodily morphology (Fink et al. 2007; Sell et al. 2009; Windhager et al. 2011), and voices (Raine et al. 2018; Sell et al. 2010). Men from the USA accurately assess fighting ability from male faces and bodies of US college students, Andean pastoralists, and Bolivian horticulturalists (Sell et al. 2009). Among professional mixed martial arts fighters, facial masculinity is positively associated with victories in fights and ratings of aggressiveness (Třebický et al. 2013, 2015; Zilioli et al. 2015). In non-physical intra-sexual contexts, physical formidability may translate into greater

bargaining power, higher social rank, and social status (Lukaszewski et al. 2016; von Rueden and Jaeggi 2016), which may maintain social group cohesion (Lukaszewski et al. 2016). Finally, men's mate value is positively associated with social status in industrialized (Hill et al. 2013; Kordsmeyer et al. 2018) and non-industrialized (von Rueden and Jaeggi 2016) societies.

In a similar vein to judgments of facial masculinity, children of 2–5 years of age associated beardedness with judgments of men's age, masculinity, and dominance, but not attractiveness (Nelson et al. 2019). The onset of facial hair is an important milestone in pubertal development and adolescent boys with facial hair report feeling more physically attractive than boys without facial hair (Tobin-Richards et al. 1983). Adolescent boys who participated in competitive sports developed thicker facial hair than age-matched boys who did not compete in sports (Singal et al. 2006). During puberty, judgments of masculinity, dominance, and attractiveness become more adult-like (Nelson et al. 2019) and adults consistently judge beards higher for age, masculinity, social status, dominance, and aggressiveness compared to clean-shaven faces (for review see Dixson et al. 2018a). However, unlike craniofacial masculinity there is no evidence that beards are associated with men's fighting performance (Dixson et al. 2018a). Individual differences in beardedness are primarily attributable to genetic factors (Adhikari et al. 2016) and facial hairs are expressed via the conversion of testosterone to dihydrotestosterone within the dermal papillae of hair follicles rather than total testosterone that underpins other masculine secondary sexual traits (Randall 2008). These differences have implications for how beards may function as a socio-sexual signal (Dixson and Rantala 2016; Dixson et al. 2016). Thus, facial hair enhances dominance and aggressiveness in men by exaggerating the size of masculine structural features, including the size of jaw and facial length (Dixson et al. 2017c; Sherlock et al. 2017). Less masculine male faces are judged as significantly more masculine and dominant when bearded than masculine clean-shaven faces (Dixson et al. 2017c; Sherlock et al. 2017). Beards enhance aggressiveness ratings as well as the speed and accuracy of recognition of angry facial expressions over clean-shaven faces (Dixson and Vasey 2012; Craig et al. 2019). Rather than communicating physical formidability, beards may function as a badge of status advertising men's age, masculinity, and social aspects of dominance (Dixson et al. 2018a).

Agonistic displays that lead to fights provide an opportunity for individuals to assess the formidability and fighting ability of opponents relative to their own (Pinto et al. 2019). Among US and Fijian men, physical strength was negatively associated with judgments of height, body size, and muscularity in a hypothetical rival (Fessler et al. 2014). Taller men are less sensitive to facial masculinity and lower vocal pitch when assessing male dominance than shorter men (Watkins et al. 2010a). Men reporting higher social dominance were also less sensitive to facial masculinity when judging male dominance than less socially dominant men (Watkins et al. 2010b). Facially masculine men report higher mating success (Hill et al. 2013; Kordsmeyer et al. 2018; Peters et al. 2008; Rhodes et al. 2005), less restricted sociosexualities (Boothroyd et al. 2008, 2011), stronger preferences for short-term relationships (Rhodes et al. 2005), and more mate poaching (Arnocky et al. 2018; Polo et al. 2019) than less masculine men. As a result, men concerned with guarding their mates may be sensitive to physical cues of masculinity in potential rivals. Indeed, men's sexual jealousy when assessing socially dominant, physically attractive, and high status

males is negatively associated with their height (Buunk et al. 2008) and masculine men are more jealous of facially and vocally masculine men than less masculine men (O'Connor and Feinberg 2012). Thus, men's responses to intra-sexually selected traits in male conspecifics may vary due to their own degree of social dominance, status seeking, and formidability.

The current study tests a series of hypotheses regarding how individual differences in men's social dominance, status seeking, intra-sexual jealousy, and masculine morphology are associated with judgments of male facial masculinity and beardedness. We employed stimuli varying in five levels of masculinity (60% and 30% feminised, unmanipulated, and 30% and 60% masculinised) and two levels of facial hair (clean-shaven and full beards), which male participants rated for masculinity, social dominance, and physical aggressiveness. After completing their ratings, participants responded to questionnaires quantifying their drive for success and achievement, social status and dominance, intra-sexual jealousy, and morphology (height, facial hair, and facial masculinity). Previous research has shown that ratings of male masculinity, dominance, and aggressiveness are enhanced by masculine facial features and beards (Dixson et al. 2017c; Sherlock et al. 2017). Thus, men high in self-reported dominance and assertiveness may assign lower ratings of dominance and aggressiveness to facial masculinity (Hypothesis 1) and beardedness (Hypothesis 2). Rather than communicating physical strength, beardedness may reflect age, masculinity, and social aspects of dominance that translate into higher social status (Carter and Astrom 2004). We hypothesised that men high in status seeking, as measured using the Success and Dedication scale, would ascribe lower ratings to facial masculinity (Hypothesis 3) and beardedness (Hypothesis 4). Facially masculine men report more open sociosexualities (Boothroyd et al. 2008, 2011), pursue more short-term relationships (Rhodes et al. 2005), are more likely to poach mates (Rhodes et al. 2013), and sexually dimorphic masculine traits are judged as more intra-sexually threatening in mating contexts (Buunk et al. 2008; O'Connor and Feinberg 2012). In contrast, beardedness has been associated with traditional views of masculine gender roles in some populations (Oldmeadow and Dixson 2016). Therefore, men high in intra-sexually jealousy may ascribe higher ratings of dominance and aggressiveness to facial masculinity (Hypothesis 5), but not necessarily to beardedness (Hypothesis 6). Past research has shown that taller men were less sensitive to masculine characteristics in hypothetical rivals (Watkins et al. 2010a, b). We hypothesised that men's judgments of facial masculinity and beardedness when rating masculinity, dominance, and aggressiveness may be negatively associated with their height, facial masculinity, and beardedness (Hypothesis 7).

Methods

Facial Hair Stimuli

Thirty-seven men (mean age ± SD = 27.86 ± 5.75 years) of European ethnicity were photographed posing neutral facial expressions in front and profile view using a Canon digital camera (8.0 megapixels resolution), 150 cm from the participant under controlled lighting (Dixson et al. 2017c; Janif et al. 2014). Males were photographed when clean-shaven and with 4–8 weeks of natural beard growth (Fig. 1).

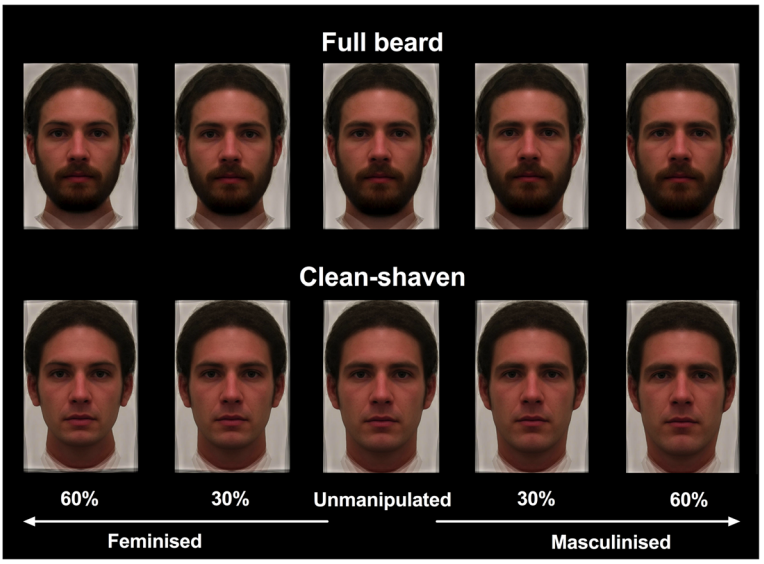

Fig. 1 An example of the stimuli that were used in the current study. Faces are composites of the same five men when bearded (top row) and clean-shaven (bottom row). The composites were manipulated to appear 60% and 30% feminised, unmanipulated, and 30% and 60% masculinised

Facial Masculinity Manipulation

A composite male and female face were created from a separate face set of 40 male and 40 European females based on the same 189 landmarks. To manipulate facial masculinity, the linear shape differences between the average male and female faces were applied to the clean-shaven and bearded composites at 60%, and 30% feminised, unmanipulated and 30% and 60% masculinised while keeping colour and textural information of the original face constant (Fig. 1). Participants also rated the unmanipulated composite. This procedure manipulated the images on the dimension representing sexual dimorphism while retaining the identity of the original composite is a standard approach for manipulating sexual dimorphism in faces (Benson and Perrett 1993; Perrett et al. 1998) and has been used in several previous studies on perceptions of men's facial hair (Clarkson et al. 2020; Dixson et al. 2018b, c; McIntosh et al. 2017).

Procedure

The study was constructed on Qualtrics and administered on-line. Participants first read an information sheet and then provided consent to partake in the study. Participants were shown three male composite faces that varied on five levels of masculinity (60% and 30% feminised, unmanipulated, and 30% and 60% masculinised) that were either bearded or clean-shaven. Faces were presented in a random sequence to participants. In total, participants saw 50 (25 bearded, 25 clean-shaven) male faces. Participants were asked to rate how masculine, socially dominant, and physically aggressive they thought the faces looked using scales where 0 = extremely low to 100 = extremely high.

Demographics

Participants reported their sexuality using the seven-point Kinsey sexual orientation scale where 0 = exclusively heterosexual and 6 = exclusively homosexual. They then provided their age (in years), biological sex (male, female, other), ethnicity (open question) and their relationship status (single or currently in a relationship).

Success Dedication Scale

To quantify male status seeking behaviour, participants completed the Success Dedication Subscale of the Masculine Behaviour Scale (MBS; Snell 1989). The success dedication subscale of the MBS is designed to measure concern with success attainment. This subscale was a 5-point Likert scale for all items ranging from +2 (agree) to −2 (disagree) with a midpoint of 0 (agree nor disagree). All scale items were positively scored (e.g., "I do whatever I have to in order to work toward job success"). Thus, higher scores reflect a greater emphasis on success accomplishments via status acquisition. Internal reliability in the current study for the total score was high ($\alpha = .93$).

Dominance and Assertiveness Scale

The IPIP/CPI scales for dominance and assertiveness was used to assess participants' individual differences (Goldberg et al. 2006). Responses were recorded using a 5-point scale where 1 = disagree to 5 = agree. An example item from the 11-item dominance scale is: "I am quick to correct others". An example item from the 10-item Assertiveness scale is: "I know how to convince others". This scale has been used in previous studies of male perceptions of facial masculinity (Watkins et al. 2010b). In the current study, internal reliability was high for the dominance subscale ($\alpha = .88$) and the assertiveness subscale ($\alpha = .83$). The scales were moderately correlated ($r\ (19) = .47$, $p < .001$) and the internal consistency for the combined 21-item scale was high ($\alpha = .89$).

