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Upper-Body Strength and Political Egalitarianism: Twelve Conceptual Replications

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Abstract: Animal models of conflict behavior predict that an organism's behavior in a conflict situation is influenced by physical characteristics related to abilities to impose costs on adversaries. Stronger and larger organisms should be more motivated to seek larger shares of resources and higher places in hierarchies. Previous studies of human males have suggested that measures of upper-body strength are associated with measures of support for inequality including Social Dominance Orientation (SDO), a measure of individual differences in support for group-based hierarchies. However, other studies have failed to replicate this association. In this article, we re-examine the link between upper-body strength and support for inequality using twelve different samples from multiple countries in which relevant measures were available. These samples include student and locally representative samples with direct measures of physical strength and nationally representative samples with self-reported measures related to muscularity. While the predicted correlation does not replicate for every single available measure of support for inequality, the overall data pattern strongly suggests that for males, but not females, upper-body strength correlates positively with support for inequality.

Resource conflict is a central feature of politics. In one of the most celebrated definitions of political science, Lasswell (1950) defined the field as the study of “who gets what, when and how.” If the presence of and solutions to resource conflict lie at the kernel of politics, then politics is a phenomenon that is much more widespread than often acknowledged. Resource conflict occurs not only at the level of political institutions, such as national or regional governments, but at all levels of human social interaction, in the household, the local community, the workplace, and so forth (Lopez et al., 2011). Moreover, resource conflicts are not confined to modern societies—they are part of the catalogue of human universals identified by anthropologists (Pinker, 2003), and the archaeological record reveals ample evidence of conflict in the form of fossils with lethal injuries from weapon-inflicted trauma (Walker, 2001). It is therefore hardly surprising that the navigation of resource conflict is not just a human activity; resource conflict is zoologically widespread.

Evolution by natural selection is a process that propagates the genetic designs that propagate themselves. In a world of finite resources, that inevitably leads to conflicts of interest between non-related organisms. Because resource conflicts are so exceptionally common across all animal taxa (Clutton-Borck & Parker, 1995; Huntingford, 2013), researchers of animal behavior have devoted considerable resources to understanding how animals behave in conflicts, and there is clear consensus on the relevant models and variables for animal conflict behavior (Huntingford, 2013). According to this consensus and the scores of studies underlying it, animals utilize information about physical strength in conflicts such that stronger organisms are more likely to prevail in conflicts whereas weaker organisms are more likely to cede resources (Hammerstein & Parker, 1982; Smith & Price, 1973).

In this article, we ask whether physical strength, a crucial variable in animal conflict behavior, also influences how humans intuitively reason about resource conflicts as expressed in political attitudes at the mass level. Following Price et al. (2011), we focus specifically on attitudes

to egalitarianism and the role of male physical strength and formidability in regulating these attitudes. This role has previously been examined in three British convenience samples with mixed results (Price et al., 2011, 2015, 2017; see also Petersen et al., 2013). In the present article, however, we utilize a diverse set of 12 separate samples obtained from laboratory experiments, representative online surveys, and various countries. The results of this large-scale replication effort generally indicate that physical formidability in men—but not in women—is related to anti-egalitarianism, operationalized as the psychological trait of Social Dominance Orientation and the political attitude dimension of economic conservatism.

Consistent with the general movement to incorporate findings from neuroscience, behavioral genetics, and evolutionary psychology into the study of political behavior (Fowler & Schreiber, 2008; Hibbing, Smith, & Alford, 2013; Petersen, 2015), these findings suggest that advances can be made by appreciating that humans are one animal among others and, hence, that firm conclusions from animal behavior studies can be fruitfully utilized in the study of human political psychology.

Formidability and Conflicts in Humans and Other Animals

The canonized model of animal conflict behavior is named the asymmetric war of attrition (Hammerstein & Parker, 1982), which has been validated across an enormous range of animals, including spiders, frogs, cockroaches, wolves, lions, and deer (Huntingford, 2013). The model focuses on two animals engaged in a conflict, with an incentive structure corresponding to the well-known Hawk–Dove game. In the conflict, each animal has a choice: escalate it or withdraw. Within the model framework, the choice is essentially viewed as a coordination problem. Fights are costly in terms of time, energy, and wounds. It is therefore adaptive to avoid fighting, if possible, by one animal withdrawing from the conflict before it escalates. The question becomes: Who will withdraw?

Both animals are better off if the other withdraws and, hence, have an incentive to escalate. The insight of the model—and the reason for its name—is that conflicts are usually asymmetrical and there are important individual differences between contestants' fighting abilities; i.e., their ability to impose costs and, hence, prevail in a fight.

Individual differences in fighting ability reflect differences in body size, strength, or natural weaponry (e.g., fangs, claws, horns, and antlers). Because individual differences in fighting ability are directly causally related to who would prevail in an actual fight, they serve as a natural focal point for coordination in the process preceding the fight (Hammerstein & Parker, 1982; Smith & Price, 1973). The animal with the relatively inferior fighting ability has an interest in withdrawing before the conflict turns physical. Consistent with this, animal behavior studies have repeatedly demonstrated how animal fights are preceded by a range of almost ritualistic steps whereby contestants assess fighting ability through roars and visual inspection, only becoming locked in actual combat if these steps reveal no clear signs of differences in fighting ability (Hardy & Briffa, 2013).

The asymmetric war of attrition model has also been applied to humans to better understand human psychology and physiology. This research has especially focused on upper-body strength as a crucial component of human fighting ability and how individual differences in upper-body strength shape human interactions. Under evolutionarily recurrent conditions, upper-body strength would have been crucial to prevail in face-to-face combat (for a review, see Sell et al., 2012). Consistent with this, studies of professional, contemporary fighters (e.g., mixed martial arts fighters) show that individual differences in strength-related features consistently predict fighting success (e.g., Little et al., 2015; Zilioli et al., 2015). Testifying to the evolutionarily recurrent importance of upper-body strength, this trait is one of the most physically dimorphic traits in humans, with males—the more aggressive sex—having on average 90% greater upper-body strength than females; a difference that is comparable to the difference between male and female gorillas (Lassek & Gaulin, 2009). Such

dimorphisms only emerge via natural selection if there has been an intense selection pressure, and the available evidence suggests that this selection pressure relates to male-to-male competition for status (Puts, 2010). Indeed, anthropologists have found that male physical strength is a positive and sizeable predictor of within-group status among Amazonian horticulturalists, over and beyond other prowess-related abilities such as the ability to acquire food (Von Rueden et al., 2008). Research also shows that humans are exceptionally capable of predicting the upper-body strength of other individuals on the basis of cues such as the voice, face, and body (Sell et al., 2009b, 2010). Against the notion that these competences reflect culturally learned attentional patterns, research has also shown that even preverbal infants attend to differences in the physical size of individuals in conflict, using them to form expectations regarding conflict outcomes (Thomsen et al., 2011).

