

## **Is sociopolitical egalitarianism related to bodily and facial formidability in men?**

Michael E. Price\*<sup>1</sup>, Jennifer Sheehy-Skeffington<sup>2</sup>, James Sidnaius<sup>3</sup>  
& Nicholas Pound<sup>1</sup>

\*Corresponding author ([michael.price@brunel.ac.uk](mailto:michael.price@brunel.ac.uk))

<sup>1</sup>Department of Life Sciences  
Brunel University London

<sup>2</sup>Department of Psychological & Behavioural Science  
London School of Economics & Political Science

<sup>3</sup>Department of Psychology  
Harvard University

Word count (excluding references): 7,070

## **Is sociopolitical egalitarianism related to bodily and facial formidability in men?**

### **Abstract**

Social bargaining models predict that men should calibrate their egalitarian attitudes to their formidability and/or attractiveness. A simple social bargaining model predicts a direct negative association between formidability/attractiveness and egalitarianism, whereas a more complex model predicts an association moderated by wealth. Our study tested both models with 171 men, using two sociopolitical egalitarianism measures: social dominance orientation and support for redistribution. Predictors included bodily formidability and attractiveness and four facial measures (attractiveness, dominance, masculinity, and width-to-height ratio). We also controlled for time spent lifting weights, and experimentally manipulated self-perceived formidability in an attempt to influence egalitarianism. Both the simple and complex social bargaining models received partial support: sociopolitical egalitarianism was negatively related to bodily formidability, but unrelated to other measures of bodily/ facial formidability/attractiveness; and a formidability-wealth interaction did predict variance in support for redistribution, but the nature of this interaction differed somewhat from that reported in previous research. Results of the experimental manipulation suggested that egalitarianism is unaffected by self-perceived formidability in the immediate short-term. In sum, results provided some support for both the simple and complex social bargaining models, but suggested that further research is needed to explain why male formidability/attractiveness and egalitarianism are so often negatively related.

**Keywords:** Formidability; egalitarianism; social bargaining power; social dominance orientation; attractiveness; facial masculinity

Over human evolutionary history, individuals who were relatively physically formidable and/or attractive would also have been relatively more able to bestow benefits and/or impose harm on others, and consequently would have had increased bargaining power in social interactions (Lukaszewski, 2013; Sell, Tooby, and Cosmides, 2009). Formidability increases an individual's bargaining power by enhancing abilities both to threaten violence and to offer protection and work effort (Price, Dunn, Hopkins, and Kang, 2012; Sell et al., 2009b; Snyder et al., 2011). Moreover, attractive people have higher bargaining power because they are preferred as social associates (Langlois et al., 2000), a manifestation of the attractiveness "halo effect" which leads to the attribution of a range of positive traits to attractive individuals (Dion, 2002; Eagly, Ashmore, Makhijani, & Longo, 1991). In part, this may be because traits perceived as attractive are signals of underlying characteristics such as health, developmental stability, and fertility (Grammer, Fink, Møller, and Thornhill, 2003; Nedelec & Beaver, 2014; Roney, 2009).

Due to their increased bargaining power, formidable/attractive individuals would have been relatively more likely to prevail in social competitions, and thus to benefit from the inequities in status and resource distribution that would have been the outcome of such competitions. Individuals who were more formidable and/or attractive would thus have had more opportunity to benefit from social norms promoting inequality rather than those promoting equality. By this reasoning, a tendency for people who are more formidable and/or attractive to exhibit a reduced tendency to support egalitarian norms may be an element of evolved human psychology (Price, Brown, Dukes, & Kang, 2015; Price, Kang, Dunn, & Hopkins, 2011). We'll refer to this proposition as the 'simple social bargaining' model of egalitarianism ('simple' because as discussed below, a more complex social bargaining model of egalitarianism has also been proposed).

*Evidence consistent with the simple social bargaining model*

Several studies support the hypothesis that formidability and/or attractiveness are negatively related to egalitarianism, particularly in males. Sell et al. (2009b) reported that stronger men perceive themselves to be more entitled to special treatment, while Price et al. (2011) found that male bodily attractiveness and formidability correlated negatively with egalitarianism on several measures, including the measure of social dominance orientation devised by Pratto, Sidanius and colleagues (Pratto, Sidanius, Stallworth, & Malle, 1994). Price et al. (2015) also found that men with more attractive bodies are less egalitarian on a variety of behavioral and psychological measures, but found no relationship between bodily formidability and these egalitarianism measures. Several experimental economic studies (Sanchez-Pages and Turiegano, 2010; Shinada & Yamagishi, 2014; Takahashi, Yamagishi, Tanida, Kiyonari, and Kanazawa, 2006; Zaatari and Trivers, 2007) have demonstrated that relatively inequalitarian resource distribution decisions are made by men who possess traits that are judged as more attractive by others, and/or who possess more symmetrical faces and bodies (symmetry being a putative indicator of attractiveness, health, and underlying genotypic quality [Møller, 2006]). Finally, Holtzman, Augustine and Senne (2011) reported that bodily/facial symmetry relates negatively to prosocial personality traits, including some related to egalitarianism (e.g., fairness, empathy), in both men and women.

Three points should be noted about the studies cited in the preceding paragraph. First, although not all have found significant relationships between all attractiveness/formidability measures and all egalitarianism measures (e.g. as noted with regard to Price et al., 2015), when significant relationships have been observed, they have always been negative. Second, the results reported above refer to measures of formidability and attractiveness that were either objectively measured (e.g., bicep circumference, physical strength, fluctuating asymmetry) or based on others' perceptions (e.g., faces rated for attractiveness), as opposed

to self-assessments. This emphasis on objective and other-perceived measures is important because self-assessments of physical characteristics are not necessarily reliable reflections of reality as perceived by others. This appears to be particularly true with regard to women's ratings of their own attractiveness, which tend to correlate only weakly with anthropometric measures and others' ratings of their attractiveness (Brewer, Archer & Manning, 2007; Paunonen, 2003; Price, Dunn, Hopkins & Kang, 2012). Third, not all of these studies were designed to test for relationships between egalitarianism and objectively measured or other-perceived attractiveness/formidability in women (as well as men). However, of those that were, only one has found such relationships (Holtzman et al., 2011). All other studies have reported these relationships in men only (Price et al., 2011, 2015; Sell et al., 2009b; Shinada & Yamagishi, 2014; Zaatari and Trivers, 2007; Takahashi et al., 2006). Two studies have reported negative relationships between egalitarianism and *self*-perceived attractiveness in women (Price et al., 2011; Sell et al., 2009b), and an additional study (not cited above) reported positive correlations between self-perceived attractiveness and support for inequality in both women and men (Belmi & Neale, 2014). However, as just noted, self-perceived attractiveness does not appear to reliably reflect attractiveness as perceived by others, and thus seems like a relatively unreliable measure of social bargaining power (although it may be a useful measure of personality traits such as narcissism [Bleske-Rechek, Remiker & Baker, 2008] or confidence).

The absence of a relationship between formidability and egalitarianism in females is not surprising, since ancestrally, upper body strength was probably much less important to women than to men as a determinant of competitive ability (Lassek & Gaulin, 2009). However, the lack of good evidence for an attractiveness-egalitarianism relationship in females is more unexpected, as attractiveness is assumed to be an important aspect of female social bargaining power (Sell et al., 2009b), perhaps especially among women of

reproductive age. A potential explanation for this finding may be rooted in theories of parental investment and sexual selection (Trivers, 1972), which suggest that success in ancestral status/resource competition was a higher-stakes game in terms of reproductive payoffs for males than for females. Ancestral men may thus have had greater incentives to base their attitudes about resource distribution not just on their formidability, but also on other aspects of their intrasexual competitive ability, including their attractiveness (Price et al., 2015). Females, on the other hand, with less to gain from status/resource competition, are subject to less selective pressure to bring their resource-related attitudes in line with their social bargaining power. If the greater attractiveness-egalitarianism correlation in men were a reflection of higher-stakes reproductive competition among males, this may also help explain why this correlation seems highest among younger men (Shinada & Yamagishi, 2014), of the age range associated with intensified male mating competition (Wilson & Daly, 1985).