Intra-Sexual Jealousy Scale

Participants also completed the Intra-sexual Jealousy Scale (Buunk and Fisher 2009), a 12-item scale in which participants rate each statement using a 7-point scale ranging from 1 (not at all applicable) to 7 (completely applicable). This scale measures the degree of competitiveness present in confrontation with same-sex individuals especially in contexts that involve the opposite sex. Examples of the scale items include, "I always want to beat other men" and "I wouldn't hire a very attractive man as a colleague." Internal consistency in participant's responses to the scale were high ($\alpha = .94$).

Morphological Masculinity Measures

Participants were asked to report their height (in inches and feet) and weight (in pounds). Participants also reported how masculine they thought their face was using a scale where 1 = Much less masculine than average and 7 = Much more masculine

than average (Debruine et al. 2006). Participants stated the level of facial hair that was the most appropriate of ten possible facial hair styles (0 = clean-shaven, 1 = stubble, 2 = moustache, 3 = goatee (without moustache), 4 = Goatee (with moustache), 5 = Sideburns, 6 = Sideburns and moustache, 7 = moustache and soul patch, 8 = Full beard (trimmed), 9 = Full beard (bushy); Fig. 2). For our analyses, we created three categories; 1) the 'clean-shaven' category included the percentage of men with no facial hair of any kind (image 0), 2) the 'beard' category included the percentage of men with trimmed and bushy full beards (8&9), and 3) the 'non-beard facial hair' category included the percentage of men in all classes of facial hair except clean-shaven and full beards (1–7).

Participants

Participants were recruited through the web-based marketplace research program Amazon Mechanical Turk (MTurk), which provides researchers with large non-student samples (Mason and Suri 2012). Participants were first screened for gender so that only males remained in the study. After removing those who did not satisfy the selection criteria, a total of 951 male participants completed the survey (Mean age = 37.47 years, *SD* = 12.09) remained. The survey took approximately 15 min to complete and participants recieved $1.00 USD for their time. Of the sample, 78% described themselves as White or Caucasian, 9% were Black or African American, 6% were Asian, 5% were Hispanic and the remaining 2% were classified as other. The majority of participants lived in the USA (98.1%). The study was approved from the University of Queensland's Behavioural and Social Sciences Ethical Review Committee and the School of Psychology's Ethics Review Panel (Ethics Approval Number: 18-PSYCH-4G-13-JMC).

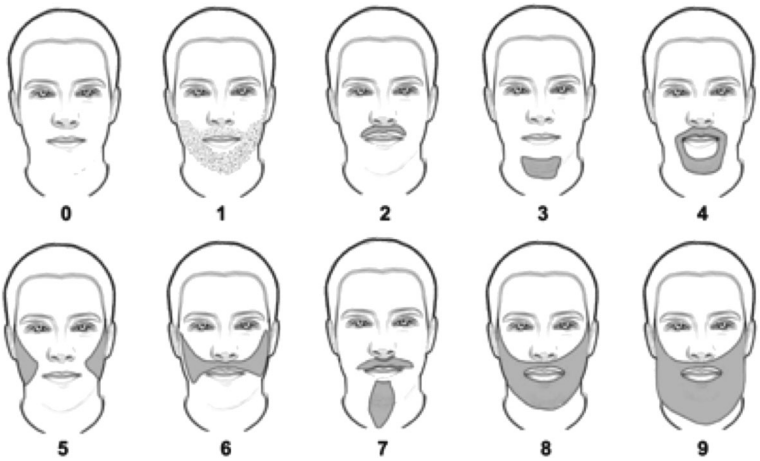

Fig. 2 The stimuli participants used to rank their own degree of facial hair. Each participant selected the stimulus image they thought best represented their own facial hair from ten possible facial hair styles: 0 = clean-shaven, 1 = stubble, 2 = moustache, 3 = goatee (without moustache), 4 = Goatee (with moustache), 5 = Sideburns, 6 = Sideburns and moustache, 7 = moustache and soul patch, 8 = Full beard (trimmed), 9 = Full beard (bushy)

Statistical Analyses

For Analysis 1, masculinity, dominance, and aggressiveness ratings were the dependent variables in repeated-measures MANOVAs where facial masculinity (very low, low, neutral, high, very high) and facial hair (bearded, clean-shaven) were entered in as within-subject factors. Effect sizes are reported as eta squared (η^2). Effect sizes for post-hoc Bonferroni corrected t-tests are reported as Cohen's d. We repeated the analyses using Bayesian repeated measures ANOVAs. Bayesian analyses were undertaken to ascertain the presence or absence of a hypothesized effect over the competing null effect. The Bayes Factor (BF_{10}) provides an estimation of the strength of support a hypothesis receives relative to another competing hypothesis. A BF_{10} of 1–3 is considered weak evidence, a BF_{10} of 3–10 is considered moderate evidence, and a BF_{10} above 10 is considered strong evidence (van Doorn et al. 2019). All analyses were conducted using JASP 3.

For Analysis 2, data were analysed using linear mixed effects modelling using the lme4 (Bates et al. 2015) and lmerTest (Kuznetsova et al. 2015) packages in R (R Core Team 2013). Three separate models were conducted with each judgement of dominance, masculinity, and aggressiveness as the outcome variables. All models had the same predictors. At the participant level, predictors included participant's score on Success and Dedication subscales of the Masculine Behavior scale, the Dominance and Assertiveness Scale, the Intra-sexual Jealousy Scale, and the morphological data. At the stimulus level, predictors included the level of facial masculinity manipulation, and whether faces were clean-shaven or bearded (coded as −.5 and .5 respectively). All continuous predictors were z-standardised at the appropriate group-level. All two-way interactions between participant-level predictors and stimulus-level predictors were also included. Random intercepts were specified for each participant and each stimulus identity. Random slopes were specified maximally following recommendations in Barr (2013) and Barr et al. (2013). Here, we report the fixed effects from each model; for full model specifications and results, including random effects, see the supplementary materials.

Results

Analysis 1: The Effect of Facial Masculinity and Beardedness on Men's Masculinity, Dominance and Aggressiveness Ratings

Masculinity Ratings

There was a significant main effect of facial hair on masculinity ratings (Table 1), which received strong support in Bayesian analyses (Table 2). This reflects that beards received higher masculinity ratings than clean-shaven faces ($t = 35.14$, $p < 0.001$, $d = 1.14$). There was also a significant main effect of facial masculinity on masculinity ratings (Table 1) that received strong support in Bayesian analyses (Table 2). Very high masculinity was judged as more masculine than all other degrees of facial masculinity (all $t \geq 12.23$, all $p \leq 0.001$, $d = 0.40$–0.85). High masculinity received higher masculinity ratings than medium, low, and very low masculinity (all $t \geq 9.31$, all $p \leq 0.001$, $d = 0.30$–0.75). Medium facial masculinity was judged as more masculine than low and very low masculinity (all $t \geq 12.71$, all $p \leq 0.001$, $d = 0.41$ and 0.65 respectively), while

Table 1 Repeated-measures ANOVA on the effects of facial hair and facial masculinity on ratings of masculinity, dominance and aggressiveness

	Facial masculinity				Facial hair			
	F	df	*p*	η_p^2	*F*	df, error	*p*	η_p^2
Masculinity	416.29	4, 3796	<.001	.305	1235.16	1, 949	<.001	.566
Dominance	297.45	4, 3796	<.001	.239	826.77	1, 949	<.001	.466
Aggressiveness	166.55	4, 3800	<.001	.149	568.75	1, 949	<.001	.374
	Facial masculinity x Facial hair							
	F	df	*p*	η_p^2				
Masculinity	47.26	4, 3796	<.001	.047				
Dominance	18.32	4, 3796	<.001	.019				
Aggressiveness	20.24	4, 3800	<.001	.021				

low masculinity was judged as more masculine than very low masculinity ($t = 11.72$, $p < 0.001$, $d = 0.38$).

There was also a significant facial hair × facial masculinity interaction (Table 1), which received strong support in Bayesian analyses (Table 2). This reflects that masculinity ratings rose linearly with both full bearded and clean-shaven stimuli (Fig. 3a). Full beards received significantly higher masculinity ratings than clean-shaven faces within each level of facial masculinity. Beards were rated more masculine than clean-shaven faces for very high masculinity ($t = 30.51$, $p < 0.001$, $d = 0.99$), high masculinity ($t = 32.32$, $p < 0.001$, $d = 1.05$), medium masculinity ($t = 33.06$, $p < 0.001$, $d = 1.07$), low masculinity ($t = 33.74$, $p < 0.001$, $d = 1.09$), and very low masculinity ($t = 34.10$, $p < 0.001$, $d = 1.11$). Further, faces with very low masculinity and full beards received higher masculinity ratings than clean-shaven faces with very high facial masculinity ($t = 18.91$, $p < 0.001$, $d = 0.61$; Fig. 3a).

Dominance Ratings

There was a significant main effect of facial hair on dominance ratings (Table 1) that received strong support in Bayesian analyses (Table 3). This reflects that beards

Table 2 Bayesian repeated-measures ANOVA on the effects of facial hair and facial masculinity on ratings of masculinity

Models	P(M)	P(M|data)	BF_M	BF_{10}	error %
Null model (incl. subject)	0.200	0.000	0.000	1.000	
Beard + Facial masc + Beard x Facial masculinity	0.200	1.000	1.229e +6	>30	1.338
Beard + Facial masculinity	0.200	3.254e -6	1.302e -5	>30	1.541
Facial Hair	0.200	8.705e − 129	3.482e − 128	>30	1.318
Facial masculinity	0.200	0.000	0.000	6.056e + 61	0.590

Bayes Factors 10 (BF_{10}) noted as >30 actually received infinite support (i.e. ∞ symbol in JASP)

Table 3 Bayesian repeated-measures ANOVA on the effects of facial hair and facial masculinity on ratings of dominance

Models	P(M)	P(M|data)	BF_M	BF_{10}	error %
Null model (incl. subject)	0.200	0.000	0.000	1.000	
Beard + Facial masc + Beard x Facial masc	0.200	0.676	8.364	>30	2.542
Beard + Facial masculinity	0.200	0.324	1.913	>30	1.484
Facial Hair	0.200	1.572e − 98	6.287e − 98	>30	2.827
Facial masculinity	0.200	0.000	0.000	5.911e + 59	0.689

Bayes Factors 10 (BF_{10}) noted as >30 actually received infinite support (i.e. ∞ symbol in JASP)

received significantly higher dominance ratings than clean-shaven faces ($t = 28.75$, $p < 0.001$, $d = 0.93$). There was also a significant main effect of facial masculinity on dominance ratings (Table 1), which received strong support in Bayesian analyses (Table 3). This reflects very high masculinity was judged as more dominant than all other degrees of facial masculinity (all $t \geq 10.66$, all $p \leq 0.001$, $d = 0.35$–0.76). High masculinity received higher dominance ratings than medium, low, and very low masculinity (all $t \geq 7.08$, all $p \leq 0.001$, $d = 0.23$–0.65). Medium facial masculinity was judged as more dominant than low and very low masculinity (all $t \geq 10.95$, all $p \leq 0.001$, $d = 0.35$–0.54), while low masculinity was judged as more dominant than very low masculinity ($t = 8.24$, $p < 0.001$, $d = 0.27$).