Individual differences in upper-body strength have also been found to shape male psychological responses in a number of important ways across cultures. Consistent with the asymmetric war-of-attrition model, stronger individuals tend to feel more entitled to better treatment, become angry more easily, and are more aggressive (Sell et al., 2012). A recent meta-analysis of the link between strength and aggression including 32 published and unpublished studies and over 9000 subjects (Durkee & Goertz, 2017) demonstrated the existence of a robust positive correlation between aggression and measures of strength. These effects have been obtained for a range of different measures of strength, such as hand-grip strength, upper-arm circumference, chest-strength, and also for other measures of physical formidability (e.g., height or bulk).

Most of these studies are correlational and, hence, cannot determine the direction of causality. Because modern environments provide many opportunities to build muscle mass (e.g., the gym), more assertive individuals might simply be motivated to do so. Price et al. (2017), however, found associations with formidability even controlling for time spent in the gym. Furthermore, a recent study applied quasi-experimental techniques to longitudinal twin data to demonstrate that the effect

runs from strength to aggression and that this causal effect was exerted by genetic components of strength (Petersen & Dawes, 2017). We return to this question of causality in the conclusion. Finally, it should be noted that these effects are usually only obtained for males and not females. Theoretically, this is predictable given the large differences in upper-body strength. Females evolved in a world in which they were physically dominated by males and, hence, evolved alternative strategies to navigate conflict (Sell et al., 2009).

Formidability and Political Attitudes

There is increasing attention in political science to how stable individual differences in personality shape political attitudes (e.g., Gerber et al., 2010; Hibbing et al., 2013). Personality traits that might be viewed as associated with formidability (e.g., trait compassion and trait aggressiveness) have been found to shape political behavior and overall ideology (Hirsch et al., 2010; Kalmoe, 2013). Previous research has also specifically examined potential associations between formidability and political attitudes. One set of studies has focused on attitudes that can be construed as reflecting support for aggression in the political domain, such as support for harsh punishment and militarism (Sell et al., 2009, 2017). These studies have generally produced consistent evidence that more formidable males—but not females—are more likely to support aggressive policies. This association has been demonstrated in countries as different as the United States, Denmark, Argentina, and Romania; however, the association was not obtained for Israeli males.

As stated in the introduction, the present research focuses on political attitudes about resource conflict. Previous research on the stable individual differences underlying such attitudes has been particularly oriented towards the psychological trait of Social Dominance Orientation (SDO). Individual differences in SDO are characterized as “the extent to which one desires that one’s in-group dominate and be superior to outgroups” (Pratto et al., 1994: 742). High-SDO individuals are

predisposed to favor competition and intergroup inequality, which has downstream effects on numerous political attitudes, particularly including attitudes within the economic domain. Hence, studies have shown that high-SDO individuals are more economically conservative and less likely to favor redistribution and social welfare and more likely to value economic inequality (e.g., Duckitt & Sibley, 2007; Pratto et al., 1994).

On this basis, Price et al. (2011) suggested that individual differences in male formidability might influence SDO and other predictors of egalitarianism. In ancestral social environments, competing groups would usually contain a limited number of individuals and, hence, the strength of any individual could be decisive for the outcome of the competition (Sell et al., 2009). Accordingly, under the conditions to which our psychology is adapted, formidable individuals and their allies would be more likely to prevail in resource conflicts and needed to rely less on norms that enforced sharing and equality within or between groups in order to prosper (see also Petersen, 2013). In modern societies, egalitarian policies can be conceptualized as redistributing resources both within groups (i.e., within a specific society) and between groups (i.e., between specific groups in society, such as ethnic groups). Hence, individual differences in male formidability could regulate support for egalitarian policies, whether because formidable individuals intuitively believe they are more likely to prevail in a conflict or because they believe their group is.

The evidence for the existence of a link between formidability and SDO and other measures of egalitarianism is mixed. On the one hand, using a 3D body scanner to obtain a precise measure of individual differences in muscle mass, Price et al. (2011) found in a sample of British subjects that male (but not female) muscularity increased opposition to egalitarianism in four of four measures including SDO. Price et al. (2017) replicated the effect of male (and not female) muscularity on SDO and another measure of egalitarianism. Similarly, Swami et al. (2013) focused on a self-reported measure designed to gauge so-called Drive for Muscularity and found it to predict SDO among a

sample of males. On the other hand, in an effort to replicate their own findings, Price et al. (2015) failed to find the predicted relationship between egalitarianism and formidability in another sample of British subjects. Furthermore, when analyzing samples from Argentina, Denmark, and the United States, Petersen et al. (2103) found no overall positive effect of formidability on anti-egalitarianism, with formidability measured as flexed bicep circumference and anti-egalitarianism measured as opposition to redistribution. In that study, it was predicted and found that a positive effect was restricted to individuals with high socio-economic status (SES); i.e., with an economic self-interest in reduced redistribution. For low-SES individuals, the effect was significantly negative. Price et al. (2017) find some evidence consistent with this model; specifically, that formidability is only related to opposition to redistribution among the wealthy. Among the less-wealthy half of Price et al.'s (2017) sample, however, male formidability and anti-egalitarianism were completely unrelated (rather than negatively related, as predicted by Petersen et al. [2013]).

The Present Studies

In this article, we ask: Is there an overall positive relationship between formidability and anti-egalitarianism among human males? While this was suggested by the initial study by Price et al. (2011), studies published since have produced mixed evidence in favor of this suggestion, as is clear from the review above. As the so-called “replication crisis” that is sweeping through psychology and other disciplines has made evident, however, one additional difficulty in assessing the overall weight of evidence in favor of or against empirical claims is the existence of the so-called file drawer problem (e.g., Nosek et al., 2012); that is, that many findings go unpublished, ending in the file drawer instead. While this is often viewed as reflecting attempts to “hide” difficult-to-publish findings or findings that run counter to pet hypotheses, another reason for filing findings away is simply that they were not related to the primary aim of the data collection.