#### *Alternatives to the simple social bargaining model of egalitarianism*

The studies reviewed above provide evidence that is consistent with the simple social bargaining model, which proposes a direct negative association between formidability/attractiveness and egalitarianism, especially in men. However a more complex version of the social bargaining model has been presented by Peterson and colleagues (Petersen, Sznycer, Sell, Cosmides, & Tooby, 2013), who propose that the effect of formidability on 'support for redistribution' (i.e., the belief that the government should redistribute wealth from richer to poorer) in males is moderated by income. They report that in three samples of male participants (university students from Argentina and the USA, and a nationally representative Danish sample), a significant interaction effect was observed between upper body strength and wealth whereby strength and support for redistribution were negatively related in wealthier men but positively related in less-wealthy men. These results

were interpreted as evidence that support for redistribution reflects male self-interest, as shaped by their contemporary resource stock: wealthier men are in a better position to defend their wealth if they are stronger, whereas less-wealthy men are in a better position to demand redistribution if they are stronger. The finding that strength and egalitarianism are positively related in poorer men is especially interesting as it represents an exception to the rule, noted above, that whenever relationships between egalitarianism and formidability/attractiveness have been found, they have been negative.

It could also be the case that both the simple and complex social bargaining models of egalitarianism are mistaken in their suggestion that egalitarianism levels are caused by formidability/attractiveness. The studies cited above have demonstrated correlations between formidability/attractiveness and egalitarianism, but formidability/attractiveness could actually be caused by egalitarianism, if less-egalitarian men were more motivated to increase their own formidability/attractiveness, for example by engaging in more resistance training activities such as weightlifting (Price et al., 2015). (Motivation to lift weights could increase both formidability and attractiveness in males, as male muscularity is perceived as attractive if not too extreme [Frederick & Haselton, 2007]). Alternatively, egalitarianism and formidability/attractiveness could both be influenced by some third variable (e.g., narcissism or dominance striving; for discussion see below) associated with both reduced egalitarianism and greater motivation to build one's muscles. Consistent with the notion that men who strive for muscularity tend to be less egalitarian, Swami and colleagues (2013) report that among UK men, social dominance orientation is correlated with higher scores on a "drive for muscularity" scale (McCreary, 2007).

*The current study*

Our study aimed to make progress on several issues described above concerning egalitarianism's relationships with formidability and attractiveness. Given the weak theoretical and empirical case for the existence of these relationships among females, we focused our research efforts on males. Our primary goals were to test for the two types of relationships between formidability/attractiveness and egalitarianism described above: a simple negative association, and a more complex relationship moderated by wealth. We also focused on a particular form of egalitarianism, 'sociopolitical egalitarianism'—that is, attitudes about how status and resources ought to be distributed among different groups within society—as this kind of egalitarianism seems relevant to real-world human affairs in an especially concrete way. For our first measure of sociopolitical egalitarianism we chose social dominance orientation (SDO; Pratto et al., 1994), a widely-used measure of the extent to which one approves of some social groups maintaining a position of dominance over others. SDO scores are positively correlated with real-world political attitudes such as conservatism, right-wing authoritarianism, and opposition to policies which promote equality (Ho et al., 2015; Pratto, et al, 1994; Sibley, 2006; Sidanius, Cotterill, Sheehy-Skeffington, Kteily, & Carvacho, 2016). Our second measure of sociopolitical egalitarianism was the support for redistribution scale. This scale measures a fundamental political attitude—preference for large-scale economic redistribution—and as noted above was devised for the complex social bargaining model of Peterson et al. (2013). SDO and support for redistribution are similar in that both are forms of sociopolitical egalitarianism that have been analyzed in relation to male formidability in previous studies (Price et al., 2011; Peterson et al., 2013). However they are also quite different conceptually, so in our analysis we regarded them as distinct outcome variables.



In addition to focusing on bodily formidability and attractiveness, we also examined facial formidability and attractiveness. Several aspects of facial shape and appearance are presumed to be good indicators of physical condition and formidability, and we measured them in order to determine the strength of their associations both with egalitarianism and with bodily formidability itself. These measures included others' ratings of facial dominance and of facial attractiveness; both of these variables positively predict ability to compete for resources in modern organisations (Fruhen, Watkins & Jones, 2015), and the former is a positive predictor of male strength (Toscano, Schubert & Sell, 2014). Facial variables also included objectively-measured facial shape masculinity (Penton Voak et al., 2001), which, like muscularity, is believed to increase with developmental testosterone exposure and is correlated with circulating testosterone levels in adult males exposed to competitive stimuli (Pound, Penton-Voak & Surridge, 2009). Moreover, we included facial width-to-height ratio (fWHR), a variable which has recently been shown to be associated with a range of related behavioural traits in males (for a review see Hodges-Simeon et al., 2016). Of particular note, fWHR has been shown to correlate positively with male strength (Windhager et al., 2011), fighting ability (Zilioli et al., 2015), aggression (Haselhuhn et al., 2015), and perceived dominance (Mileva et al., 2014). However, unlike the measure of facial masculinity used by Penton Voak et al. (2001) and Pound et al. (2009), fWHR is not reliably sexually dimorphic (Kramer, Jones, & Ward, 2012; Lefevre et al., 2012; Özener, 2012). Moreover, evidence of an association between fWHR and testosterone levels is equivocal (Hodges-Simeon et al., 2016; Lefevre et al., 2013).

In order to test whether changes in self-perceived formidability may exert a causal influence on egalitarian beliefs we included an experimental manipulation in which participants received “feedback” about their own relative formidability. Some participants were provided with information suggesting that they were much more formidable than the

population average, and others that they were much less formidable. Moreover, in order to examine the possibilities that either less-egalitarian men are more motivated to build their own muscles, or that some third variable might lead to both reduced egalitarianism and increased muscularity-striving, we asked participants to indicate how much time they spend taking part in resistance training (i.e. lifting weights).

## **Method**

### *Participants*

Male participants ( $N = 171$ ) aged 18-40 ( $M = 21.10$ ,  $SD = 2.83$ ), 98% of whom were students, were recruited via advertisements posted around the campus of a UK university and paid £5 for about 30 minutes of participation time. Ethnically the sample was 51% White, 25% Asian or Asian British, 11% Black or Black British, 6% mixed, and 6% other.

### *Procedure*

After providing informed consent, each participant removed his shoes, any hat and outer layers of clothing, and any objects in his pockets. If he was wearing a thin base layer (e.g. t-shirt) without any bulky aspects (pockets, buttons, etc.), he was allowed to keep wearing it. Otherwise he changed into a t-shirt provided by researchers. His height (in centimetres, by stadiometer) and weight (in kilograms, by digital scale) were then recorded.

Anthropometric measurements were then taken via tape measure of circumferences of shoulders, chest, bicep, and waist. Chest and shoulders were measured at fullest and widest circumference, with the chest measurement crossing the shoulder blades; participants stood in a relaxed position, with arms hanging loose at sides of body, without flexing any muscles or puffing out chest. Flexed bicep circumference was measured at the widest point (the bicep peak) of the dominant arm. Waist was measured at the narrowest circumference above the upper pelvis (iliac crest) and below the lower rib cage. Upper body measurements were

recorded independently by two researchers and entered on separate record sheets. These independent measurements were then averaged and written on the cover sheet of the study questionnaire (as part of the experimental manipulation, described below). Repeatabilities (intraclass correlation coefficients) for all upper body measurements were high (.96-.98).