There was also a significant facial hair × facial masculinity interaction (Table 1), which received strong support in Bayesian analyses (Table 3). This reflects that dominance ratings rose linearly with both full bearded and clean-shaven stimuli (Fig. 3b). Full beards received significantly higher dominance ratings than clean-shaven faces within each level of masculinity. Thus, beards were rated more dominant than clean-shaven faces for very high masculinity ($t = 23.84$, $p < 0.001$, $d = 0.77$), high masculinity ($t = 26.31$, $p < 0.001$, $d = 0.85$), medium masculinity ($t = 26.90$, $p < 0.001$, $d = 0.87$), low masculinity ($t = 27.28$, $p < 0.001$, $d = 0.89$), and very low masculinity ($t = 27.27$, $p < 0.001$, $d = 0.88$). The additive effect of beards on dominance ratings is also reflected in the significantly higher ratings for faces with very low masculinity and full beards over very high masculinity clean-shaven faces ($t = 13.74$, $p < 0.001$, $d = 0.45$; Fig. 3b).

Aggressiveness Ratings

There was a significant main effect of facial hair on aggressiveness ratings (Table 1) and strong support in Bayesian analyses (Table 4). Beards received significantly higher aggressiveness ratings than clean-shaven faces ($t = 23.84$, $p < 0.001$, $d = 0.77$). There was also a significant main effect of facial masculinity on aggressiveness ratings (Table 1), which received strong support in Bayesian analyses (Table 4). This reflects very high masculinity was judged as more aggressive than all other degrees of facial masculinity (all $t \geq 8.87$, all $p \leq 0.001$, $d = 0.29$–0.55). High masculinity received higher masculinity than medium, low, and very low masculinity (all $t \geq 6.62$, all $p \leq 0.001$, $d = 0.22$–0.42). Medium facial masculinity was judged as more aggressive than low and very low masculinity (all $t \geq 8.67$, all $p \leq 0.001$, $d = 0.28$–0.30), while low masculinity was not judged as more aggressive than very low masculinity ($t = 1.66$, $p = 0.976$, $d = 0.05$).

Table 4 Bayesian repeated-measures ANOVA on the effects of facial hair and facial masculinity on ratings of aggressiveness

Models	P(M)	P(M|data)	BF_M	BF_{10}	error %
Null model (incl. subject)	0.200	0.000	0.000	1.000	
Beard + Facial masc + Beard x Facial masc	0.200	0.970	127.318	>30	6.265
Beard + Facial masculinity	0.200	0.030	0.126	>30	1.378
Facial Hair	0.200	1.381e − 58	5.524e − 58	>30	1.000
Facial masculinity	0.200	0.000	0.000	1.905e + 39	0.610

Bayes Factors 10 (BF_{10}) noted as >30 actually received infinite support (i.e. ∞ symbol in JASP)

There was also a significant facial hair × facial masculinity interaction (Table 1), which received strong support in Bayesian analyses (Table 4). This reflects that masculinity ratings rose linearly within both full bearded and clean-shaven stimuli (Fig. 3c). However, full beards received significantly higher masculinity ratings than clean-shaven faces within each level of masculinity. Thus, beards were rated more masculine than clean-shaven faces for very high masculinity ($t = 30.51$, $p < 0.001$, $d = 0.99$), high masculinity ($t = 32.32$, $p < 0.001$, $d = 1.05$), medium masculinity ($t = 33.06$, $p < 0.001$, $d = 1.07$), low masculinity ($t = 33.74$, $p < 0.001$, $d = 1.09$), and very low masculinity ($t = 34.10$, $p < 0.001$, $d = 1.11$). Faces with very low masculinity and beards were rated higher for aggressiveness than clean-shaven faces with very high facial masculinity ($t = 11.84$, $p < 0.001$, $d = 0.38$; Fig. 3c).

Analysis 2: Predictors of men's masculinity, dominance, and aggressiveness ratings for facial masculinity and beardedness

We first explored correlations among the psychological and morphological predictors of male dominance. Self-rated facial masculinity was positively correlated with success and determination ($r = 0.179$, $p < .001$), dominance and assertiveness ($r = .262$, $p < .001$), and intra-sexual jealousy ($r = 0.164$, $p < .001$), but not height ($r = -.02$, $p = .53$). There was a significant negative relationship between men's height and their self-reported intra-sexual jealousy, ($r = -.279$, $p < .001$), but associations were not statistically significant between height and success and determination ($r = -.045$, $p = .416$) or dominance and assertiveness ($r = -.035$, $p = .280$). Men's self-reported facial hair was positively associated with self-reported dominance and assertiveness ($r = .119$, $p < .001$), self-perceived facial masculinity ($r = .158$, $p < .001$), and with intra-sexual jealousy ($r = .065$, $p = .046$), but not with height ($r = -.031$, $p = .332$). Self-reported success and determination scores were positively associated with dominance and assertiveness ($r = .507$, $p < .001$) and intra-sexual jealousy ($r = .15$, $p < .001$). Self-reported dominance and assertiveness was also positively associated with their self-reported intra-sexual jealousy ($r = .276$, $p < .001$).

The self-reported psychological and morphological data were then analysed using linear mixed effects modelling to test for association with facial masculinity and beardedness. Separate models were run for masculinity, dominance, and aggressiveness ratings and are presented in Table 5. Across all models, we found significant main effects for Dominance and Assertiveness and intra-sexual jealousy, such that

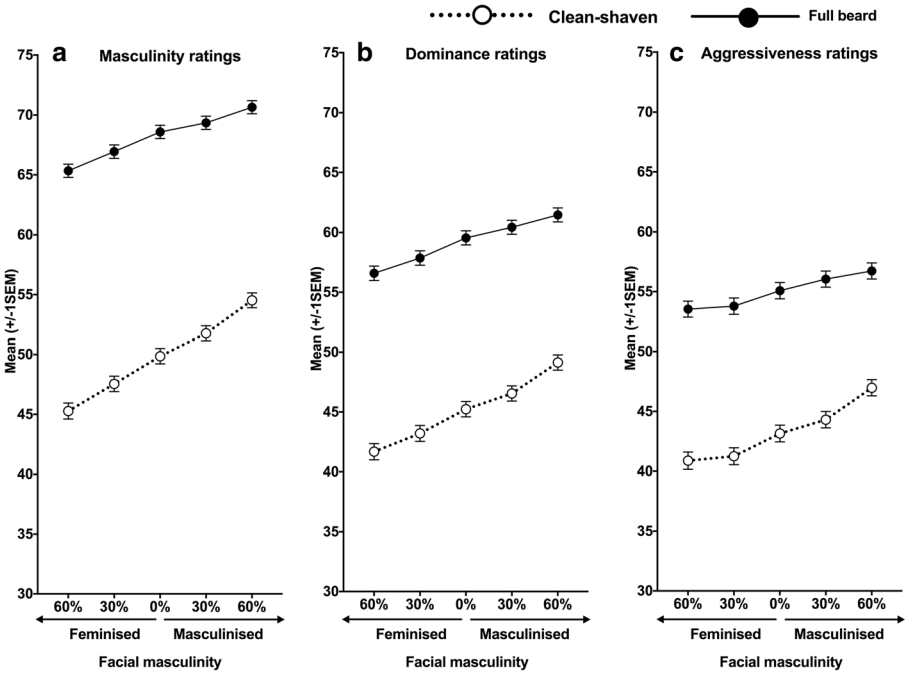

Fig. 3 The effect of men's facial hair (full beard = black circle with solid black line and clean-shaven = white circle with dotted line) and facial masculinity (60% and 30% feminised, 0% (i.e. unmanipulated), and 30% and 60% masculinised) on men's judgments of o male masculinity (**a**), dominance (**b**), and aggressiveness (**c**). Data are the mean ratings (± 1 SEM). Note the rating scale on Y axis ranges from 0 to 100

participants low in Dominance and Assertiveness, and high in intra-sexual jealousy rated faces higher overall in dominance, masculinity, and aggressiveness. We also found a significant, positive main effect of Success and Dedication on dominance ratings, but this was not significant for masculinity or aggressiveness ratings. There was a significant main effect of self-rated masculinity in all three models, such that men who rated themselves as more facially masculine gave higher dominance, masculinity, and aggressiveness ratings overall. Taller participants also gave lower aggressiveness ratings, but this relationship was non-significant for dominance and masculinity ratings. As with the ANOVAs, there were significant main effects for facial masculinity, such that masculinised faces were rated as more dominant, masculine, and aggressive. We also found significant main effects of facial hair, such that bearded faces were rated as more dominant, masculine, and aggressive compared to clean-shaven faces (Table 5).

We hypothesised that men reporting higher Dominance and Assertiveness scores would assign lower ratings of dominance and aggressiveness to facial masculinity (Hypothesis1) and beardedness (Hypothesis 2) than participants reporting lower Dominance and Assertiveness. We found no significant negative associations between judgments of facial masculinity and self-reported Dominance and Assertiveness scores. While we report a significant interaction between stimulus beardedness and participant Dominance and Assertiveness in all three models, such that participants high in Dominance and Assertiveness rated bearded faces as more masculine (Fig. 4), dominant (Fig. 5), and aggressive (Fig. 6). These results suggest that men are more sensitive

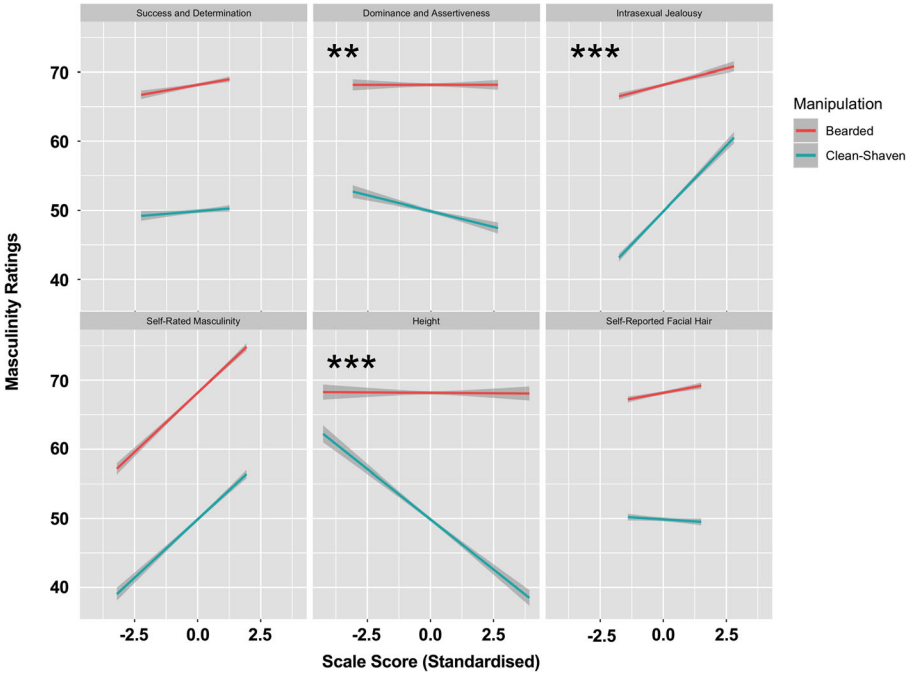

Fig. 4 The associations between psychological measures (top row: self-reported success and dedication, dominance and assertiveness) and morphological characters (bottom row: facial masculinity, height and facial hair) and men's masculinity ratings of male faces varying in facial hair (± 95% CI) when judging bearded (red line) and clean-shaven faces (blue line). ** < .01; *** < .001

to beards as a badge of dominance and status if they themselves report high social dominance.