We seek to contribute to the question of the link between formidability and anti-egalitarianism by opening our own file drawer. In recent years, we have conducted numerous studies wherein we obtained measures of or related to formidability and a range of different measures of anti-egalitarianism—including SDO and economic conservatism. In so doing, the totality of studies not only allows us (1) to leverage substantial new evidence in answering whether there is a relationship between formidability and anti-egalitarianism among human males but also (2) to assess whether and how the effect of formidability differs for personality measures of anti-egalitarianism (e.g., SDO) compared to more policy-oriented measures of anti-egalitarianism (e.g., economic conservatism). Given that we rely on data collected for other purposes, none of the studies are direct replications of the original Price et al. (2011) study. Instead, each is a conceptual—or near—replication of the original, each utilizing slightly different measures and methods. Still, across these differences, the analyses conclude that formidability seems to be a crucial individual difference variable underlying political views related to egalitarianism among males whether operationalized as SDO or economic conservatism. Importantly, however, mediation analyses suggest that the policy effects of formidability are statistically mediated via SDO.

Materials and Methods

In total, we analyze data from 12 different samples with various measures of formidability and anti-egalitarianism.¹ This set includes seven large-scale (mostly) representative samples, including mainly self-reported measures from a diverse variety of countries: United States, Denmark, Ukraine, Poland, Belarussians (residing in Lithuania), and Venezuela. Table 1a provides an overview of these seven studies with respect to respondent nationality, the character of the sample, operationalizations of key dependent and independent variables, and sample compositions regarding gender and age.

¹ Data and command files for the 12 studies are available at the following link at Dataverse (thedata.org): <https://doi.org/10.7910/DVN/BSSWYZ>.

[Table 1a about here]

We also analyze five laboratory studies including well-validated physiological measures of formidability. Three of these five laboratory studies are based on Danish student samples, whereas the remaining two studies are based on locally representative samples of the Aarhus area in Denmark and the Lincoln, Nebraska area in the United States, respectively. Table 1b provides an overview of the five laboratory studies, their composition of respondents, and measures.

[Table 1b about here]

In total, the 12 diverse datasets and different measures of formidability and anti-egalitarianism applied across the samples comprise a solid, well-suited starting point for investigating the robustness of the relationship between male formidability and anti-egalitarianism. Below, we provide a brief overview of the measures of formidability and anti-egalitarianism employed in studies. Because of the many samples include, more detailed information is provided in the online Supplementary Materials. Supplementary Materials S.1 provides detailed information on recoding, scaling (including reliability coefficients) and descriptives and Supplementary Materials S.2 provides the full wordings of all the applied scales across studies. Importantly, unless otherwise noted, all measures are recoded to 0–1 scales, “0” constituting the minimum and “1” the maximum observed value on a given variable within gender. That is, given the gender-specific nature of the prediction, variables are coded based on the *intra-gender* sample distributions to compare egalitarianism validly between individuals low and high in formidability within sex.

Formidability: Studies 1–7 were all collected over the internet and, consequently, include self-reported measures of formidability. Following Sell et al. (2009), subjects in Studies 1 and 4-7 were asked to state how physically strong they were compared to other individuals of their own sex. In Studies 2-4, we follow Swami et al. (2013) and relied on agreement with eight items (e.g., “I lift weights to build up muscle”) from the Drive for Muscularity Scale. Importantly, while Drive for Muscularity is not a direct measure of strength, it taps muscularity-related motivations and, in particular, the motivation to build muscularity (McCreary & Sasse, 2000). Because Study 4 include both self-reported measures, we created a composite measure of self-perceived formidability by averaging across the two measures. Studies 8–12 are laboratory experiments and employ different objective indicators of formidability including handgrip strength, chest strength, flexed bicep circumference of dominant arm and chest circumference (cf. Gallup et al., 2007; Sell et al. 2009). In each study, we extracted a composite measure of formidability using Principal Component analysis and utilize the first component.

Anti-egalitarianism: In Studies 1-7, anti-egalitarianism is measured as SDO. In Study 8, a measure of economic conservatism is available and, in Studies 9-12, both measures of SDO and economic conservatism is available. In Studies 1 and 9-10, SDO was measured based on six items from Pratto et al. (1994). In Studies 2-5 and 11-12, anti-egalitarianism was measured using the short, 8-item version of the SDO₇ scale from Ho et al. (2016). Studies 6 and 7 also relied on the short SDO-7 scale (Ho et al., 2016) but, due to survey length restrictions, only a sub-sample of four items was included. In Studies 8 and 10, a 6-item measure of economic conservatism was used and, in Studies 9 and 11-12, 5-item measures were used. All measures of economic conservatism are based on degrees of disagreement or agreement with specific policy statements (for example, disagreement with the statement "High incomes should be taxed harder than is currently the case" indicated a high

degree of economic conservatism). All scale reliabilities exceed conventional thresholds (see Supplementary Materials S.1).

Modelling procedures and control variables: The main analyses rely on OLS regression to estimate the relationship between formidability and anti-egalitarianism. We estimate the relationship for each sample separately and, in line with the underlying theory, we report results for female and male subjects separately. All reported results are based on models controlling for subjects' age (cf. Gelman & Loken, 2014), and we also control for subjects' education in diverse and/or representative samples (Studies 2–5, 7, 11, and 12). We report unstandardized regression coefficients and—because all variables are recoded to 0–1 scales based on intra-gender observed minimum and maximum values for a specific sample—they reflect changes in anti-egalitarianism as a function of a change from minimum to maximum observed formidability within a given sample. In some subsequent analyses, we utilize other methods and note this below.

Results

Are individual differences in formidability related to SDO in males and not in females? Investigating first the relationship between formidability and SDO across the studies, we find a positive and significant relationship for male subjects in eight of the 11 studies for which we have measures of SDO ($P_s < 0.05$). Studies 1, 11, and 12 are the only exceptions to this pattern. Even in these three studies, however, we find positive (but non-significant relationships) between male formidability and SDO (Study 1: $b=0.109$, $P=0.186$; Study 11: $b=0.121$, $P=0.235$; study 12: $b=0.163$, $P=0.219$). Substantially, the estimated regression coefficients take on values from 0.09 to 0.57, meaning that a change from the lowest to the largest observed value in male formidability increases SDO by 9–57 percentage points. In contrast, no such general pattern is found for female subjects. Rather, a set of very mixed findings occurs across the studies with positive and significant relationships in Studies 2,

3, 4, and 6, a negative trend in Study 11, and no clear trends in the remaining studies. Figure 1 displays the estimated relationships between formidability and SDO for female and male subjects, respectively, across the 12 studies (see Supplementary Materials S.3 for full models). Furthermore, for the samples that allow a split of SDO into its two sub-dimensions SDO-Dominance (SDO-D) and SDO-Egalitarianism (SDO-E) (following Ho et al., 2016), Supplementary Materials S.4 reports and replicates the above analyses for SDO-D and SDO-E, respectively.