Next, hand grip and arm/chest strength were measured via digital dynamometer (Saehan Corporation: Yeongdeok-dong, South Korea) in a manner similar to previous studies (Lukaszewski et al., 2014; Price et al., 2015). Each participant was instructed to hold the dynamometer (a) in his dominant hand, squeezing it as hard as possible (for grip strength), and (b) in front of his chest, pressing inward with both hands as hard as possible (for arm/chest strength).

Participants then completed the study questionnaire at their own pace, seated in an area of the lab space that afforded maximum privacy.

Participants' faces were photographed in a standing position, with a neutral expression, using a digital camera (Canon EOS 350D) at a resolution of 1629 x 2304 pixels, with bilateral illumination (Portaflash DL 1000). Where necessary to reveal the hairline, hair was pulled back with a hairband. The vertical position of the camera was adjusted to position the image centre point on the midpoint between the participant's pupils and participants were asked to relax but stand straight, looking directly ahead at camera with a neutral expression. Three photos were taken and reviewed immediately; if none appeared to have captured the participant in a neutral expression then additional photos were taken.

Finally participants were paid, given a debrief form, and dismissed.

### *Variables*

*Bodily formidability.* A composite measure of bodily formidability was computed by converting all measurements for males in the sample to  $z$ -scores, and taking the mean of

shoulder, chest, bicep, grip strength, and arm/chest strength measurements. All five  $z$  scores were highly intercorrelated (mean item-total correlation = .73) so the composite measure had high reliability ( $\alpha = .89$ ).

*Waist-chest ratio.* This measure of bodily attractiveness was calculated by dividing waist circumference by chest circumference. Several studies suggest that measures of torso “v-shapedness,” in particular lower waist-to-chest ratio, are excellent predictors of male bodily attractiveness (Coy, Green and Price, 2014; Fan, Dai, Liu, and Wu, 2005; Horvath, 1979; Maisey, Vale, Cornelissen, and Tovée, 1999; Price et al., 2013; Swami and Tovée, 2005; Swami et al., 2007).

*Social Dominance Orientation.* This composite measure ( $\alpha = .88$ ) is the most widely-used index of support for social inequality in social and political psychology. Participants responded to the 16 items of the SDO<sub>6</sub> scale (Pratto et al., 1994) on a 7-point Likert scale from ‘disagree strongly’ to ‘agree strongly’. Sample items were “Inferior groups should stay in their place” and “Increased social equality is beneficial to society” (reverse-coded).

*Support for Redistribution.* This composite measure ( $\alpha = .82$ ) consisted of the ten items Peterson et al. (2013) used to measure support for economic redistribution. Participants responded on a 7-point Likert scale from ‘disagree strongly’ to ‘agree strongly’ to items such as “High incomes should be taxed more than is currently the case” and “The government spends too much money supporting the unemployed” (reverse-coded).

*Objective and Subjective Wealth.* We measured wealth in both objective and subjective terms. For objective wealth we asked about parental income, as 98% of our participants were students. Participants responded on an 11-point scale, from “below £10,000” to “over £150,000”, to the question: “What is your best estimate of your parents’ combined annual income before taxes in the most recent calendar year? (If both of your parents are unknown to you or deceased, please tick ‘does not apply’)”. Twenty-one

participants ticked ‘does not apply’, so the  $n$  for objective wealth was 150. We measured subjective wealth by asking participants to fill in the blank in the item “My family is wealthier than \_\_\_\_% of other families in my society”.

*Rated Facial Dominance.* Raters scored participant facial photographs on a 1-7 scale from “Not at all dominant” to “Very dominant” (the same scale used by Toscano et al., 2014). To avoid rater fatigue, each rater evaluated not all 171 faces but instead a batch of only 60, presented in random order. Raters were recruited via MTurk and were compensated \$0.25 for their time; most took 5-6 minutes to rate the 60 faces. There were three groups of 29-30 raters and 89 raters in all, and inter-rater reliability was high (mean  $\alpha$  for the three rater groups = .93). Raters were 57% male; ethnically they were 83% white/Caucasian and 17% black/African American, Hispanic/Latino, Asian, or other; and their mean age was 34.19 years ( $SD = 11.14$ ).

*Rated Facial Attractiveness.* Female raters scored participant facial photographs on a 1-7 scale from “Not at all attractive” to “Very attractive”. To avoid rater fatigue, faces were rated in batches of 60 (the same methodology described above for facial dominance). Once again, raters were recruited via MTurk, compensated \$0.25, and usually took 5-6 minutes to rate 60 faces. There were three groups of 22-28 raters and 77 raters in all, and inter-rater reliability was high (mean  $\alpha$  for the three rater groups = .90). Raters were 100% female; ethnically they were 86% white/Caucasian and 14% black/African American, Hispanic/Latino, Asian, or other; and their mean age was 34.79 years ( $SD = 12.19$ ).

*Facial masculinity.* As in Pound et al. (2009), five facial dimensions (ratios) previously shown to be sexually dimorphic (Penton-Voak et al. 2001) were measured. These ratios were: (i) eye size, (ii) lower face/face height, (iii) cheekbone prominence, (iv) face width/lower face height, and (v) mean eyebrow height. Landmarks and dimensions used are shown in the Supplementary Material. Details of the facial landmarks used to define these

dimensions can be found in Penton-Voak et al. (2001) and Pound et al. (2009). Measurements were made as described in Penton-Voak et al. (2001) by using Psychomorph software (Tiddeman et al., 2001) to record landmark locations. However, unlike in Penton-Voak et al. (2001), in order to standardize face position and orientation, prior to the calculation of any dimensions, the x–y coordinates of the facial landmarks were superimposed using the Procrustes fit procedure in MorphoJ (Klingenberg, 2011) to remove positional, rotational and scale differences. Then, as in the previous studies, for each dimension the measures were converted to standardized ( $z$ ) scores, and a composite facial masculinity index was computed as the sum of these  $z$  scores (oriented such that higher scores are more masculine for each dimension).

*Facial width-to-height ratio (fWHR).* As with facial masculinity, facial width-to-height ratio (fWHR) was measured with landmarks positioned using Psychomorph software, and subsequently registered using the Procrustes fit procedure in MorphoJ (Klingenberg, 2011). Landmarks and dimensions used are shown in the Supplementary Material. Facial height has been measured in various ways in previous studies, but most commonly from the upper lip to the lower border of the eyebrows rather than the pupils (Haselhuhn, 2015), so we used this method. Facial width was measured as the horizontal distance between the most outward projecting points on the face at or below the eyes, that is, approximating the distance between the left and right zygion left and the right zygion (bizygomatic width). Facial height was measured as the vertical distance from upper vermilion border of the upper lip (i.e. average position of left and right philtra) to the average vertical position of the lower borders of the eyebrows directly above the pupils.

*Time in gym.* The questionnaire contained the item “Approximately how much time per week do you spend lifting weights, in order to build your muscles?” Responses were on a 1-6 scale (1 = none at all, 6 = more than four hours).

### *Experimental manipulation*

In order to manipulate participants' perception of their relative formidability compared to other participants, different versions of the questionnaire cover page were used to provide participants with different information, creating four experimental conditions, two of which involved deception. In all four conditions, eight of the participant's own anthropometric and strength measurements—height, weight, shoulder/chest/waist/bicep circumferences, and grip/chest strength—were entered by researchers on a cover page table, in a column titled “Your measurements”. In the “no reference data” condition, the participant's own measurements were the only ones provided. The first 44 participants (approximately  $\frac{1}{4}$  of the total sample) were all assigned to this condition (because their mean scores would go on to determine the information shown to participants in the other three conditions). The last 127 participants (approximately  $\frac{3}{4}$  of the total sample) were assigned randomly to one of the three other conditions. In these conditions, additional information was displayed prominently in the cover page table, in a column titled “Average measurement of male participants in previous version of this study”. Entries in this column were “N/A” for five of the eight measurements, but for the remaining three—bicep circumference, grip strength, and chest strength—measurements were entered which the participant could compare directly to his own. Measurements were provided for these three particular variables because they are the ones most directly indicative of formidability, and N/A was entered for the other variables to avoid distracting participants with less-relevant information. The values provided for other participants' bicep and strength measurements varied by condition: in the “accurate reference data” condition, these values were the actual means of the 44 “no reference data” participants; in the “increased self-perceived formidability” condition, they were these means reduced by one standard deviation (to make the participant feel relatively

strong); and in the “decreased self-perceived formidability” condition, they were these means raised by one standard deviation (to make the participant feel relatively weak).