We hypothesised that men high in status seeking, as measured using the Success and Dedication scale, would ascribe lower ratings to facial masculinity (Hypothesis 3) and beardedness (Hypothesis 4). However, we found no significant associations between self-reported status seeking and judgments of facial hair or facial masculinity. Across all three models we found significant interactions between both stimulus beardedness and masculinity, and participant intra-sexual jealousy (Table 5). We had hypothesised that men high in intra-sexually jealousy should ascribe higher ratings of social dominance and aggressiveness to facial masculinity (Hypothesis 5), but not beardedness (Hypothesis 6). However, we found that participants reporting lower in intra-sexual jealousy rated clean-shaven and/or feminised faces as less dominant, less masculine, and less aggressive than participants reporting higher intra-sexual jealousy.

Hypothesis 7 was that men high in masculine secondary sexual trait development would be less sensitive to facial masculinity and beardedness when judging masculinity, dominance, and aggressiveness. For ratings of facial hair, there was a significant interaction between height and trait ratings (Table 5). However, rather than reflecting lower ratings ascribed to full beards among taller male participants, ratings of clean-shaven faces were significantly lower among taller than shorter participants when judging masculinity (Fig. 7), dominance (Fig. 8), and aggressiveness (Fig. 9). For ratings of facial masculinity there was also a significant interaction involving

Table 5 Fixed effect estimates for models predicting dominance, masculinity, and aggressiveness ratings

	Dominance			Masculinity			Aggressiveness		
	Estimate (Std Error)	t-value (approx df)	*p* value	Estimate (Std Error)	t-value (approx df.)	*p* value	Estimate (Std Error)	t-value (approx df.)	*p* value
Intercept	52.21 (1.15)	45.21 (6.07)	<.001***	59.04 (.80)	73.46 (10.24)	<.001***	49.21 (1.57)	31.36 (5.11)	<.001***
Success and dedication	1.44 (.59)	2.45 (900.14)	.014*	.66 (.58)	1.14 (916.51)	0.256	.87 (.63)	1.39 (900.07)	0.164
Dominance and assertiveness	−2.31 (.62)	−3.73 (846.40)	<.001***	−2.31 (.60)	−3.82 (943.00)	<.001***	−2.34 (.65)	−3.57 (896.37)	<.001***
Intrasexual competition	4.98 (.62)	8.08 (82.83)	<.001***	2.10 (.56)	3.77 (451.77)	<.001***	8.27 (.65)	12.64 (82.02)	<.001***
Self-rated masculinity	4.00 (.54)	7.36 (559.33)	<.001***	3.59 (.53)	6.83 (823.86)	<.001***	3.23 (.61)	5.26 (126.49)	<.001***
Height	−.80 (.54)	−1.48 (584.61)	0.139	−.85 (.54)	−1.59 (357.45)	0.114	−1.63 (.59)	−2.77 (257.84)	.006**
Self-reported beardedness	−.31 (.51)	−.60 (943.00)	0.548	−.25 (.50)	−.50 (917.75)	0.618	−.36 (.55)	−.66 (876.39)	0.508
Facial masculinity	2.44 (.10)	24.49 (943.00)	<.001***	2.86 (.10)	28.00 (943.00)	<.001***	1.92 (.10)	18.62 (943.00)	<.001***
* Success and dedication	.06 (.12)	.55 (943.00)	0.58	.07 (.12)	.55 (943.00)	0.584	.18 (.12)	1.46 (943.00)	0.144
* Dominance and assertiveness	−.06 (.12)	−.46 (943.00)	0.646	−.13 (.12)	−1.01 (943.00)	0.313	.04 (.13)	.34 (943.00)	0.734
* Intrasexual Competition	−.49 (.11)	−4.46 (943.00)	<.001***	−.55 (.11)	−4.92 (943.00)	<.001***	−.31 (.11)	−2.78 (943.00)	.006**
* Self-rated masculinity	.00 (.11)	.02 (943.00)	0.982	−.09 (.11)	−.87 (943.00)	0.387	−.01 (.11)	−.05 (943.00)	0.957
* Height	.28 (.10)	2.71 (943.00)	.007**	.34 (.11)	3.18 (943.00)	.002**	.32 (.11)	3.02 (943.00)	.003**
* Self-reported beardedness	−.09 (.10)	−.89 (943.00)	0.371	−.11 (.10)	−1.07 (943.00)	0.286	−.08 (.10)	−.73 (943.00)	0.467
Beardedness	13.92 (.48)	29.29 (943.00)	<.001***	18.28 (.51)	36.11 (943.00)	<.001***	11.62 (.48)	24.03 (943.00)	<.001***
* Success and dedication	.43 (.55)	.77 (943.00)	0.442	.00 (.59)	.00 (943.00)	0.998	.53 (.56)	.94 (943.00)	0.349
* Dominance and assertiveness	1.84 (.58)	3.18 (943.00)	.002**	1.65 (.62)	2.67 (943.00)	.008**	1.24 (.59)	2.11 (943.00)	.035*
* Intrasexual competition	−2.00 (.52)	−3.86 (943.00)	<.001***	−2.76 (.55)	−5.00 (943.00)	<.001***	−1.15 (.53)	−2.18 (943.00)	.030*
* Self-rated masculinity	.12 (.50)	.24 (943.00)	0.809	−.07 (.53)	−.12 (943.00)	0.903	.96 (.51)	1.89 (943.00)	0.059
* Height	1.78 (.50)	3.58 (943.00)	<.001***	2.18 (.53)	4.13 (943.00)	<.001***	1.50 (.50)	2.97 (943.00)	.003**
* Self-Reported beardedness	.16 (.48)	.32 (943.00)	0.748	.98 (.52)	1.90 (943.00)	0.057	−.21 (.49)	−.42 (943.00)	0.675

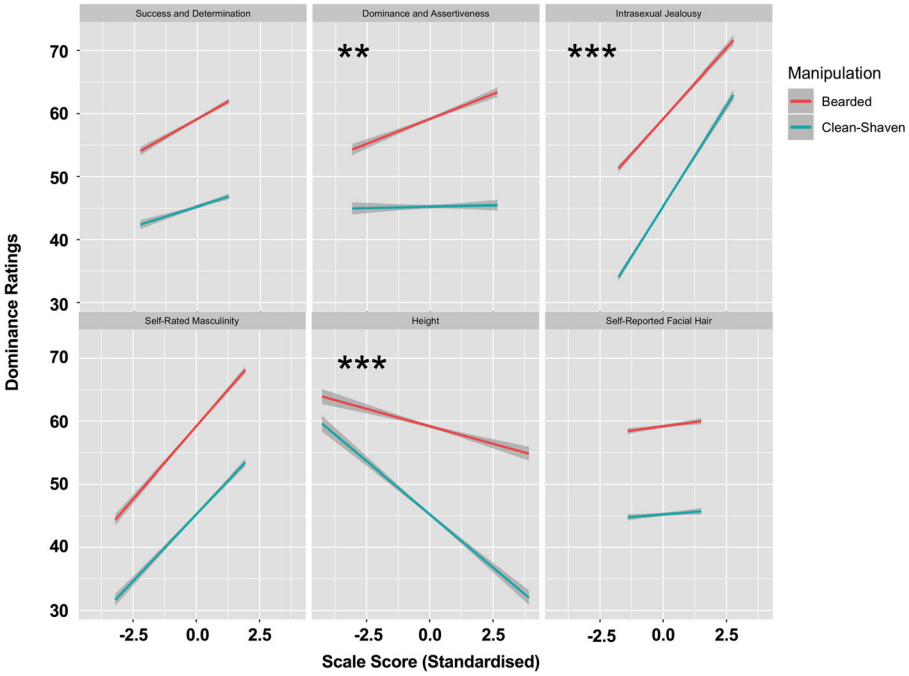

Fig. 5 The associations between psychological measures (top row: self-reported success and dedication, dominance and assertiveness) and morphological characters (bottom row: facial masculinity, height and facial hair) and men's dominance ratings of male faces varying in facial hair (±95% CI) when judging bearded (red line) and clean-shaven faces (blue line). ** < .01; *** < .001

participant's height and trait ratings (Table 5), so that ratings were lower among taller than shorter men when rating feminised but not masculinised faces for masculinity (Fig. 7), dominance (Fig. 8), and aggressiveness (Fig. 9). There were no significant interactions between either self-reported success and dedication or participant's self-rated facial masculinity with either stimuli beardedness or facial masculinity. There were also no significant main effect or interactions involving self-reported beardedness (Table 5).

Discussion

A growing body of research implicates intra-sexual selection in shaping the evolution of men's secondary sexual traits, dominance, and status seeking (Lukaszewski et al. 2016; Puts 2010; Rosenfield et al. 2020). The current study reports men's ratings of masculinity, dominance, and aggressiveness for male faces increased linearly with craniofacial masculinity, being lowest for the least masculine faces and highest for the most masculine faces. Beards were also judged as more masculine, dominant, and aggressive than clean-shaven faces. However, the effects of craniofacial masculinity on judgments of male faces were dwarfed by the effect of facial hair, such that ratings for masculinity, dominance, and aggressiveness were higher at each level of facial masculinity for bearded compared to clean-shaven faces. Our findings replicate previous studies reporting that beards exert stronger effects than facial masculinity on judgments of

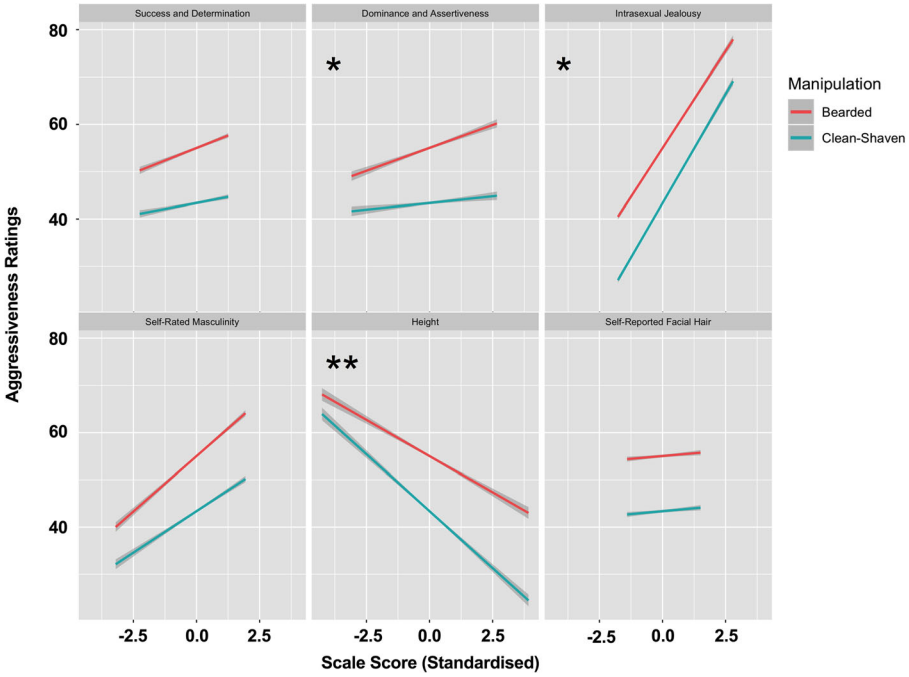

Fig. 6 The associations between three psychological measures (top row: self-reported success and dedication, dominance and assertiveness) and three morphological characters (bottom row: facial masculinity, height and facial hair) and aggressiveness ratings of male faces varying in facial hair (±95% CI) when judging bearded faces (red line) and clean-shaven faces (blue line). * < .05; ** < .001

men's masculinity and dominance (Dixson et al. 2017c; Sherlock et al. 2017). As an example of the size of these effects, we report significantly higher ratings (all *ps* < .001) for bearded faces with very feminine facial shape over the most masculine clean-shaven faces for ratings of masculinity ($d = .61$), dominance ($d = .45$), and aggressiveness ($d = .38$), highlighting that facial hair potentially enhances male intra-sexual formidability through amplifying underlying masculine craniofacial features such as jaw width, facial length and width.