[Figure 1 about here]

Are individual differences in formidability related to economic conservatism in males but not in females? Next, we investigate if similar results are found for the other measure of anti-egalitarianism—economic conservatism—which was included in the five laboratory studies. Again, a clear pattern appears for male subjects: Formidability positively and significantly predicts economic conservatism ($P_s < 0.05$), with estimated regression coefficients between 0.29 and 0.44 for Studies 8–11, while a positive but non-significant trend is found for Study 12 ($b=0.182$, $P=0.219$). That is, comparing the least and most formidable males within a given sample, the estimated economic conservatism is 18–44 percentage points larger for the most compared to the least formidable individual. Importantly, the pattern is quite different for female subjects. Study 9 finds a positive relationship ($P=0.020$), whereas the remaining four studies report non-significant relationships in different directions ($P_s > 0.1$). Figure 2 illustrates these patterns across studies (see Supplementary Materials S.5 for full models).

[Figure 2 about here]

A meta-analytical assessment of the combined evidence from 12 samples and two measures of anti-egalitarianism. The analyses reported above support that male formidability positively relates to anti-egalitarianism across different measures of both formidability and anti-egalitarianism, across both laboratory and online sampling methods, and across a range of different nationalities (including, e.g., Americans, Danes, and Venezuelans). For females, in contrast, there is much less evidence of an association between formidability and anti-egalitarianism. Because of this wealth of data, we can use meta-analytical techniques to summarize the combined evidence across our 12 samples (specifically, we use the technique developed by Harbord & Higgins [2008]). For samples including two measures of anti-egalitarianism, we utilize the average effect sizes and standard errors as input in the meta-analysis. Across the samples, the estimate of the association between formidability and anti-egalitarianism is $b=0.17$ ($p < 0.001$) for males and $b=0.11$ ($p=0.001$) for females. While the combined evidence suggests that there is indeed also a significant association for females, the strength of the association is weaker for females than males (the gender difference in the estimates is marginally significant, $b=0.06$, $p=0.09$). Furthermore, we can assess these associations independently for the laboratory samples with more objective measures of formidability and for the online samples that exclusively rely on self-reporting.² In the online samples, the combined estimate is $b=0.14$ ($p=0.001$) for males and $b=0.11$ ($p=0.005$) for females (this gender difference equals $b=0.04$, $p=0.34$). In contrast, we find much more pronounced gender differences in the laboratory samples with more objective measures ($b=0.19$, $p=0.05$). For males, the estimate is twice as large as in the online samples ($b=0.28$, $p=0.009$). For females, the estimate is non-significant ($b=0.09$, $p=0.22$). Overall, a meta-

² The formidability measure in some of the laboratory samples also includes a self-reported component. To verify that it is not driving the reported results, we re-estimated the relationship between formidability and anti-egalitarianism entirely excluding self-reported components in the formidability variables across studies 8–12 (see Supplementary Materials S.6 for full models). Importantly, the same substantial conclusions were reached on this basis, with male formidability constituting a positive and consistent predictor of anti-egalitarianism, while no such pattern was obtained among female subjects.

analytical approach reinforces the conclusion that formidability is a reliable driver of anti-egalitarianism among males but not females.

Testing a Range of Alternative Explanations

Overall, we find a positive relationship between male formidability and anti-egalitarianism across the 12 studies conducted in vastly different countries and with a range of different operationalizations of formidability and anti-egalitarianism. Theoretically, we predicted this relationship on the basis of evolutionary models of animal conflict and the burgeoning interdisciplinary support for these models. Still, it is relevant to assess whether alternative, potentially non-evolutionary theories can explain the observed relationship. In this section, we test such rival explanations and models of the relationship between formidability and anti-egalitarianism utilizing different available variables across the 12 studies.

Are individual differences in formidability related to Rightwing Authoritarianism in males and females? The proposed evolutionary-grounded theory suggests that male formidability specifically drives attitudes and behavior related to resource conflict. Based on the results presented thus far, however, male formidability could be related to rightwing and conservative orientations in general rather than to anti-egalitarianism in particular. A central distinction in the literature on political ideology relates to the underlying dimensionality of the concept, with recent work in political science usually distinguishing between two main sub-components (Duckitt & Sibley, 2010; Feldman & Johnston, 2014). On the one hand, rightwing and conservative ideologies relate to economic-political issues connected to egalitarianism and preferences for redistribution that are often captured with the measures employed above, SDO, and economic conservatism. Conversely, ideology is also composed of predispositions for adhering to social norms, complying with authorities and preferences for social order in society. This is often captured by the variable, right-wing authoritarianism (RWA).

8 of the 12 samples included measures of RWA (studies 1–3, 5, and 9–12; Supplementary Materials S.1 and S.2 for full details). To test if male formidability predicts not just anti-egalitarianism but rightwing and conservative ideologies and predispositions in general, we regressed male subjects' RWA on measures of formidability across the studies for which RWA was measured. No clear pattern emerged; rather, formidability was sometimes negatively associated with RWA (Study 2: $b=-0.104$, $P=0.003$), sometimes approaching a positive trend (study 10: $b=0.144$, $P=0.182$), but usually unrelated to RWA (the remaining studies) (see Supplementary Materials S.7 for full models).

Is the positive relationship between male formidability and anti-egalitarianism driven by individual personality differences? The observed relationship between formidability and anti-egalitarianism might be caused by unobserved factors. One such potentially confounding variable is participants' personality dispositions. Personality factors are found to be related to ideological orientations—particularly openness to liberalism and conscientiousness to conservatism (e.g., Gerber et al. 2010; see also Hibbing et al., 2013 for a recent overview). Moreover, recent psychological research finds that formidability is associated with greater extraversion, theorizing that the reproductive payoffs of extraverted behaviors have most likely increased with male formidability over most of human evolutionary history (Lukaszewski & Roney, 2011). That is, different personality dispositions might relate to both male formidability and anti-egalitarian orientations and, consequently, we sought to control for personality dispositions in the studies for which such measures were available. Specifically, we were able to control for the Big Five personality model (i.e., openness to new experiences, conscientiousness, extraversion, agreeableness, and neuroticism) in Studies 8–12 using the so-called TIPI scale (Mondak et al., 2010). However, results remain unchanged when controlling for the Big Five inventory for male as well as for female subjects (see Supplementary Materials S.8 for full models). This suggests that the association between anti-egalitarianism and male formidability does not emerge as a spurious association from broader personality dispositions.