## Results

### *Bodily and facial predictors of sociopolitical egalitarianism*

Intercorrelations and descriptive statistics are shown in Table 1 (all  $p$  values in this table and throughout this paper are 2-tailed). As predicted, bodily formidability correlated significantly positively with SDO ( $r[168] = .22, p = .004$ ) and significantly negatively with support for redistribution ( $r[169] = -.19, p = .012$ ). After controlling for the effects of time in gym on SDO, bodily formidability’s relationship with SDO remained significantly positive (partial  $r[161] = .17, p = .03$ ), but its relationship with support for redistribution fell to non-significance (partial  $r[162] = -.08, p = .32$ ). Controlling for formidability, time spent in the gym did not significantly predict SDO (partial  $r[161] = .08, p = .31$ ), though it did significantly predict support for redistribution (partial  $r[162] = -.24, p = .002$ ).

Contrary to predictions, there were no significant correlations between SDO or support for redistribution and either bodily attractiveness (waist-chest ratio) or any of the facial measures (attractiveness, dominance, fWHR, and masculinity). These predictors also failed to explain significant variance in SDO and support for redistribution when they were entered in combination with other predictors into multiple regression models. Table 2 displays the results of regressing SDO and support for redistribution on all of these predictors simultaneously. When SDO was the outcome variable and bodily formidability was entered as the first predictor, no other single predictor (from the set of the four facial variables, waist-chest ratio, and time in gym) could be added to explain additional significant variance in SDO. When support for redistribution was the outcome variable and time in gym was entered as the first predictor, no other single predictor (from the set of the four facial variables, waist-



chest ratio, and bodily formidability) could be added to explain additional significant variance in support for redistribution.

#### *Effects of the conditions on sociopolitical egalitarianism*

To test whether the experimental manipulation had any effect on expressed sociopolitical egalitarianism, we ran ANOVA models with either SDO or support for redistribution as the dependent variable, experimental condition as the factor, and bodily formidability and time in gym as co-variates. The effects of condition were non-significant, both when the dependent variable was SDO ( $p = .62$ ) and when it was support for redistribution ( $p = .32$ ), and pairwise comparisons revealed no significant differences in either dependent variable between any two conditions ( $p$ 's  $\geq .10$ ).

#### *Interaction effects of bodily formidability and wealth on sociopolitical egalitarianism*

To test whether an interaction between bodily formidability and wealth explained any unique variance in sociopolitical egalitarianism, we ran a series of multiple regression models in which either SDO or support for redistribution was the outcome variable, and the predictors were bodily formidability, one of the (centred) wealth measures (either objective or subjective wealth), and the formidability-wealth interaction term. Results of these models are shown in Table 3.

When SDO was the outcome variable, bodily formidability was a significant positive predictor, regardless of whether the wealth predictor was subjective or objective. However, neither subjective nor objective wealth, nor either of the wealth-formidability interaction terms, were significant predictors.

When support for redistribution was the outcome variable, bodily formidability was a significant negative predictor, regardless of whether the wealth predictor was subjective or

objective. Further, both subjective and objective wealth were significant negative predictors in their respective models, and when objective wealth was the predictor (but not when subjective wealth was the predictor), the formidability-wealth interaction term was also significantly negative.

To explore the dynamics of this significant interaction effect, we categorized our participants as either below sample mean or above sample mean on objective wealth, and checked the correlation between bodily formidability and support for redistribution within each category. Figure 1 illuminates the source of the interaction effect: bodily formidability and support for redistribution were significantly negatively correlated among participants of above-mean wealth ( $r[62] = -.40, p = .001$ ), but uncorrelated among those of below-mean wealth ( $r[88] = -.04, p = .73$ ). Very similar results were obtained by splitting objective wealth at sample median rather than mean (above median,  $r[67] = -.40, p = .001$ ; at and below median,  $r[83] = -.01, p = .92$ ).

Finally, we ran four multiple regression models that were identical to those in Table 3 except they also included time in gym as a predictor. Inclusion of time in gym had little effect on the two models in which SDO was the outcome variable: time in gym was not a significant predictor in either model, and bodily formidability remained the only significant predictor in each model ( $p$ 's  $\leq .04$ ). In both of the models in which support for redistribution was the outcome variable, however, inclusion of time in gym caused bodily formidability to drop out as a significant predictor ( $p$ 's  $\geq .30$ ), and the variance that formidability had explained in support for redistribution was now explained by time in gym ( $p$ 's  $\leq .007$ ). Apart from this change, both support for redistribution models were largely unaffected by the inclusion of time in gym, in that subjective and objective wealth remained significant predictors in their respective models ( $p$ 's  $\leq .01$ ), and as before, the formidability-wealth interaction was significant with objective wealth ( $p = .008$ ) but not with subjective wealth.

**Table 1:** Intercorrelations and descriptive statistics

	1	2	3	4	5	6	7	8	9	10	11
1. Bodily formidability	-										
2. Waist-chest ratio	-.05	-									
3. SDO	.22**	-.11	-								
4. Support for redistribution	-.19*	.04	-.42**	-							
5. Objective wealth	-.01	-.02	-.04	-.25**	-						
6. Subjective wealth	.07	.01	.13	-.20**	.59**	-					
7. Facial dominance	.32**	.08	.05	-.09	-.09	-.08	-				
8. Facial attractiveness	.03	-.22**	.08	-.07	.02	-.04	-.10	-			
9. Facial Width-height ratio	.14	.24**	<.01	.12	-.08	-.16*	.15	-.20**	-		
10. Facial masculinity	.19*	.01	.04	-.11	-.06	-.06	.16*	.21**	-.17*	-	
11. Time in gym	.44**	-.18*	.17*	-.30**	.08	<-.01	.17*	-.02	-.09	.18*	-
M	0.00	0.85	2.75	4.24	5.17	44.11	-4.33	-5.34	1.93	0.00	2.67
SD	0.84	0.04	1.04	1.11	3.12	23.37	0.77	0.63	0.14	2.4	1.83
N	171	171	170	171	150	166	171	171	171	171	165

\* $p < .05$ , \*\* $p < .01$ . SDO = Social dominance orientation.