Converging evidence demonstrates that men's facial masculinity predicts men's intra-sexual formidability (Puts 2010; Sell et al. 2012). Men with more masculine faces have greater upper body strength (Fink et al. 2007; Windhager et al. 2011), fighting ability (Třebický et al. 2013, 2015, 2018; Zilioli et al. 2015), and higher mating success (Hill et al. 2013; Kordsmeyer et al. 2018) than less facially masculine men. The degree to which men are sensitive to other men's secondary sexual traits, including facial masculinity, when assessing their dominance may vary due to their own physical and psychological dominance (Puts 2010; Sell et al. 2012; Watkins et al. 2010a, b). In the current study, we did not find that men high in social dominance (Hypothesis 1) or status seeking (Hypothesis 3) were less sensitive to facial masculinity when ranking male facial masculinity, dominance, or aggressiveness than less dominant men (Watkins et al. 2010b). We also tested whether men's physical masculinity was negatively associated with their judgments of facial masculinity (Hypothesis 7). Thus, height is positively associated with men's social dominance (Puts 2010),

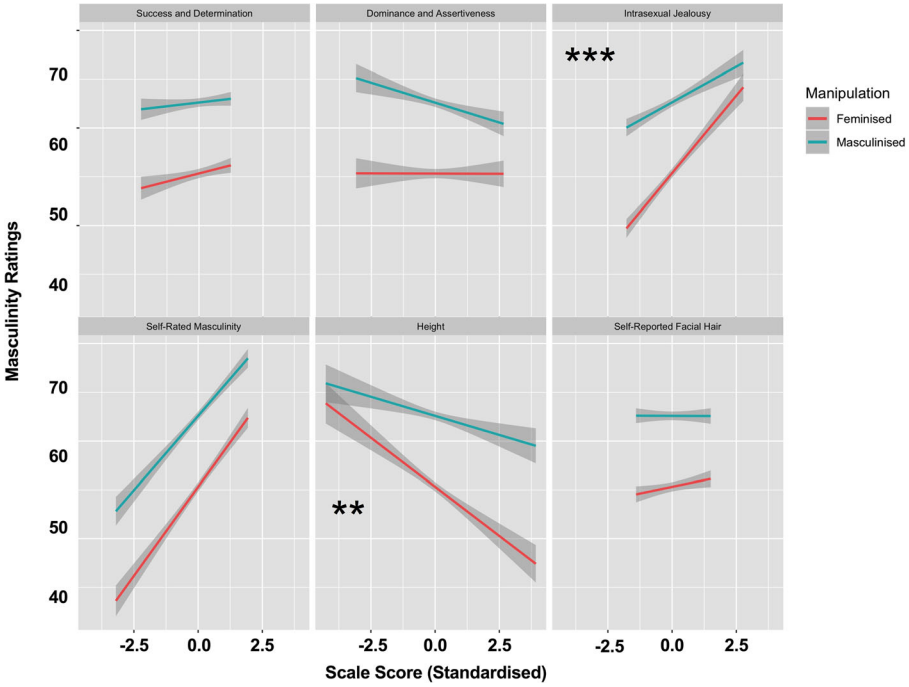

Fig. 7 The associations between psychological measures (top row: self-reported success and dedication, dominance and assertiveness) and morphological characters (bottom row: facial masculinity, height and facial hair) and men's masculinity ratings of male faces varying in facial masculinity (±95% CI) when judging feminised (red line) and masculinised faces (blue line). ** < .01; *** < .001

aggressiveness (Archer 2009), and fighting ability (Sell et al. 2012). While we found that height was negatively associated with judgments of male masculinised and feminised faces for ratings of masculinity, dominance, and aggressiveness, the significant interaction was driven by lower ratings for feminised rather than masculinised faces. This provides partial support that taller men are less sensitive to cues of facial dominance in male faces, but does not directly replicate past findings that height is negatively associated with dominance judgments for male facial masculinity (Watkins et al. 2010a). We also found that participants with higher self-reported facial masculinity gave higher ratings of dominance, masculinity, and aggressiveness. However, there were no associations between self-reported facial masculinity and self-reported social dominance, assertiveness, or success and dedication on men's judgments of male facial masculinity.

Facially masculine men report more open sociosexualities (Boothroyd et al. 2008), greater interest in short-term relationships (Arnocky et al. 2018), having more short-term partners (Rhodes et al. 2005), and greater likelihood of poaching other men's partners (Rhodes et al. 2013). Thus, men with more masculine faces and better developed secondary sexual characters may be less jealous of masculine looking men than their less masculine contemporaries. Indeed, previous research has shown that men's height is negatively associated with their self-reported intra-sexual jealousy (Buunk et al. 2008). While we also found that taller men reported lower intra-sexual jealousy ($r = -.279$), we did not find that taller, more facially masculine, or bearded

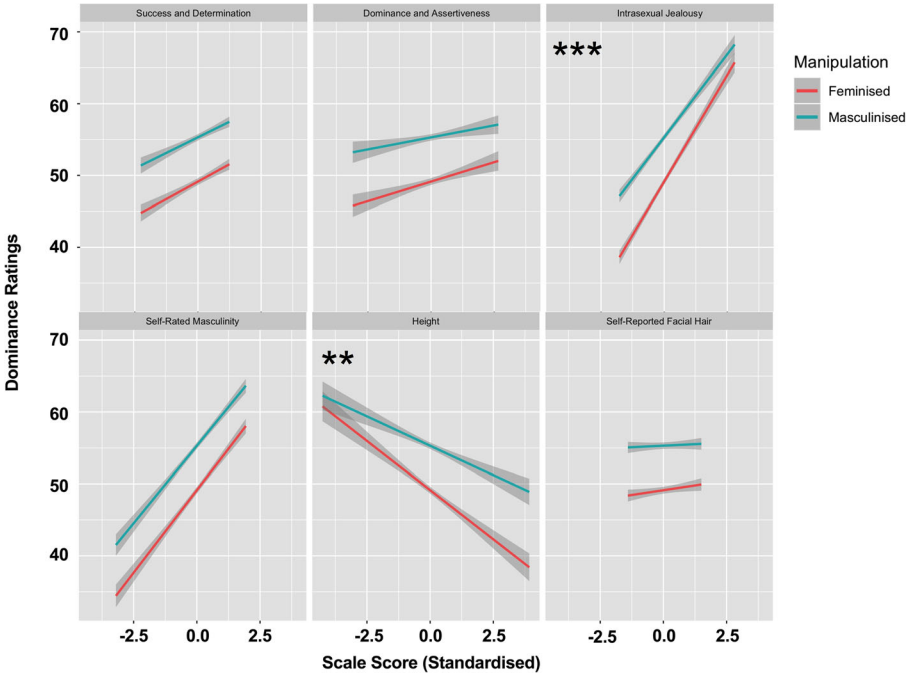

Fig. 8 The associations between three psychological measures (top row: self-reported success and dedication, dominance and assertiveness) and three morphological characters (bottom row: facial masculinity, height and facial hair) and men's dominance ratings of male faces varying in facial masculinity (± 95% CI) when judging feminised faces (red line) and masculinised faces (blue line). ** < .01; *** < .001

men were less jealous of facial masculinity in male faces. Instead, participants reporting lower intra-sexual jealousy rated clean-shaven and less masculine faces as less masculine, dominant, and aggressive than masculine or bearded faces. This could simply reflect that men attribute lower threat in mating contexts to less masculine and physically formidable looking men. However, with regards men's intra-sexual jealousy and judgments of beardedness, to our knowledge the only study measuring associations between women's sexual openness and attractiveness ratings of male facial hair reported a positive association between female sexual openness and preferences for beards (Stower et al. 2019). At present, there are no published data relating beardedness to men's sociosexuality and whether the decision to wear facial hair is a reflection of men's sociosexual attitudes is an important question for future research.

Compared to the body of research on intra-sexual selection and judgments of male facial masculinity, fewer studies have assessed individual differences in men's dominance and their judgments of male beardedness. Past research has shown that bearded men reported higher aggressive sexism scores than clean-shaven men in the U.S.A and India (Oldmeadow and Dixson 2016), but not Sweden (Hellmer and Stenson 2016; Hellmer et al. 2018). Men with facial hair report feeling more masculine (Wood 1986) and had higher serum androgens (Knussman and Christiansen 1988) than men favouring a clean-shaven appearance. In the current study, self-reported beardedness was positively associated with self-perceived facial masculinity ($r = .158$) and self-reported dominance ($r = .119$). Participants who reported higher scores on dominance