Is the positive relationship between male formidability and anti-egalitarianism driven by individual differences in social networks? The content of participants' social networks is another variable that could potentially serve as a confounding variable on the observed relationship between male formidability and anti-egalitarianism. Specifically, because anti-egalitarianism relates closely to attitudes towards redistribution, one might consider if the degree to which a participant interacts with unemployed individuals might possibly affect the estimation. Thus, we utilize questions about unemployment experiences included in Study 11 (Denmark) and Study 12 (United States) to control for the participants' and their close family members' own experiences with unemployment. Moreover, because existing research finds that attitudes towards redistribution and redistributive policies are often "racialized" (see, e.g., Gilens, 1999; Mendelberg, 2001), we further control for participants' number of immigrant friends (Study 11, Denmark) or African American friends (Study 12, US). Yet again, the results reported above do not change when controlling for these variables (see Supplementary Materials S.9 for full models; in this regard, it is also relevant to note that we only found a significant association between formidability and anti-egalitarianism in one of the four tests with these samples). This suggests that the content of participants' social networks does not confound the positive relationship between male formidability and anti-egalitarianism.

Do individual differences in socio-economic status moderate the relationship between male formidability and anti-egalitarianism? As argued in the theory section, evolutionary psychology research has advanced two distinct models for how anti-egalitarianism and formidability are related. One model argues for a positive main effect of formidability on anti-egalitarianism. The alternative model highlights the role of SES. Specifically, rather than a positive main effect of male formidability on anti-egalitarianism, the alternative model predicts that an individual's SES moderates the effect of formidability on anti-egalitarianism such that they pursue redistributive positions in their own favor the more formidable they are. High-SES males—who stand little to gain from increased

redistribution—should therefore be more anti-egalitarian the more formidable they are, whereas low-SES males—who stand to gain relatively more from increased redistribution—should be less anti-egalitarian the more formidable they are (Petersen et al., 2013; see also Price et al., 2017). Because eight of our 12 studies include measures of SES, we are able to test how well this alternative and more complex model fits the available data. Specifically, we employ a range of SES measures covering self-reported current living conditions (Studies 2, 3, and 10), self-reported social status (Studies 4–6), and a formative scale based on education and household income (Studies 11 and 12) (for detailed information, see Supplementary Materials S.10). The results are highly mixed. Studies 2, 3, and 12 provide partial support for the alternative model, with a positive and significant relationship between formidability and anti-egalitarianism only among high-SES males. Conversely, we find the opposite interaction to the one predicted by Petersen et al. (2013) in Studies 4 and 11, while the remaining analyses show no signs of any moderation by SES (see Supplementary Materials S.10 for full models). Consequently, SES does not moderate the relationship between male formidability and anti-egalitarianism in any consistent way across the available data material analyzed here. Importantly, in none of the models do we, for any group, observe a negative and significant association between male formidability and anti-egalitarianism (as reported in Petersen et al. [2013] for low-SES males). We observe a positive association in all cases, albeit only for particular socio-economic groups in some cases.

In total, across the reported main analyses as well as the different alternative explanations investigated in this section, the main conclusion across our 12 studies remains: Male—but not female—formidability constitutes a positive and consistent predictor of anti-egalitarianism. Importantly, this pattern does not replicate for predictions of social conservatism as measured by RWA, it holds even when controlling for individual differences in personality dispositions and social

networks, and the relationship is not systematically moderated by individual differences in SES (as suggested by Petersen et al. [2013] and partially supported by Price et al. [2017]).

Assessing Psychological Mechanisms

The analyses above suggest that individual differences in male formidability are indeed specifically associated with anti-egalitarianism when considering a range of alternative models. At the same time, these results raise a question that was earlier hinted at: why would strong males be motivated to be economically conservative if they were poor? After all, this would run counter to their economic self-interest. This section seeks to identify the underlying psychological motivations involved.

Does SDO mediate the effect of formidability on economic conservatism for males? In the analyses reported so far, we have not made any assumptions about the relationship between our two outcome variables: SDO and economic conservatism; rather, we have used them as two separate measures of anti-egalitarianism. However, recent theoretical and empirical developments in political and social psychology suggest that SDO is causally prior to economic conservatism (Duckitt & Sibley, 2010; Pratto et al., 1994). For example, the Dual-Process Motivational Model of political ideology argues that SDO establishes the link between individual differences in perceiving the world “as a competitive jungle” and individual differences in economic conservatism. In this model, then, SDO is seen as causally prior to economic conservatism. Similarly, Pratto et al. (1994: 742) argues that Social Dominance Orientation comprises exactly a psychological variable capturing “...central individual-differences that predict a person's acceptance or rejection of numerous ideologies and policies relevant to group relations” (Pratto et al., 1994: 742). Importantly, past research has shown that the deep-seated nature of SDO implies that it is only marginally affected by considerations relating to a person’s own SES (Pratto et al., 1994: 756). It therefore seems likely that male formidability leads to economic conservatism—even for poor individuals—because the relationship

is indirect. That is, formidability could predict support for anti-egalitarian policy orientations *through* SDO.

It is possible to test if SDO mediates the relationship between male formidability and economic conservatism in the four studies including measures of formidability, SDO, and economic conservatism: Studies 9–12. To this end, we rely on structural equation modelling and estimate the mediated path from formidability through SDO on economic conservatism for male and female subjects separately, still controlling for age and education. Starting with Study 9, we find a positive and significant mediation of male formidability through SDO on economic conservatism ($b=0.421$, $P=0.008$), and no main effect of formidability remains when this indirect relationship is accounted for ($b=0.021$, $P=0.899$). In Study 10, formidability also positively and significantly predicts economic conservatism through SDO for males ($b=0.157$, $P=0.024$). Simultaneously, a direct effect of formidability on economic conservatism is also significant ($b=0.202$, $P=0.006$). Finally, in Studies 11 and 12 the indirect path from male formidability through SDO on economic conservatism falls short of conventional levels of statistical significance, although it still shows a positive trend in line with expectations (Study 11: $B=0.089$, $P=0.268$; Study 12: $b=0.071$, $P=0.230$). Importantly, though, in Study 11 (but not in Study 12), the direct effect of formidability on economic conservatism is significant when simultaneously estimating the indirect relationship through SDO (Study 11: $b=0.193$, $P=0.045$; Study 12: $b=0.111$, $P=0.402$) (see also Supplementary Materials S.11). In total, then, these analyses provide partial support for the suggested effect of formidability on anti-egalitarian policy orientations running through SDO for male subjects. The mediation is significant in two of the four analyses, with a positive trend in another study suggesting that, for males (but not females), formidability might constitute a causal driver of anti-egalitarian political orientations through the psychological construct of SDO.

Is the association between SDO and male formidability related to status-seeking motivations?