**Table 2:** Multiple regression of sociopolitical egalitarianism on all bodily and facial predictors

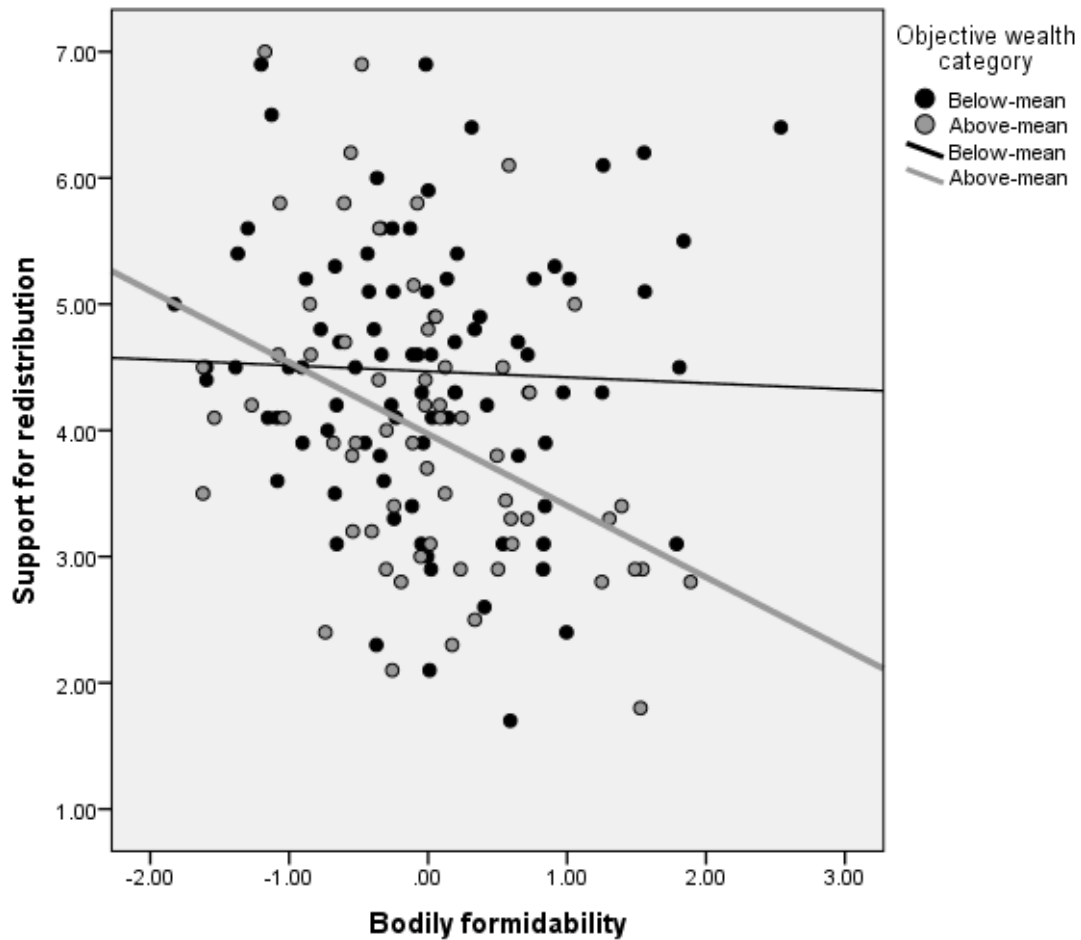
<b>Predictor</b>	Outcome variable: <b>Social dominance orientation</b>	Outcome variable: <b>Support for redistribution</b>
	<b><math>\beta</math></b>	<b><math>\beta</math></b>
Bodily formidability	.19*	-.09
Time in gym	.08	-.25**
Waist-chest ratio	-.06	-.05
Facial dominance	-.02	-.03
Facial attractiveness	.06	-.07
fWHR	<.01	.10
Facial masculinity	-.01	-.02
	Overall: $N = 164$ , $R = .26$ , Adj $R^2 = .02$	Overall: $N = 165$ , $R = .33^{**}$ , Adj $R^2 = .07$

\* $p < .05$ , \*\* $p < .01$ . fWHR = facial width-height ratio.

**Table 3:** Multiple regression models testing for interaction effect of bodily formidability and wealth on sociopolitical egalitarianism

Predictor	Outcome variable: Social dominance orientation		Outcome variable: Support for redistribution	
	Wealth predictor: Subjective	Wealth predictor: Objective	Wealth predictor: Subjective	Wealth predictor: Objective
	$\beta$	$\beta$	$\beta$	$\beta$
Bodily formidability	.22**	.21*	-.20**	-.20*
Wealth	.11	-.04	-.18*	-.25**
Wealth x formidability	<.01	.08	-.05	-.21**
	Overall: $N = 165$ , $R = .26^*$ , $Adj R^2 = .05$	Overall: $N = 149$ , $R = .23$ , $Adj R^2 = .03$	Overall: $N = 166$ , $R = .29^{**}$ , $Adj R^2 = .07$	Overall: $N = 150$ , $R = .37^{**}$ , $Adj R^2 = .12$

\* $p < .05$ , \*\* $p < .01$ .



**Figure 1: Scatterplot illustrating interaction associations between bodily formidability and support for redistribution in objectively more and less wealthy participants.** For participants of below-mean wealth (black points and fit line) there is no correlation between formidability and support for redistribution ( $r[88] = -.04$ ,  $p = .73$ ), whereas for those of above-mean wealth (grey points and fit line), this correlation is significantly negative ( $r[62] = -.40$ ,  $p = .001$ ).

## Discussion

Results were consistent with some but not all predictions tested. First, as expected, bodily formidability did relate negatively to sociopolitical egalitarianism. Bodily formidability correlated positively with SDO (a replication of Price et al., 2011) and negatively with support for redistribution. As noted above, these formidability-egalitarianism relationships could be the result of men calibrating their egalitarianism to their own formidability, or alternatively could be due to increased muscularity-striving among less-egalitarian men, or to egalitarianism and muscularity-striving both depending on a third variable. Therefore we checked whether relationships between bodily formidability and egalitarianism would remain significant, after controlling for the effects of time spent in gym on egalitarianism, and we found that they did remain significant in the case of SDO, but not in the case of support for redistribution.

We also conducted a more direct test of the hypothesis that men calibrate their egalitarianism in response to their own formidability, by experimentally manipulating the extent to which participants perceived their own formidability to be greater or lesser than that of other participants. However, the manipulation had no effect on participant egalitarianism. This lack of an effect could indicate that egalitarian attitudes are relatively stable and difficult to spontaneously manipulate; if men do calibrate their egalitarianism to their own formidability, the process by which they do so may be more slow-developing and complex than that modelled in this study. Alternatively, it may be the case that men do not calibrate their egalitarianism to their formidability, and that the negative correlations between formidability and egalitarianism that have been found (as in the current study, Price et al., 2011, and Sell et al., 2009b) have been due to something other than a causal effect of formidability on egalitarianism (a possibility discussed in more detail below). Finally, it is possible that the manipulation simply did not work. In our previous studies on male

formidability, we have noticed informally that participants tend to express a keen interest in how their measurements compare to those of other men in the sample, which led us to expect that participants in the current study would be strongly curious about this information. However, a limitation of this study was its lack of a manipulation check (e.g. a measure of self-perceived formidability), which reduces our insight into manipulation effectiveness. The information we provided participants about their relative formidability was in numerical form, which may not be a sufficiently ecologically valid form to serve as input for the psychological mechanisms that evolved to regulate self-perceived formidability. A more ecologically valid manipulation, such as physically incapacitating participants (Fessler and Holbrook, 2013), could potentially have more effectively influenced participants' egalitarianism levels.

We also found no evidence that male bodily attractiveness is negatively related to sociopolitical egalitarianism: waist-chest ratio did not significantly predict SDO or support for redistribution. This lack of a relationship between SDO and waist-chest ratio in males was also reported in Price et al. (2011). However, men with more attractive waist-chest ratios have been found to be relatively inegalitarian on some other measures of egalitarianism (e.g., social value orientation and dictator game contribution; Price et al., 2011, 2015). Based on the research so far in this area, male bodily attractiveness may be related to some forms of egalitarianism, but there is no evidence to link it specifically to SDO or to support for economic redistribution at the societal level.

Nor did we find evidence to suggest a relationship between facial shape or appearance and sociopolitical egalitarianism: neither SDO nor support for redistribution was related to facial dominance, masculinity, fWHR, or attractiveness. We observed these null effects even though some of these facial variables did appear to be good indicators of bodily traits that were themselves related to egalitarianism: bodily formidability was significantly positively



related to both facial dominance and facial masculinity, and marginally so ( $p = .08$ ) to fWHR. Nonetheless in our study only bodily formidability itself, and not any facial correlates of bodily formidability, was a significant predictor of sociopolitical egalitarianism.