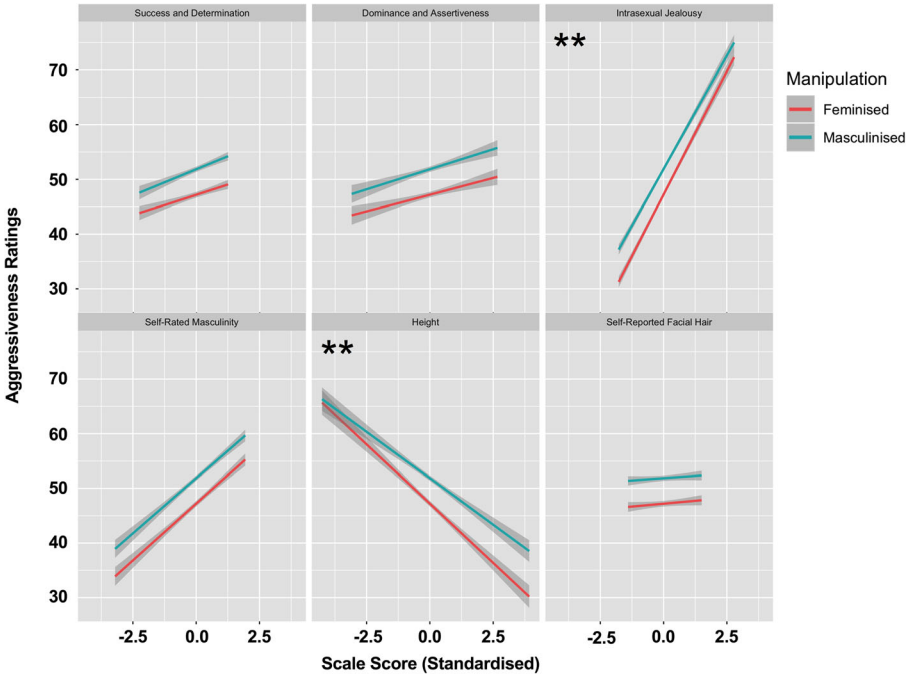

Fig. 9 The associations between three psychological measures (top row: self-reported success and dedication, dominance and assertiveness) and morphological characters (bottom row: facial masculinity, height and facial hair) and aggressiveness ratings (±95% CI) of male faces varying in facial masculinity when judging feminised (red line) and masculinised faces (blue line). ** < .01

and assertiveness personality scales also gave significantly higher masculinity, dominance, and aggressiveness ratings to bearded but not clean-shaven faces compared to participants lower in dominance and assertiveness. These findings complement growing evidence that beards enhance intra-sexual communication of masculine social dominance (Craig et al. 2019; Dixson and Vasey 2012; Dixson et al. 2017c) and provide the first evidence that facial hair is positively associated with male self-perceived social dominance. Importantly, this correlation cannot determine whether socially dominant men choose to grow their beards or whether keeping a beard augments men's self-reported social dominance due to positive social feedback from peers. There is some evidence that bearded men have higher mating success when sex ratios are more male-biased (Barber 2001) and that beards (and female preferences for them) are more common in larger cities, with low average incomes and high life expectancies (Dixson et al. 2017a). Future research exploring the causal effects of men's grooming decisions on social dominance and mating success would be valuable.

Comparative research among nonhuman animals can shed light on the roles of facial masculinity and beards in intra-sexual communication. Researchers working on non-human animals distinguish between the role of male weaponry and ornamentation in intra-sexual competition, such that weapons are employed during direct physical confrontations whereas ornaments communicate status and dominance without necessarily being associated with physical formidability (McCullough et al. 2016). Weapons involved in direct competition and fights are rarely false signals of male quality

(Berglund et al. 1996) and may augment attractiveness to females when selecting for males bearing direct benefits (Wong and Candolin 2005). Our results failed to support several past studies that found associations between men's intra-sexual competitiveness and judgments of male facial masculinity. This was surprising as masculine facial structure is positively associated with men's upper body strength (Fink et al. 2007; Windhager et al. 2011), muscularity (Holzleitner and Perrett 2016), stature (Zaidi et al. 2019) and fighting ability (Třebický et al. 2015; Zilioli et al. 2015). Mixed martial arts fighters with more masculine facial features are more often winners than less facially masculine fighters (Třebický et al. 2015; Zilioli et al. 2015) and fighters with greater anaerobic fitness are rated as better fighters (Třebický et al. 2018). Our results may have differed had we included more interactive behavioural paradigms rather than comparisons of self-report measures of dominance. For example, recent research in which men were assigned to compete in either violent or non-violent video games revealed that men who competed in violent video games were slower to retreat from a hypothetical physical confrontation with a masculine looking male, and were slower to recognise threatening facial expressions than participants in competing in non-violent video games (Denson et al. 2020). It may be beneficial to repeat our studies using more interactive experimental approaches to test whether psychologically and physically masculine men are less sensitive to masculine traits.

In contrast to sexually selected weapons, ornaments can communicate dominance without being directly involved in combat (McCullough et al. 2016). For example, in mountain gorillas (*Gorilla beringei beringei*) male dominance rank, success in male-male dyadic contests, and number of females in the social group is positively associated with cranial adipose crest size and back breadth (Wright et al. 2019). In some cases, weaponry may not reliably communicate physical formidability (Berglund et al. 1996). Thus, in male fiddler crabs (*Uca mjoebergi*) claw size is associated with attractiveness, resource holding, and in assessing fighting ability between rival males (Reaney et al. 2008). However, when males lose their claws during fights or due to predation the regrown claws are of similar size to their original claws but less robust, yet rival males are unable to discern weapon quality and overestimate their opponents fighting ability (Lailvaux et al. 2009). Similarly, male slender crayfish (*Cherax dispar*) with larger claws successfully dominate males with small claws despite any positive association between their claw size and muscle development (Wilson et al. 2009). Beardedness is possibly the most sexually dimorphic of men's secondary sexual characters (Dixson et al. 2005; Grueter et al. 2015) and enhances ratings of age, masculinity, dominance, and aggressiveness by enlarging the size of the jaw (Dixson et al. 2017c), the midface (Sherlock et al. 2017) and the saliency of agonistic expressions (Dixson and Vasey 2012; Craig et al. 2019). However, facial hair is unlikely to reflect aspects of male fighting ability (Dixson et al. 2018a) and may serve to enhance perceptions of masculinity, dominance, and aggressiveness to curtail intra-sexual conflicts from escalating into costly physical contests. Future research investigating whether bearded men are more successful than their clean-shaven counterparts in social rather than physical forms of intra-sexual competition would be valuable. Presently, our study provides some support for a role of intra-sexual selection in men's judgments of male facial masculinity and reports the first data on individual differences in men's judgments of male facial hair, which suggest beards are intra-sexually selected badges of status.

Acknowledgments This study was supported by a University of Queensland Postdoctoral Fellowship to BJWD.

Data Accessibility Data are available at the Open Science Framework.

Author Contributions BJWD, VM, HC, GS, and BF designed and conducted the study; SP and MJS collected the data; AJL, MJS, BJWD, VM, and TC analyzed the data; BJWD, VM, MJS, HC, BF, GS, TRC, SP, and AJL wrote the manuscript and commented and drafts. BJWD provided funding for the research.

Compliance with Ethical Standards

Conflict of Interest The authors have no competing interests.

Ethical Statement Ethics clearance from the University of Queensland's Behavioural and Social Sciences Ethical Review Committee and the School of Psychology's Ethics Review Panel (Ethics Approval Number: 18-PSYCH-4G-13-JMC).

References

Addison, W. E. (1989). Beardedness as a factor in perceived masculinity. *Perception and Motor Skills, 68*, 921–922.

Adhikari, K., Fontanil, T., Cal, S., Mendoza-Revilla, J., Fuentes-Guajardo, M., Chacón-Duque, J. C., et al. (2016). A genome-wide association scan in admixed Latin Americans identifies loci influencing facial and scalp hair features. *Nature Communications, 7*, 10815.

Archer, J. (2009). Does sexual selection explain human sex differences in aggression? *The Behavioral and Brain Sciences, 32*, 249–266.

Arnocky, S., Carré, J. M., Bird, B. M., Moreau, B. J., Vaillancourt, T., Ortiz, T., & Marley, N. (2018). The facial width-to-height ratio predicts sex drive, sociosexuality, and intended infidelity. *Archives of Sexual Behavior, 47*(5), 1375–1385.

Barber, N. (2001). Mustache fashion covaries with a good marriage market for women. *Journal of Nonverbal Behavior, 25*, 261–272.

Barr, D. J. (2013). Random effects structure for testing interactions in linear mixed-effects models. *Frontiers in Psychology, 4*, 328.

Barr, D. J., Levy, R., Scheepers, C., & Tily, H. J. (2013). Random effects structure for confirmatory hypothesis testing: keep it maximal. *Journal of Memory and Language, 68*, 255–278.

Bates, D., Machler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software, 67*, 48. https://doi.org/10.18637/jss.v067.i01.

Benson PJ, Perrett DI. 1993 Extracting prototypical facial images from exemplars. *Perception, 22*, 257–262.

Berglund, A., Bisazza, A., & Pilastro, A. (1996). Armaments and ornaments: an evolutionary explanation of traits of dual utility. *Biological Journal of the Linnean Society, 58*, 385–399.

Boothroyd, L. G., Jones, B. C., Burt, D. M., DeBruine, L. M., & Perrett, D. I. (2008). Facial correlates of sociosexuality. *Evolution and Human Behavior, 29*(3), 211–218.

Boothroyd, L. G., Cross, C. P., Gray, A. W., Coombes, C., & Gregson-Curtis, K. (2011). Perceiving the facial correlates of sociosexuality: Further evidence. *Personality and Individual Differences, 50*(3), 422–425.

Boothroyd, L. G., Scott, I., Gray, A. W., Coombes, C. I., & Pound, N. (2013). Male facial masculinity as a cue to health outcomes. *Evolutionary Psychology, 11*(5), 147470491301100508.

Borras-Guevara, M. L., Batres, C., & Perrett, D. I. (2017). Aggressor or protector? Experiences and perceptions of violence predict preferences for masculinity. *Evolution and Human Behavior, 38*(4), 481–489.

Brooks, R., Scott, I. M., Maklakov, A. A., Kasumovic, M. M., Clark, A. P., & Penton-Voak, I. S. (2011). National income inequality predicts women's preferences for masculinized faces better than health does. *Proceedings of the Royal Society B: Biological Sciences, 278*, 810–812.

Butovskaya, M. L., Windhager, S., Karelin, D., Mezentseva, A., Schaefer, K., & Fink, B. (2018). Associations of physical strength with facial shape in an African pastoralist society, the Maasai of northern Tanzania. *PLoS One, 13*(5), e0197738.

Buunk, A. P., & Fisher, M. (2009). Individual differences in intrasexual competition. *Journal of Evolutionary Psychology, 7*, 37–48.

Buunk, A. P., Park, J. H., Zurriaga, R., Klavina, L., & Massar, K. (2008). Height predicts jealousy differently for men and women. *Evolution and Human Behavior, 29*, 133–139.

Carter, S., & Astrom, K. (2004). Christmas-A cross-sectional study of UK academics suggests Santa Claus might be a professor. *The Pharmaceutical Journal, 273*, 897–899.

Clarkson, T. R., Sidari, M. J., Sains, R., Alexander, M., Harrison, M., Mefodeva, V., Pearson, S., Lee, A. J., & Dixson, B. J. W. (2020). A multivariate analysis of women's mating strategies and sexual selection on men's facial morphology. *Royal Society Open Science, 7*(1), 191209.

Craig, B. M., Nelson, N. L., & Dixson, B. J. W. (2019). Sexual selection, agonistic signalling, and the effect of beards on men's anger displays. *Psychological Science, 30*, 728–738.

DeBruine, L. M., Jones, B. C., Little, A. C., Boothroyd, L. G., Perrett, D. I., Penton-Voak, I. S., ... & Tiddeman, B. P. (2006). Correlated preferences for facial masculinity and ideal or actual partner's masculinity. *Proceedings of the Royal Society B: Biological Sciences, 273*, 1355–1360.

Denson, T. F., Dixson, B. J., Tibubos, A. N., Zhang, E., Harmon-Jones, E., & Kasumovic, M. M. (2020). Violent video game play, gender, and trait aggression influence subjective fighting ability, perceptions of men's toughness, and anger facial recognition. *Computers in Human Behavior, 104,* 106175.