The analyses above suggest that the link between formidability and economic conservatism is partially driven by SDO and, hence, this might account for why even poor males are supportive of economically conservative policies if they are strong. An additional psychological motivation in this regard could be that formidability shapes expectations about future social status. Low-SES individuals might support hierarchies and inequality because they feel they are able to fight their way to the top on their own and, hence, need to rely less on norms of sharing and equality (not least because such norms constrain themselves once they have acquired the resources; see Petersen [2013]). In forager societies, physical strength among males has indeed been observed to be associated with higher status (Von Rueden et al., 2008) and, in general, strength increases self-perceived bargaining power (Sell et al., 2009). To assess this, we can utilize Study 4. In this study, we have available measures of formidability, SDO, and individual variation in willingness to take risks across ten different domains that reflect significant problems over human evolutionary history (The Evolutionary Risk Scale, Wilke et al., 2014). Specifically, these domains are: between-group competition, within-group competition (specifically, taking on leadership roles), status- and power-seeking, environmental exploration, food selection, food acquisition, parent-offspring conflict, helping kin, mate attraction, and mate retention. Accordingly, we can decompose the association between male formidability and SDO to determine how much risk-seeking in each of these domains contributes to the overall association. Utilizing the multivariate decomposition method developed by Kohler, Karlson, and Holm (2011), we find that risk-seeking across the ten domains fully accounts for the association between SDO and formidability in males (see Supplementary Materials S.12). After controlling for risk-seeking behavior in the ten domains, the association between male formidability and SDO turns from significant ($b=0.21, p < 0.001$) to non-significant ($b=0.09, p=0.15$), and this difference is in itself significant ($b=0.12, p=0.001$). Furthermore, this difference is accounted

for by only two types of risk-taking: risk-taking in competition with other groups ($b=0.06$, $p < 0.001$) and risk-taking to acquire social status ($b=0.08$, $p < 0.001$). The former accounts for 28% of the original association and the latter accounts for 39% of the original association. This implies that formidability is related to a willingness to take risks in order to acquire status—both within one’s own group and relative to other groups—and this willingness translates into anti-egalitarian orientations. When strong poor males are anti-egalitarian, it is seemingly because they expect to be able to rise in status by themselves.

Discussion and Conclusion

In this article, we have provided 12 conceptual replications of Price et al.’s (2011) proposal that individual differences in physical formidability among males are positively associated with individual differences in anti-egalitarianism. Resource contests across the animal world and, most likely, over human evolutionary history were partly resolved on the basis of fighting ability such that organisms with greater physical size and strength were more likely to prevail. Consequently, the human mind should be designed to calibrate a range of psychological responses to the organism’s level of formidability, and this should particularly be the case for males due to the massive human sexual dimorphism in strength. As suggested by Price et al. (2011), one such response relates to opposition towards moral regimes that impose egalitarian resource divisions. Formidable males should intuitively reason that they are able to compete for resources on their own.

The 12 available samples allowed us to examine 16 associations between different measures of physical formidability and anti-egalitarianism (measured as individual differences in SDO and economic conservatism) in both men and women. For males, 12 of these 16 associations were significant in the expected direction and four were in the expected direction but non-significant. For females, only five of the 16 associations were significant and a number were in the non-expected

direction (with physical formidability being descriptively associated with greater egalitarianism). Hence, for males but not females, these samples provide evidence of a relatively robust positive association between formidability and anti-egalitarianism. Furthermore, additional analyses and arguments suggested that formidability initially affects SDO and that the effects on economic conservatism reflect that the large associations between SDO and economic conservatism create a spill-over effect of formidability on the policy measure. Importantly, the association between anti-egalitarianism and male formidability was obtained across very different nationalities, degrees of representativeness, measures of formidability, and measures of anti-egalitarianism, which suggests that they are not particularly for just one single group or particular operationalizations. All in all, the association between individual differences in male formidability and anti-egalitarianism were supported with high external validity.

At the same time, it is important to consider the substantial variation in the reported effect sizes. We generally find larger effect sizes in the laboratory studies where physical strength is directly and objectively assessed, which highlights the need for high degrees of measurement validity. This point may also be relevant to consider in the context of whether the association between formidability and anti-egalitarianism varies systematically as a function of the individuals' SES. Specifically, in three samples, Petersen et al. (2013) found a significant interaction effect between male formidability and SES on anti-egalitarianism but no main effect of formidability (according to the results reported in Petersen et al. [2013], there is no significant effect of formidability for the sample-specific average of SES). The present set of findings, however, does not provide any consistent evidence for such an interaction effect. Potentially, these different findings reflect the fact that Petersen et al. (2013) utilized a less direct measure of upper-body strength (flexed biceps circumference) than Price et al. (2011) and a number of the present samples (see also Gelman & Loken, 2014).

Turning to the question of internal validity, we have assessed a number of different explanations for the association between male formidability and anti-egalitarianism. We found no evidence that this association is confounded by broader personality constructs nor that it reflects the social networks of formidable individuals. Rather, and consistent with an evolutionary perspective, the association seemingly reflects that strong males intuitively believe that they are able to secure resources on their own without the help of the collective. In the context of internal validity, it is also important to observe that while evolutionary psychological theory predicts a causal effect of formidability on anti-egalitarianism, we have only provided correlational evidence (although we have included a number of controls, including education and broader personality constructs). Causal evidence is hard to obtain for research questions where the independent variable is a difficult-to-manipulate physical variable. As noted in the theory section, however, a recent study used quasi-experimental techniques to obtain evidence of causality for a variable associated with SDO (aggression). Specifically, Petersen and Dawes (2017) utilized longitudinal data and cross-lagged regression models to show that, controlling for aggression at Time 1, formidability at Time 1 predicts aggression at Time 2 (but not vice versa). If formidability and aggression are asynchronous at Time 1, it is in other words formidability that exerts a causal pull on aggression. In addition, however, a limited but direct investigation of the causal relationship between formidability and SDO does exist. In an unpublished master's thesis, Nissen (2015) implemented a pilot version of a randomized experiment designed to increase muscle mass in men and examine the effects on SDO. Nissen has kindly provided us with the underlying data, enabling us to discuss the assessment of causality in greater detail. In the experiment, 98 males were randomly assigned to either engage in endurance training or a resistance training home program for eight weeks. The endurance training program focused on running, whereas the resistance training program focused on building upper-body strength. After signup, all communication with the participant was conducted online and, hence, it

should be noted that compliance etc. was not directly monitored. At the beginning of the experiment, subjects completed a translated version of the SDO scale taken from Pratto et al. (1994) and were asked to do as many push-ups as possible. Consistent with the analyses in the present article, initial levels of SDO and number of push-ups as a measure of upper-body strength were positively and significantly correlated ($r=0.24$, $p=0.015$). After the 2 months of training, the questions were repeated. The endurance training condition served as the control group, and they showed little evidence of having increased their maximum number of push-ups ($M1=27.5$ vs. $M2=28.8$, $t=0.83$, $p=0.41$). In contrast, the treatment condition—the resistance training group—showed clear signs of increased upper-body strength ($M1=28.5$ vs. $M2=39.3$, $t=6.16$, $p < 0.001$).