The attempt to replicate the interaction effects reported in Peterson et al. (2013) produced mixed results. That paper reported that in three male samples (two of which were university students, as in our study), a significant interaction effect was observed between bodily formidability and subjective wealth whereby formidability and support for redistribution were negatively related in wealthier men and positively related in less-wealthy men. We attempted to replicate these results using both subjective and objective measures of wealth, and did so unsuccessfully with subjective wealth but to some extent successfully with objective wealth. The latter replication attempt succeeded inasmuch as we did find an interaction effect between formidability and wealth whereby formidability and support for redistribution were more negatively related in wealthier men than in less-wealthy men. However, the interaction occurred because formidability and support for redistribution were significantly negatively related in wealthier men, and non-significantly negatively in less-wealthy men; in contrast to the model proposed by Petersen et al. (2013), formidability and support for redistribution were not positively related among less-wealthy men. Our results suggest that although wealthier men do seem more motivated to defend their resources (by opposing redistribution) when they are more formidable, less-wealthy men do not seem more inclined to demand a share of these resources (by supporting redistribution) when they are more formidable. Finally, for exploratory purposes we also checked for these interaction effects when SDO (rather than support for redistribution) was the outcome variable, and we found none. The interaction effect thus does not appear to generalize to all forms of sociopolitical egalitarianism.

## Conclusion

Results presented above make several contributions to the literature on the relationship between physical traits and egalitarian attitudes. First, support was found for the general conclusion that in US and UK male samples, bodily traits associated with greater bargaining power in social interactions (i.e., attractiveness and/or formidability) tend to relate negatively to egalitarianism. Previous studies have found negative correlations in males between egalitarianism and bodily formidability (Price et al. 2011; Sell et al., 2009b) and between egalitarianism and anthropometrically-assessed bodily attractiveness (Price et al. 2011, 2015). These relationships have not always been found—for example, Price et al. 2015 found no significant relationship between egalitarianism and bodily formidability, and the current study found no significant relationship between egalitarianism and bodily attractiveness. Nevertheless, when significant relationships between bodily attractiveness/formidability and egalitarianism have been found in men, they have usually been negative. An exception is Peterson et al. (2013), which found that bodily formidability and egalitarianism were related negatively among wealthier men but positively among less-wealthy men. The current study did find this negative association among wealthier men, but did not find this positive association among less-wealthy men. A key question for future research is the extent to which the (usually negative) relationships between attractiveness/formidability and egalitarianism found in industrialised societies are also found cross-culturally. The studies on this topic reviewed in the above introduction have not been conducted exclusively in western societies (some were conducted in Japan), but studies from more diverse (and especially small-scale) societies would certainly be helpful for assessing the extent to which these relationships illuminate the evolved nature of the male mind.

Our results also suggest that more work is needed in order to determine whether previously observed negative relationships between bodily formidability/attractiveness and egalitarianism have been the result of men adjusting their egalitarianism in response to their physical bargaining power. Alternatives to this causal direction include inegalitarianism causing increased formidability/attractiveness (by increasing men's motivation to build their muscles), and inegalitarianism and muscularity-striving both being caused by a third variable. Our efforts to examine these alternative scenarios, by controlling for time spent lifting weights, yielded mixed results. These results suggest that whereas the positive relationship between formidability and SDO indicates something more than just the fact that higher-SDO men spend more time working out, the negative relationship between formidability and support for redistribution may be due to the fact that men who work out more are also more likely to oppose redistribution. Further, we were unable to produce evidence that by experientially increasing men's self-perceived formidability, we could cause them to become less egalitarian. These results do not suggest anything conclusive about why the relationship between bodily formidability and egalitarianism tends to be negative in males, but do indicate that more research is needed to answer this question. A key question for further research, for example, would be whether certain personality characteristics, such as narcissism or drive for dominance, might relate positively with both muscularity-striving and inegalitarianism. These relationships may be less straightforward than expected, however. For example, some evidence does suggest that people who are more narcissistic are less egalitarian (Piff, 2014), and it seems reasonable to hypothesize that relatively narcissistic men would also be relatively motivated to build their muscles. However, the study that has tested this latter hypothesis most comprehensively (Davis, Karvinen & McCreary, 2005) found no relationship between narcissism and drive for muscularity in men. Finally, our results suggest that although facial characteristics may provide cues to bodily formidability (Sell et

al., 2009a; Windhager et al., 2011; Zilioli et al., 2015), indicators of facial formidability are less useful than those of bodily formidability as predictors of egalitarian attitudes. In other words, the aspects of phenotypic formidability that are the best predictors of sociopolitical egalitarianism appear to be those most directly related to likelihood of prevailing in physical conflict: upper body muscularity and strength.

### **Acknowledgements**

Thanks to Savina Chapman, Suzanne Erickson, Ashleigh Gillan, Prem Mandalia, Fiona McCabe, and Sivarangeni Sivantharajah for research assistance, and also to two anonymous reviewers.

### **Data Availability**

The data associated with this research are available at [link to be added].

### **References**

- Belmi, P., & Neale, M. (2014). Mirror, mirror on the wall, who's the fairest of them all? Thinking that one is attractive increases the tendency to support inequality. *Organizational Behavior and Human Decision Processes*, *124*(2), 133-149.
- Bleske-Rechek, A., Remiker, M. W., & Baker, J. P. (2008). Narcissistic men and women think they are so hot - But they are not. *Personality and Individual Differences*, *45*, 420-424.
- Brewer, G., Archer, J., & Manning, J. (2007). Physical attractiveness: the objective ornament and subjective self-ratings. *Journal of Evolutionary Psychology*, *5*, 29-38.

Coy A., Green J., & Price M. E. (2014). Why is low waist-to-chest ratio attractive in males? The mediating roles of perceived dominance, fitness, and protection ability. *Body Image, 11*, 282-289.

Davis, C., Karvinen, K., & McCreary, D. R. (2005). Personality correlates of a drive for muscularity in young men. *Personality and Individual Differences, 39*, 349-359.

Dion, K.K. (2002). Cultural perspectives on facial attractiveness. In: Rhodes C, Zebrowitz LA, editors. *Facial attractiveness: Evolutionary, cognitive, and social perspectives*. Westport, CT: Ablex, pp. 239–259.

Eagly A.H., Ashmore R.D., Makhijani M.G., & Longo L.C. (1991). What is beautiful is good, but...: A meta-analytic review of research on the physical attractiveness stereotype. *Psychological Bulletin, 110*(1):109–128.

Fan, J., Dai, W., Liu, F., and Wu, J. (2005). Visual perception of male body attractiveness. *Proceedings of the Royal Society B, 272*, 219–226.

Fessler, D.M.T. & Holbrook, C. (2013) Bound to lose: Physical incapacitation increases the conceptualized size of an antagonist in men. *PLOS ONE 8*(8):e71306

Frederick, D. A., & Haselton, M. G. (2007). Why is muscularity sexy? Tests of the fitness indicator hypothesis. *Personality and Social Psychology Bulletin, 33*, 1167–1183.

Fruhen, L. S., Watkins, C. D., & Jones, B. C. (2015). Perceptions of facial dominance, trustworthiness and attractiveness predict managerial pay awards in experimental tasks. *The Leadership Quarterly*, 26(6), 1005-1016.

Grammer, K., Fink, B., Møller, A. P., & Thornhill, R. (2003). Darwinian aesthetics: Sexual selection and the biology of beauty. *Biological Reviews*, 78, 385–407.

Haselhuhn, M. P., Ormiston, M. E., & Wong, E. M. (2015). Men's facial width-to-height ratio predicts aggression: A meta-analysis. *PLoS ONE*, 10(4), e0122637.