Dixson, B. J., & Brooks, R. C. (2013). The role of facial hair in women's perceptions of men's attractiveness, health, masculinity and parenting abilities. *Evolution and Human Behavior, 34*, 236–241.

Dixson, B. J. W., & Rantala, M. J. (2016). The role of facial and body hair distribution in women's judgments of men's sexual attractiveness. *Archives of Sexual Behavior, 45*, 877–889.

Dixson, B. J., & Vasey, P. L. (2012). Beards augment perceptions of men's aggressiveness, dominance and age, but not attractiveness. *Behavioral Ecology, 23*, 481–490.

Dixson, A. F., Dixson, B. J., & Anderson, M. J. (2005). Sexual selection and the evolution of visually conspicuous sexually dimorphic traits in male monkeys, apes, and human beings. *Annual Review of Sex Research, 16*, 1–19.

Dixson, B. J., Tam, J., & Awasthy, M. (2013). Do women's preferences for men's facial hair change with reproductive status? *Behavioral Ecology, 24*, 708–716.

Dixson, B. J., Grimshaw, G. M., Ormsby, D. K., & Dixson, A. F. (2014). Eye-tracking women's preferences for men's somatotypes. *Evolution and Human Behavior, 35*, 73–79.

Dixson, B. J. W., Sulikowski, D., Gouda-Vossos, A., Rantala, M. J., & Brooks, R. C. (2016). The masculinity paradox: Facial masculinity and beardedness interact to determine women's ratings of men's facial attractiveness. *Journal of Evolutionary Biology, 29*, 2311–2320.

Dixson, B. J. W., Rantala, M. J., Melo, E. F., & Brooks, R. C. (2017a). Beards and the big city: displays of masculinity may be amplified under crowded conditions. *Evolution and Human Behavior, 38*, 259–264.

Dixson, B. J. W., Little, A. C., Dixson, H. G., & Brooks, R. C. (2017b). Do prevailing environmental factors influence human preferences for facial morphology? *Behavioral Ecology, 28*, 1217–1227.

Dixson, B. J. W., Lee, A. J., Sherlock, J. M., & Talamas, S. N. (2017c). Beneath the beard: do facial morphometrics influence the strength of judgments of men's beardedness? *Evolution and Human Behavior, 38*, 164–174.

Dixson, B. J. W., Sherlock, J. M., Cornwall, W., & Kasumovic, M. M. (2018a). Contest competition and men's facial hair: beards may not provide advantages in combat. *Evolution and Human Behavior, 39*, 147–153.

Dixson, B. J., Blake, K. R., Denson, T. F., Gooda-Vossos, A., O'Dean, S. M., Sulikowski, D., & Brooks, R. C. (2018b). The role of mating context and fecundability in women's preferences for men's facial masculinity and beardedness. *Psychoneuroendocrinology, 93*, 90–102.

Dixson, B. J., Lee, A. J., Blake, K. R., Jasienska, G., & Marcinkowska, U. M. (2018c). Women's preferences for men's beards show no relation to their ovarian cycle phase and sex hormone levels. *Hormones and Behavior, 97*, 137–144.

Dixson, B. J., Rantala, M. J., & Brooks, R. C. (2019a). Cross-cultural variation in women's preferences for men's body hair. *Adaptive Human Behavior and Physiology, 5*, 131–147.

Dixson, B. J. W., Kennedy-Costantini, S., Lee, A. J., & Nelson, N. L. (2019b). Mothers are sensitive to men's beards as a potential cue of paternal investment. *Hormones and Behavior, 113*, 55–66.

Durkee, P. K. (2019). Do the Maasai perceive weak walkers to be stronger and more attractive than strong walkers? A re-analysis of Fink et al. (2019). *Biology Letters, 15*, 20190240.

Emlen, D. J. (2008). The evolution of animal weapons. *Annual Review of Ecology, Evolution, and Systematics, 39*, 387–413.

Fessler, D. M., Holbrook, C., & Gervais, M. M. (2014). Men's physical strength moderates conceptualizations of prospective foes in two disparate societies. *Human Nature, 25*, 393–409.

Fink, B., Neave, N., & Seydel, H. (2007). Male facial appearance signals physical strength to women. *American Journal of Human Biology, 19*, 82–87.

Fink, B., Wübker, M., Ostner, J., Butovskaya, M. L., Mezentseva, A., Muñoz-Reyes, J. A., et al. (2017). Cross-cultural investigation of male gait perception in relation to physical strength and speed. *Frontiers in Psychology, 8*, 1427.

Fink, B., Butovskaya, M. L., & Shackelford, T. K. (2019). Assessment of physical strength from gait: data from the Maasai of Tanzania. *Biology Letters, 15*(3), 20180803.

Gallup, A. C., O'Brien, D. T., White, D. D., & Wilson, D. S. (2010). Handgrip strength and socially dominant behavior in male adolescents. *Evolutionary Psychology, 8*, 147470491000800207.

Geniole, S. N., & McCormick, C. M. (2015). Facing our ancestors: judgments of aggression are consistent and related to the facial width-to-height ratio in men irrespective of beards. *Evolution and Human Behavior, 36*, 279–285.

Geniole, S. N., Denson, T. F., Dixson, B. J., Carré, J. M., & McCormick, C. M. (2015). Evidence from meta-analyses of the facial width-to-height ratio as an evolved cue of threat. *PLoS One, 10*(7), e0132726.

Goldberg, L. R., Johnson, J. A., Eber, H. W., Hogan, R., Ashton, M. C., Cloninger, C. R., & Gough, H. C. (2006). The international personality item pool and the future of public domain personality measures. *Journal of Research in Personality, 40*, 84–96.

Grueter, C. C., Isler, K., & Dixson, B. J. (2015). Are badges of status adaptive in large complex primate groups? *Evolution and Human Behavior, 36*, 398–406.

Hellmer, K., & Stenson, T. J. (2016). Contradicting data and comments on Oldmeadow and Dixson's (2015) "the association between men's sexist attitudes and facial hair". *Archives of Sexual Behavior, 45*(4), 783–784.

Hellmer, K., Stenson, J. T., & Jylhä, K. M. (2018). What's (not) underpinning ambivalent sexism? Revisiting the roles of ideology, religiosity, personality, demographics, and men's facial hair in explaining hostile and benevolent sexism. *Personality and Individual Differences, 122*, 29–37.

Hill, A. K., Hunt, J., Welling, L. L., Cárdenas, R. A., Rotella, M. A., Wheatley, J. R., et al. (2013). Quantifying the strength and form of sexual selection on men's traits. *Evolution and Human Behavior, 34*, 334–341.

Holzleitner, I. J., & Perrett, D. I. (2016). Perception of strength from 3D faces is linked to facial cues of physique. *Evolution and Human Behavior, 37*, 217–229.

Isen, J. D., McGue, M. K., & Iacono, W. G. (2015). Aggressive-antisocial boys develop into physically strong young men. *Psychological Science, 26*, 444–455.

Janif, Z. J., Brooks, R. C., & Dixson, B. J. (2014). Negative frequency-dependent preferences and variation in male facial hair. *Biology Letters, 10*, 20130958.

Knussman, R., & Christiansen, K. (1988). Attributes of masculinity and androgen level. *Homo., 39*, 45–50.

Kordsmeyer, T. L., Hunt, J., Puts, D. A., Ostner, J., & Penke, L. (2018). The relative importance of intra-and intersexual selection on human male sexually dimorphic traits. *Evolution and Human Behavior*.

Kordsmeyer, T. L., Freund, D., Pita, S. R., Jünger, J., & Penke, L. (2019). Further evidence that facial width-to-height ratio and global facial masculinity are not positively associated with testosterone levels. *Adaptive Human Behavior and Physiology*, 1–14.

Kuznetsova, A., Brockhoff, P. B., & Christensen, R. H. B. (2015). lmerTest: Tests for random and fixed effects for linear mixed effect models. *Journal of Statistical Software, 82*(13).

Lailvaux, S. P., Reaney, L. T., & Backwell, P. R. (2009). Dishonest signalling of fighting ability and multiple performance traits in the fiddler crab Uca mjoebergi. *Functional Ecology*, 359–366.

Lassek, W. D., & Gaulin, S. J. (2009). Costs and benefits of fat-free muscle mass in men: relationship to mating success, dietary requirements, and native immunity. *Evolution and Human Behavior, 30*(5), 322–328.

Lukaszewski, A. W., Simmons, Z. L., Anderson, C., & Roney, J. R. (2016). The role of physical formidability in human social status allocation. *Journal of Personality and Social Psychology, 110*, 385.

Marcinkowska, U. M., Rantala, M. J., Lee, A. J., Kozlov, M. V., Toivo, A., Cai, T. H., Contreras-Garduño, J., David, O. A., Kaminski, G., Li, N. P., Onyishi, I. E., Prasai, K., Pazhoohi, F., Prokop, P., Cardozo, S. L. R., Sydney, N., Taniguchi, H., Krams, I., & Dixson, B. J. W. (2019). Women's preferences for men's facial masculinity are strongest under favorable ecological conditions. *Scientific Reports*.

Marečková, K., Weinbrand, Z., Chakravarty, M. M., Lawrence, C., Aleong, R., Leonard, G., et al. (2011). Testosterone-mediated sex differences in the face shape during adolescence: subjective impressions and objective features. *Hormones and Behavior, 60*, 681–690.

Mason, W., & Suri, S. (2012). Conducting behavioral research on Amazon's Mechanical Turk. *Behavior Research Methods, 44*, 1–23.

McCullough, E. L., Miller, C. W., & Emlen, D. J. (2016). Why sexually selected weapons are not ornaments. *Trends in Ecology & Evolution, 31*, 742–751.

McIntosh, T., Lee, A. J., Sidari, M., Stower, R., Sherlock, J. M., & Dixson, B. J. W. (2017). Microbes and masculinity: does exposure to pathogenic cues alter women's preferences for male facial masculinity and beardedness? *PLoS One, 12*(6), e0178206.

Muñoz-Reyes, J. A., Gil-Burmann, C., Fink, B., & Turiegano, E. (2012). Physical strength, fighting ability, and aggressiveness in adolescents. *American Journal of Human Biology, 24*, 611–617.

Muscarella, F., & Cunningham, M. R. (1996). The evolutionary significance and social perception of male pattern baldness and facial hair. *Ethology and Sociobiology, 17*, 99–117.

Neave, N., & Shields, K. (2008). The effects of facial hair manipulation on female perceptions of attractiveness, masculinity, and dominance in male faces. *Personality and Individual Differences, 45*, 373–377.

Nelson, N. L., Kennedy-Costantini, S., Lee, A. J., & Dixson, B. J. W. (2019). Children's judgements of facial hair are influenced by biological development and experience. *Evolution and Human Behavior, 113*, 55–66.

O'Connor, J. J., & Feinberg, D. R. (2012). The influence of facial masculinity and voice pitch on jealousy and perceptions of intra-sexual rivalry. *Personality and Individual Differences, 52*, 369–373.

Oldmeadow, J. A., & Dixson, B. J. (2016). The association between men's sexist attitudes and facial hair. *Archives of Sexual Behavior, 45*, 891–899.