[Figure 3 about here]

Figure 3 displays the changes in SDO among the subjects from before to after the training period (each SDO scale measured on a 1–6 scale). As seen in Figure 3, when all subjects are examined together, we observe an overall positive and just significant increase in SDO ($b=0.11$, $p=0.049$). Consistent with the argument that SDO is particularly affected by upper-body strength, Figure 3 also shows that this increase in SDO is primarily driven by the resistance training group. In this group, the increased SDO is significant ($b=0.16$, $p=0.043$). The change is also positive in the endurance training condition but far from significant ($b=0.05$, $p=0.53$). At the same time, it is important to note that the increase in the resistance training group is not significantly larger than the increase in the endurance training group ($p=0.33$). Hence, this study only provided suggestive evidence of a direct link, but it does serve as a pilot study upon which a large-scale study could be modelled. At the same time, power analyses suggest that a full study is indeed a large-scale effort. Given the observed means and standard

deviations, a total N of 788 is required to detect a significant effect of resistance training relative to endurance training with an alpha-level of 0.05 and a power of 0.80.

In sum, the results presented in this article support that a key biological variable, upper-body strength, shapes the political views of human males such that stronger males are more opposed to collectively enforced egalitarian distributions of resources. From the perspective of a consilient view of the sciences (Wilson, 1999), this should not be surprising. Humans are one animal among others, and the default expectation should be that we are regulated by the same set of regularities as other species. Physical size and strength are the main variables affecting conflict behavior in all other species and, indeed, previous studies in psychology and biology have provided strong evidence that numerous psychological traits (e.g., trait aggression) in human males are affected by individual differences in strength. In essence, this article has contributed to extending these effects into the political domain. Aristotle described humans as a *zoon politikon* and, for humans, politics has been a key domain for the presence and resolution of resource conflicts (Petersen, 2015). Just as physical strength shapes the conflict behavior of other animals in the domains that are important to them (e.g., mating and territorial contests), physical strength appears to shape the behavior of the political animal in this key conflict domain. In this way, the present article helps bridge the gulf that often exists between the natural and social sciences and paves the way for the further utilization of the massive stocks of knowledge on animal behavior in illuminating human political behavior.

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Table 1a: Descriptive statistics for the five online and mostly representative samples applied for testing the relationship between formidability and egalitarianism. Information on sample character; operationalizations of key independent and dependent variables; and descriptive information with respect to gender and age.

	Study 1	Study 2	Study 3	Study 4	Study 5	Study 6	Study 7
Nationality	Danish	Ukrainian	Polish	American	Danish	Belarussian (residing in Lithuania)	Venezuelan
Sample character	Student sample	Nationally representative	Nationally representative	MTurk sample	Nationally representative	Convenience student sample	Nationally representative (on age and gender)
Time for data gathering	January 2012	March 2014	March 2014	March 2016	December 2016	Feb.-March 2017	September 2017
Formidability measure	Self-reported relative strength	Self-reported Drive for Muscularity (DMS)	Self-reported Drive for Muscularity (DMS)	Composite measure (DMS & Self-reported relative strength)	Self-reported relative strength	Self-reported relative strength	Self-reported relative strength
Measure(s) of egalitarianism	Social Dominance Orientation	Social Dominance Orientation	Social Dominance Orientation	Social Dominance Orientation	Social Dominance Orientation	Social Dominance Orientation	Social Dominance Orientation
Gender							
- Female (pct.)	53	53	50	53	50	82	48
- Male (pct.)	47	47	50	47	50	18	52
Age	M = 23.38 SD = 2.33	M = 35.12, SD = 10.07	M = 41.07, SD = 13.36	M = 35.81 SD = 12.25	M = 47.32 SD = 15.71	M = 21.27 SD = 3.37	M = 36.09 SD = 12.47
N	303	1,004	1,005	933	1,012	372	1,000

Table 1b: Descriptive statistics for the 5 laboratory studies applied for testing the relationship between formidability and egalitarianism. Information on sample character; operationalizations of key independent and dependent variables; and descriptive information with respect to gender and age.

	Study 8	Study 9	Study 10	Study 11	Study 12
Nationality	Danish	Danish	Danish	Danish	American
Sample character	Student sample	Student sample	Student sample	Locally representative	Locally representative
Time for data gathering	March 2012	November 2013	Dec. 2013-Feb. 2014	Oct.-Nov. 2015	June-Oct. 2016
Formidability measure	Composite Strength Index	Composite Strength Index	Handgrip Strength	Composite Strength Index	Composite Strength Index
Measure(s) of egalitarianism	Economic Conservatism	Social Dominance Orientation Economic Conservatism	Social Dominance Orientation Economic Conservatism	Social Dominance Orientation Economic Conservatism	Social Dominance Orientation Economic Conservatism
Gender					
- Female (pct.)	45	51	47	51	59
- Male (pct.)	55	49	53	49	41
Age	M = 23.56, SD = 3.86	M = 22.04, SD = 1.96	M = 22.36 SD = 2.20	M = 42.64, SD = 14.91	M = 49.56 SD = 16.44
N	116	108	165	171	160

Figure 1: Prediction of Social Dominance Orientation across Studies 1-12 (SDO not measured in study 8). Bars are regression coefficients from OLS regressions and dashed lines are 95 percent Confidence Intervals.