Ho, A. K., Sidanius, J., Kteily, N., Sheehy-Skeffington, J., Pratto, F., Henkel, K., Foels, R., & Stewart, A. (2015). The nature of social dominance orientation: Theorizing and measuring preferences for intergroup inequality. *Journal of Personality and Social Psychology*, 109(6), 1003-1028.

Hodges-Simeon CR, Hanson Sobraske KN, Samore T, Gurven M, & Gaulin SJC (2016). Facial Width-To-Height Ratio (fWHR) Is Not Associated with Adolescent Testosterone Levels. *PLoS ONE*, 11(4): e0153083. doi:10.1371/journal.pone.0153083

Holtzman, N. S., Augustine, A. A., & Senne, A. L. (2011). Are pro-social or socially aversive people more physically symmetrical? Symmetry in relation to over 200 personality variables. *Journal of Research in Personality*, 45, 687-691.

Horvath, T. (1979). Correlates of physical beauty in men and women. *Social Behavior and Personality*, 7, 145–151.

Klingenberg, C. P. (2011). MorphoJ: an integrated software package for geometric morphometrics. *Molecular Ecology Resources*, *11*, 353-357.

Kramer RS, Jones AL, & Ward R. (2012). A lack of sexual dimorphism in width-to-height ratio in white European faces using 2D photographs, 3D scans, and anthropometry. *PLoS ONE*, *7*(8). doi: 10.1371/journal.pone.0042705.

Langlois, J. H., Kalakanis, L., Rubenstein, A. J., Larson, A., Hallam, M., & Smoot, M. (2000). Maxims or myths of beauty? A meta-analytic and theoretical review. *Psychological Bulletin*, *126*, 390-423.

Lassek, W. D., & Gaulin, S. J. C. (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*, 322-328.

Lefevre CE, Lewis GJ, Bates TC, Dzhelyova M, Coetzee V, Deary IJ, et al. (2012). No evidence for sexual dimorphism of facial width-to-height ratio in four large adult samples. *Evolution & Human Behavior*, *33*(6): 623–627. doi: 10.1016/j.evolhumbehav.2012.03.002.

Lefevre CE, Lewis GJ, Perrett DI, & Penke L. (2013). Telling facial metrics: Facial width is associated with testosterone levels in men. *Evolution & Human Behaviour*, *34*(4): 273–279. doi: 10.1016/j.evolhumbehav.2013.03.005.

Lukaszewski, A. W. (2013). Testing an adaptationist theory of trait covariation: Relative bargaining power as a common calibrator of an interpersonal syndrome. *European Journal of Personality* (DOI: 10.1002/per.1908).

Lukaszewski, A. W., Larson, C. M., Gildersleeve, K. A., Roney, J. R., & Haselton, M. G. (2014). Condition-dependent calibration of men's uncommitted mating orientation: Evidence from multiple samples. *Evolution and Human Behavior*, 35, 319-326.

Maisey, D. S., Vale, E. L., Cornelissen, P. L., & Tovée, M. J. (1999). Characteristics of male attractiveness for women. *Lancet*, 353, 1500.

McCreary, D. R. (2007). The Drive for Muscularity Scale: Description, psychometrics, and research findings. In J.K. Thompson & G. Cafri (Eds.), *The Muscular Ideal: Psychological, Social, and Medical Perspectives* (pp. 87–106). Washington, DC: American Psychological Association.

Mileva, V. R., Cowan, M. L., Cobey, K. D., Knowles, K. K., & Little, A. C. (2014). In the face of dominance: Self-perceived and other-perceived dominance are positively associated with facial-width-to-height ratio in men. *Personality and Individual Differences*, 69, 115-118.

Møller, A. P. (2006). A review of developmental instability, parasitism and disease. *Infection, Genetics and Evolution*, 6, 133-140.



Nedelec, J. L., & Beaver, K. M. (2014). Physical attractiveness as a phenotypic marker of health: an assessment using a nationally representative sample of American adults. *Evolution and Human Behavior*, 35(6), 456-463.

Özener B. (2012). Facial width-to-height ratio in a Turkish population is not sexually dimorphic and is unrelated to aggressive behavior. *Evolution & Human Behavior*, 33(3): 169–173. doi: 10.1016/j.evolhumbehav.2011.08.001.

Paunonen, S. V. (2003). Big Five factors of personality and replicated predictions of behavior. *Journal of Personality and Social Psychology*, 84, 411–422.

Penton-Voak, I. S., Jones, B. C., Little, A. C., Baker, S., Tiddeman, B., Burt, D. M., & Perrett, D. I. (2001). Symmetry, sexual dimorphism in facial proportions and facial attractiveness. *Proc. R. Soc. B*, 268, 1617–1625. doi: 10.1098/rspb.2001.1703.

Petersen, M. B., Sznycer, D., Sell, A., Cosmides, L., & Tooby, J. (2013). The ancestral logic of politics: Upper-body strength regulates men's assertion of self-interest over economic redistribution. *Psychological Science*, 24, 1098-1103.

Piff, P. K. (2014). Wealth and the inflated self: Class, entitlement, and narcissism. *Personality and Social Psychology Bulletin*, 40, 34–43.

Pound, N., Penton-Voak, I. S., & SurrIDGE, A. K. (2009). Testosterone responses to competition in men are related to facial masculinity. *Proceedings of the Royal Society B*, 276, 153–159.

Price M. E., Brown S., Dukes A., & Kang J. (2015). Bodily attractiveness and egalitarianism are negatively related in males. *Evolutionary Psychology* 13: 140-166.

Price, M. E., Dunn, J., Hopkins, S., & Kang, J. (2012). Anthropometric correlates of human anger. *Evolution and Human Behavior*, 33, 174-181.

Price, M. E., Kang, J., Dunn, J., & Hopkins, S. (2011). Muscularity and attractiveness as predictors of human egalitarianism. *Personality and Individual Differences*, 50, 636-640.

Price, M. E., Pound, N., Dunn, J., Hopkins, S., & Kang, J. (2013). Body shape preferences: Associations with rater body shape and sociosexuality. *PLoS ONE* 8(1): e52532.

Pratto, F., Sidanius, J., Stallworth, L. M., & Malle, B. F. (1994). Social dominance orientation: A personality variable predicting social and political attitudes. *Journal of Personality and Social Psychology*, 67(4), 741-763. doi:10.1037/0022-3514.67.4.741.

Roney, J. R. (2009). The role of sex hormones in the initiation of human mating relationships. In Ellison, P. T. and Gray, P. B. (Eds.), *Endocrinology of social relationships* (pp. 246-269). Cambridge: Harvard University Press.

Sanchez-Pages, S., & Turiegano, E. (2010). Testosterone, facial symmetry and cooperation in the prisoners' dilemma. *Physiology and Behavior*, 99, 355-361.

Sell A, Cosmides L, Tooby J, Sznycer D, von Rueden C, & Gurven M. (2009a). Human adaptations for the visual assessment of strength and fighting ability from the body and face. *Proc Biol Sci* 276:575–584.

Sell, A., Tooby, J., & Cosmides, L. (2009b). Formidability and the logic of human anger. *Proceedings of the National Academy of Sciences USA*, 106, 15073–15078.

Shinada, M., & Yamagishi, T. (2014). Physical attractiveness and cooperation in a prisoner's dilemma game. *Evolution and Human Behavior*, 35(6), 451-455.

Sibley, C. G., Robertson, A., & Wilson, M. S. (2006). Social dominance orientation and right-wing authoritarianism: additive and interactive effects. *Political Psychology*. 27 (5): 755–768. doi: 10.1111/j.1467-9221.2006.00531.