Penton-Voak, I. S., & Chen, J. Y. (2004). High salivary testosterone is linked to masculine male facial appearance in humans. *Evolution and Human Behavior, 25*, 229–241.

Perrett DI, Lee KJ, Penton-Voak I, Rowland D, Yoshikawa S, Burt DM, Henzi SP, Castles DL, Akamatsu S. 1998 Effects of sexual dimorphism on facial attractiveness. *Nature, 394*, 884–887.

Peters, M., Simmons, L. W., & Rhodes, G. (2008). Testosterone is associated with mating success but not attractiveness or masculinity in human males. *Animal Behaviour, 76*, 297–303.

Phalane, K. G., Tribe, C., Steel, H. C., Cholo, M. C., & Coetzee, V. (2017). Facial appearance reveals immunity in African men. *Scientific Reports, 7*(1), 7443.

Pinto, N. S., Palaoro, A. V., & Peixoto, P. E. (2019). All by myself? Meta-analysis of animal contests shows stronger support for self than for mutual assessment models. *Biological Reviews*.

Polo, P., Muñoz-Reyes, J. A., Pita, M., Shackelford, T. K., & Fink, B. (2019). Testosterone dependent facial and body traits predict men's sociosexual attitudes and behaviors. *American Journal of Human Biology*, e23235.

Puts, D. A. (2010). Beauty and the beast: mechanisms of sexual selection in humans. *Evolution and Human Behavior, 31*, 157–175.

Puts, D. A., Bailey, D. H., & Reno, P. L. (2015). *Contest competition in men. The Handbook of evolutionary psychology.* John Wiley & Sons, Inc.

R Core Team. (2013) *R: a language and environment for statistical computing.* Vienna, Austria: R Foundation for Statistical Computing.

Raine, J., Pisanski, K., Oleszkiewicz, A., Simner, J., & Reby, D. (2018). Human listeners can accurately judge strength and height relative to self from aggressive roars and speech. *iScience, 4*, 273–280.

Randall, V. A. (2008). Androgens and hair growth. *Dermatologic Therapy, 21*, 314–328.

Rantala, M. J., Moore, F. R., Skrinda, I., Krama, T., Kivleniece, I., Kecko, S., & Krams, I. (2012). Evidence for the stress-linked immunocompetence handicap hypothesis in humans. *Nature Communications, 3*, 694.

Rantala, M. J., Coetzee, V., Moore, F. R., Skrinda, I., Kecko, S., Krama, T., et al. (2013). Adiposity, compared with masculinity, serves as a more valid cue to immunocompetence in human mate choice. *Proceedings of the Royal Society B: Biological Sciences, 280*(1751), 20122495.

Reaney, L. T., Milner, R. N. C., Detto, T., & Backwell, P. R. Y. (2008). The effects of claw regeneration on territory ownership and mating success in the fiddler crab, *Uca mjoebergi*. *Animal Behaviour, 75*, 1473–1478.

Rhodes, G., Simmons, L. W, & Peters, M. (2005). Attractiveness and sexual behavior: Does attractiveness enhance mating success? *Evolution and Human Behavior, 26*, 186–201.

Rhodes, G., Chan, J., Zebrowitz, L. A., & Simmons, L. W. (2003). Does sexual dimorphism in human faces signal health? *Proceedings of the Royal Society of London B, 270*, S93–S95.

Rhodes, G., Morley, G., & Simmons, L. W. (2013). Women can judge sexual unfaithfulness from unfamiliar men's faces. *Biology Letters, 9*, 20120908.

Rico-Guevara, A., & Hurme, K. J. (2019). Intrasexually selected weapons. *Biological Reviews, 94*, 60–101.

Roosenboom, J., Indencleef, K., Lee, M. K., Hoskens, H., White, J. D., Liu, D., et al. (2018). SNPs associated with testosterone levels influence human facial morphology. *Frontiers in Genetics*, 9.

Rosenfield, K. A., Sorokowska, A., Sorokowski, P., & Puts, D. A. (2020). Sexual selection for low male voice pitch among Amazonian forager-horticulturists. *Evolution and Human Behavior, 41*, 3–11.

Saxton, T. K., Mackey, L. L., McCarty, K., & Neave, N. (2016). A lover or a fighter? Opposing sexual selection pressures on men's vocal pitch and facial hair. *Behavioral Ecology, 27*, 512–519.

Scott, I. M., Clark, A. P., Boothroyd, L. G., & Penton-Voak, I. S. (2013). Do men's faces really signal heritable immunocompetence? *Behavioral Ecology, 24*, 579–589.

Scott, I. M., Clark, A. P., Josephson, S. C., Boyette, A. H., Cuthill, I. C., Fried, R. L., et al. (2014). Human preferences for sexually dimorphic faces may be evolutionarily novel. *Proceedings of the National Academy of Sciences, 111*, 14388–14393.

Sell, A., Cosmides, L., Tooby, J., Sznycer, D., von Rueden, C., & Gurven, M. (2009). Human adaptations for the visual assessment of strength and fighting ability from the body and face. *Proceedings of the Royal Society of London B, 276*, 575–584.

Sell, A., Bryant, G., Cosmides, L., Tooby, J., Sznycer, D., von Rueden, C., Krauss, A., & Gurven, M. (2010). Adaptations in humans for assessing physical strength from the voice. *Proceedings of the Royal Society B, 277*, 3509–3518.

Sell, A., Hone, L. S., & Pound, N. (2012). The importance of physical strength to human males. *Human Nature, 23*, 30–44.

Sherlock, J. M., Tegg, B., Sulikowski, D., & Dixson, B. J. (2017). Facial masculinity and beardedness determine men's explicit, but not their implicit, responses to male dominance. *Adaptive Human Behavior and Physiology, 3*, 14–29.

Singal, P., Bhatnagar, D. P., & Kaur, S. (2006). Anthropometric profile and development of facial hair in male athletes. *Journal of Exercise Science and Physiotherapy, 2*, 52–58.

Snell Jr., W. E. (1989). Development and validation of the masculine behavior scale: a measure of behaviors stereotypically attributed to males vs. females. *Sex Roles, 21*, 749–767.

Štěrbová, Z., Tureček, P., & Kleisner, K. (2019). She always steps in the same river: similarity among long-term partners in their demographic, physical, and personality characteristics. *Frontiers in Psychology, 10*.

Stower, R. E., Lee, A. J., McIntosh, T. L., Sidari, M. J., Sherlock, J. M., & Dixson, B. J. (2019). Mating strategies and the masculinity paradox: how relationship context, relationship status, and Sociosexuality shape women's preferences for facial masculinity and beardedness. *Archives of Sexual Behavior*, 1–12.

Stulp, G., & Barrett, L. (2016). Evolutionary perspectives on human height variation. *Biological Reviews, 91*, 206–234.

Terrizzi, B. F., Brey, E., Shutts, K., & Beier, J. S. (2019). Children's developing judgments about the physical manifestations of power. *Developmental Psychology, 55*, 793.

Thornhill, R., & Gangestad, S. W. (2006). Facial sexual dimorphism, developmental stability, and susceptibility to disease in men and women. *Evolution and Human Behavior, 27*, 131–144.

Tobin-Richards, M. H., Boxer, A. M., & Petersen, A. C. (1983). The psychological significance of pubertal change. In J. Brooks-Gunn & A. C. Petersen (Eds.), *Girls at puberty* (pp. 127–154). Boston: Springer US.

Třebický, V., Havlíček, J., Roberts, S. C., Little, A. C., & Kleisner, K. (2013). Perceived aggressiveness predicts fighting performance in mixed-martial-arts fighters. *Psychological Science, 24*, 1664–1672.

Třebický, V., Fialová, J., Kleisner, K., Roberts, S. C., Little, A. C., & Havlíček, J. (2015). Further evidence for links between facial width-to-height ratio and fighting success: commentary on Zilioli et al.(2014). *Aggressive Behavior, 41*, 331–334.

Třebický, V., Fialová, J., Stella, D., Coufalová, K., Pavelka, R., Kleisner, K., et al. (2018). Predictors of fighting ability inferences based on faces. *Frontiers in Psychology, 9*, 2740.

Valentova, J. V., Varella, M., Bártová, K., Štěrbová, Z., & Dixson, B. J. W. (2017). Mate preferences and choices for facial and body hair in heterosexual women and homosexual men: effects of sex, population, homogamy, and imprinting-like effects. *Evolution and Human Behavior, 38*, 241–248.

van Doorn, J., van den Bergh, D., Bohm, U., Dablander, F., Derks, K., Draws, T., … Wagenmakers, E. (2019, January 23). The JASP Guidelines for Conducting and Reporting a Bayesian Analysis. https://doi.org/10.31234/osf.io/yqxfr

von Rueden, C. R., & Jaeggi, A. V. (2016). Men's status and reproductive success in 33 nonindustrial societies: effects of subsistence, marriage system, and reproductive strategy. *Proceedings of the National Academy of Sciences of the United States of America, 113*, 10824–10829.

Watkins, C. D., Fraccaro, P. J., Smith, F. G., Vukovic, J., Feinberg, D. R., DeBruine, L. M., & Jones, B. C. (2010a). Taller men are less sensitive to cues of dominance in other men. *Behavioral Ecology, 21*, 943–947.

Watkins, C. D., Jones, B. C., & DeBruine, L. M. (2010b). Individual differences in dominance perception: dominant men are less sensitive to facial cues of male dominance. *Personality and Individual Differences, 49*, 967–971.

Whitehouse, A. J., Gilani, S. Z., Shafait, F., Mian, A., Tan, D. W., Maybery, M. T., et al. (2015). Prenatal testosterone exposure is related to sexually dimorphic facial morphology in adulthood. *Proceedings of the Royal Society B: Biological Sciences, 282*, 20151351.

Wilson, R. S., James, R. S., Bywater, C., & Seebacher, F. (2009). Costs and benefits of increased weapon size differ between sexes of the slender crayfish, *Cherax dispar*. *Journal of Experimental Biology, 212*, 853–858.

Windhager, S., Schaefer, K., & Fink, B. (2011). Geometric morphometrics of male facial shape in relation to physical strength and perceived attractiveness, dominance, and masculinity. *American Journal of Human Biology, 23*, 805–814.

Wong, B. B., & Candolin, U. (2005). How is female mate choice affected by male competition? *Biological Reviews, 80*, 559–571.

Wood, D. R. (1986). Self-perceived masculinity between bearded and non-bearded males. *Perceptual and Motor Skills, 62*, 769–770.

Wright, E., Galbany, J., McFarlin, S. C., Ndayishimiye, E., Stoinski, T. S., & Robbins, M. M. (2019). Male body size, dominance rank and strategic use of aggression in a group-living mammal. *Animal Behaviour, 151*, 87–102.

Zaidi, A. A., White, J. D., Mattern, B. C., Liebowitz, C. R., Puts, D. A., Claes, P., & Shriver, M. D. (2019). Facial masculinity does not appear to be a condition-dependent male ornament and does not reflect MHC heterozygosity in humans, Proceedings of the National Academy of Sciences*., 116*, 1633–1638.

Zilioli, S., Sell, A. N., Stirrat, M., Jagore, J., Vickerman, W., & Watson, N. V. (2015). Face of a fighter: bizygomatic width as a cue of formidability. *Aggressive Behavior, 41*, 322–330.