Sidanius, J., Cotterill, S., Sheehy-Skeffington, J., Kteily, N., & Carvacho, H. (2016). Social dominance theory: Explorations in the psychology of oppression. In C. G. Sibley & F. K. Barlow, (Eds.) *Cambridge Handbook of the Psychology of Prejudice* (149 - 187). Cambridge, UK: Cambridge University Press.

Sidanius, J. & Pratto, F. (1999). *Social Dominance: An Intergroup Theory of Social Hierarchy and Oppression*. Cambridge: Cambridge University Press.

Snyder, J. K., Fessler, D. M. T., Tiokhin, L., Frederick, D. A., Lee, S. W., & Navarrete, C. D. (2011). Trade-offs in a dangerous world: women's fear of crime predicts preferences for aggressive and formidable mates. *Evolution and Human Behavior*, 32, 127–137.

Swami, V., & Tovée, M. J. (2005). Male physical attractiveness in Britain and Malaysia: A cross-cultural study. *Body Image*, 2, 383–393.

Swami, V., Neofytou, R. V., Jablonska, J., Thirlwell, H., Taylor, D., & McCreary, D. R. (2013). Social dominance orientation predicts drive for muscularity among British men. *Body image*, 10(4), 653-656.

Swami, V., Smith, J., Tsiokris, A., Georgiades, C., Sangareau, Y., Tovée, M. J., & Furnham, A. (2007). Male physical attractiveness in Britain and Greece: A cross-cultural study. *Journal of Social Psychology*, 147, 15–26.

Takahashi, C., Yamagishi, T., Tanida, S., Kiyonari, T., & Kanazawa, S. (2006). Attractiveness and cooperation in social exchange. *Evolutionary Psychology*, 4, 315–329.

Tiddeman, B., Burt, D.M, & Perrett, D. (2001). Computer Graphics in Facial Perception Research, *IEEE Computer Graphics and Applications*, 21, 5, 42-50.

Toscano, H., Schubert, T. W., & Sell, A. N. (2014). Judgments of dominance from the face track physical strength. *Evolutionary Psychology*, 12(1), 147470491401200101.

Trivers, R. L. (1972). Parental investment and sexual selection. In Campbell, B. (Ed.), *Sexual selection and the descent of man, 1871–1971* (pp. 136–179). Chicago: Aldine.

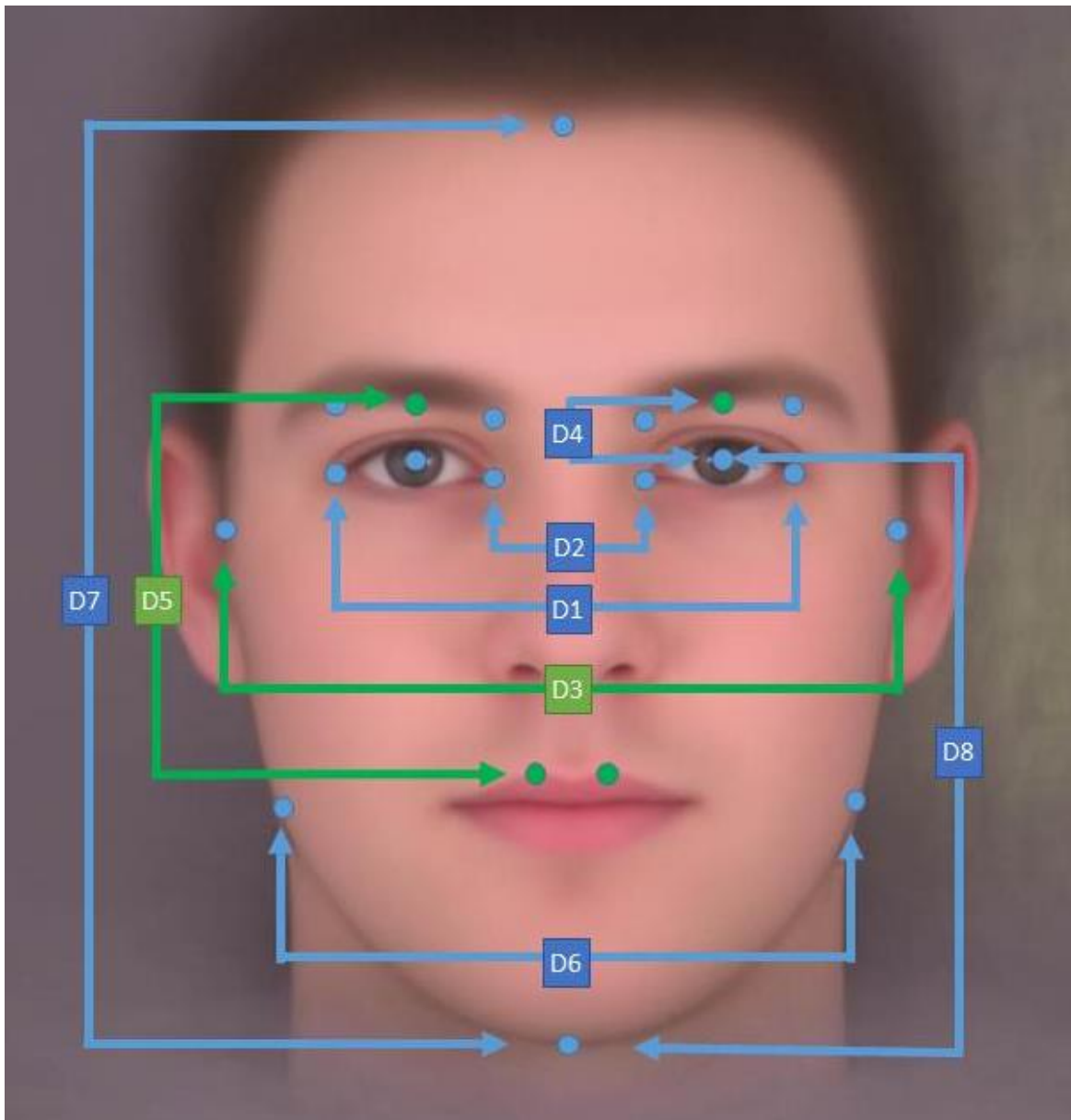
Wilson, M., & Daly, M. (1985). Competitiveness, risk taking, and violence: the young male syndrome. *Ethology and Sociobiology*, 6, 59–73.

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. doi: 10.1002/ajhb.21219.

Zaatari, D., & Trivers, R. (2007). Fluctuating asymmetry and behavior in the ultimatum game in Jamaica. *Evolution and Human Behavior*, 28, 223–227.

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(4), 322–330.

## Supplementary Material



**Supplementary Figure: Landmarks and dimensions used to calculate the index of facial masculinity and facial width-to-height ratio.** D1 = horizontal inter-exocanthial distance; D2 = horizontal inter-endocanthial distance; D3 = horizontal distance between the most outward projecting points on the face at or below the eyes (i.e. approximating bizygomatic width); D4 = eyebrow height (mean of vertical distances from level of pupil to inferior aspect of brow directly above endocanthion, pupil and exocanthion); D5 = vertical

distance from upper vermilion border of the upper lip (i.e. average position of left and right philtra) to the average vertical position of the inferior aspect of eyebrows directly above the pupils; D6 = horizontal distance between left and right gonion approximations; D7 = vertical distance from trichion to gnathion approximation; D8 = vertical distance from mean pupil height to gnathion approximation. Five dimensions were calculated as (i) eye size  $(D1-D2)/2$ ; (ii) lower face/face height  $(D8/D7)$ ; (iii) cheekbone prominence  $(D3/D6)$ ; (iv) face width/lower face height  $(D3/D8)$ , and (v) mean eyebrow height  $(D4)$ . For each dimension, the measures were converted to standardized (z) scores, and a composite facial masculinity index was computed as the sum of these z scores (oriented such that higher scores are more masculine for each dimension). Facial width-to-height ratio was calculated as  $D3/D5$ .