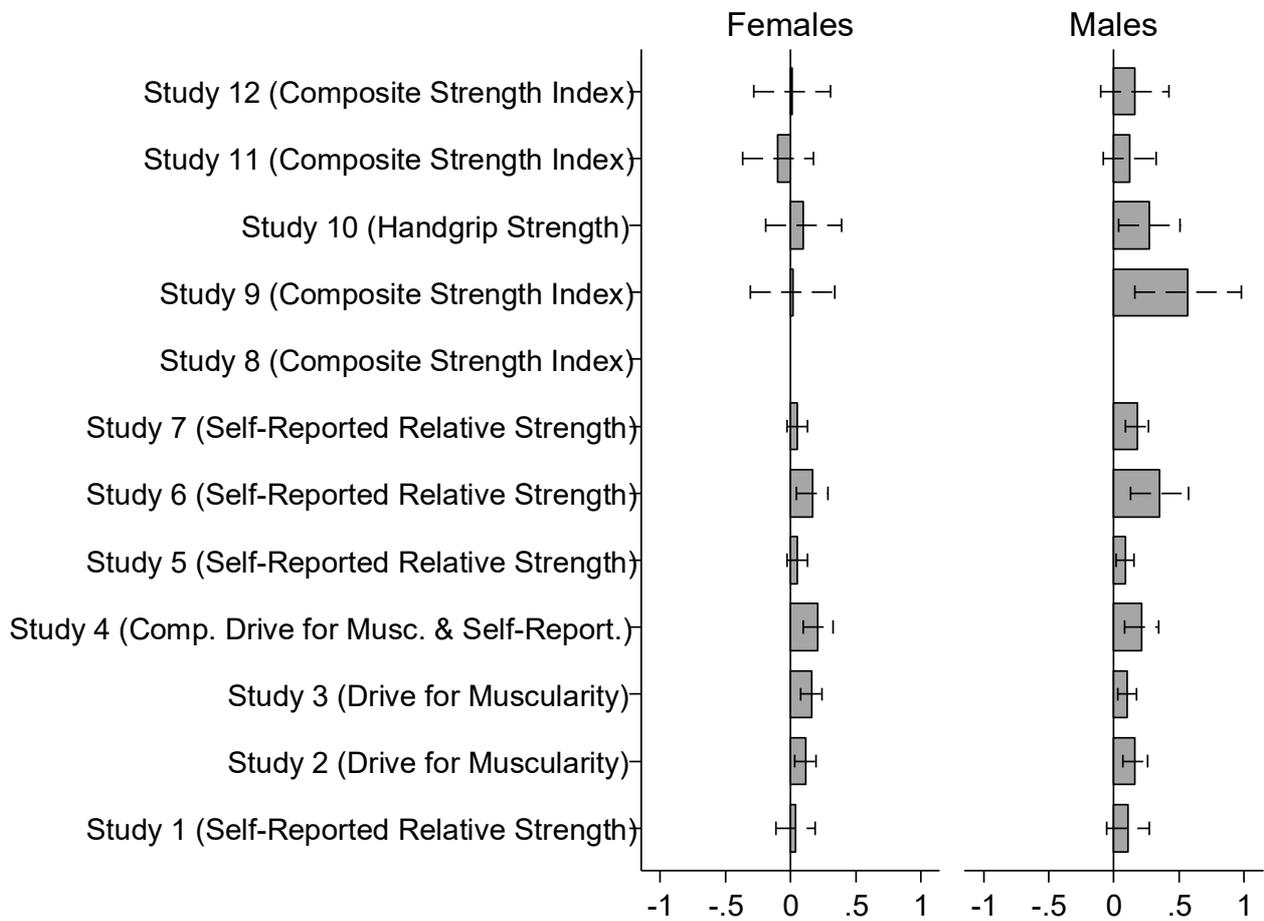


Figure 2: Prediction of economic conservatism across studies 8-12 (economic conservatism not measured in studies 1-7). Bars are regression coefficients from OLS regressions and dashed lines are 95 percent Confidence Intervals.

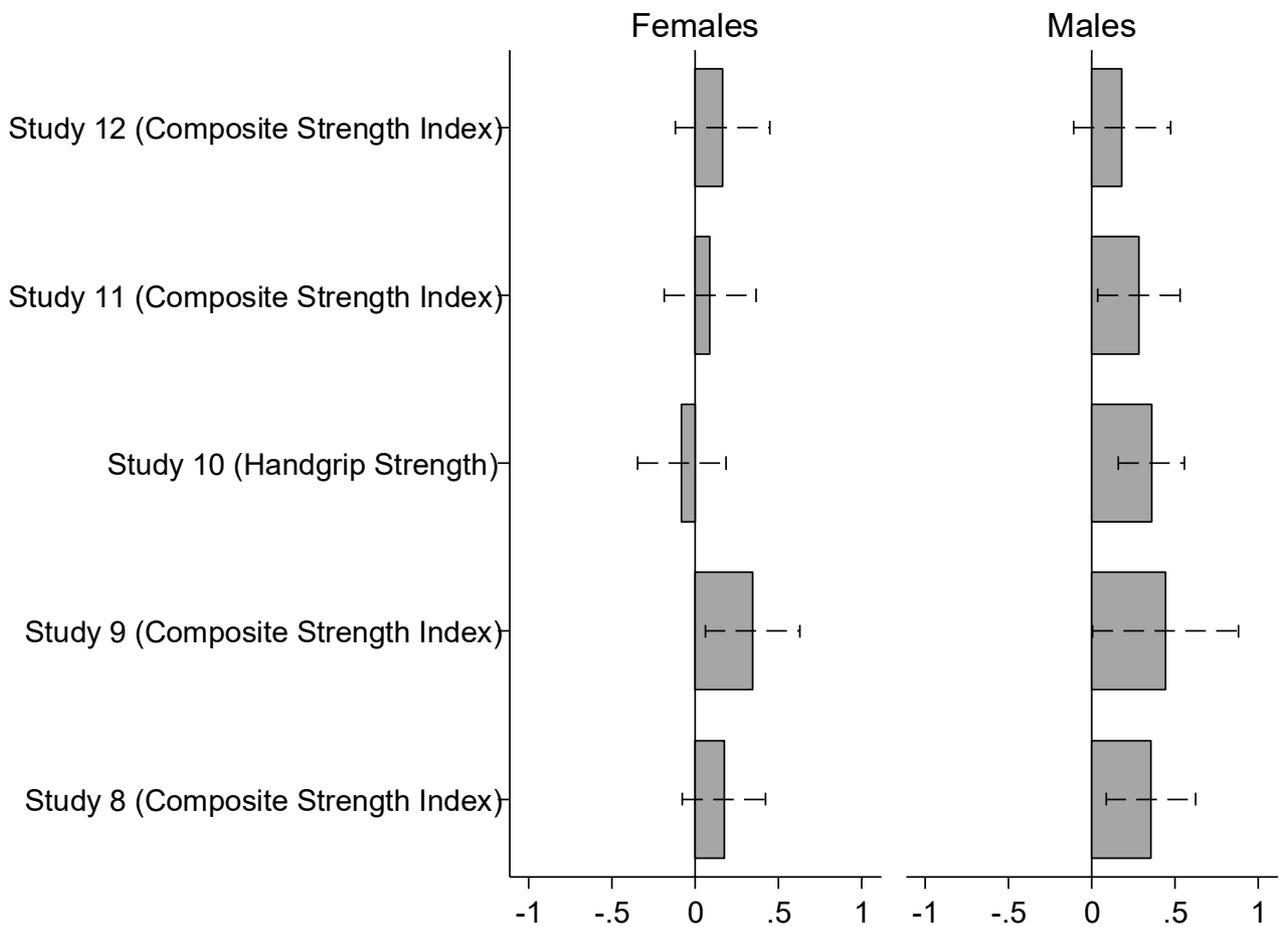
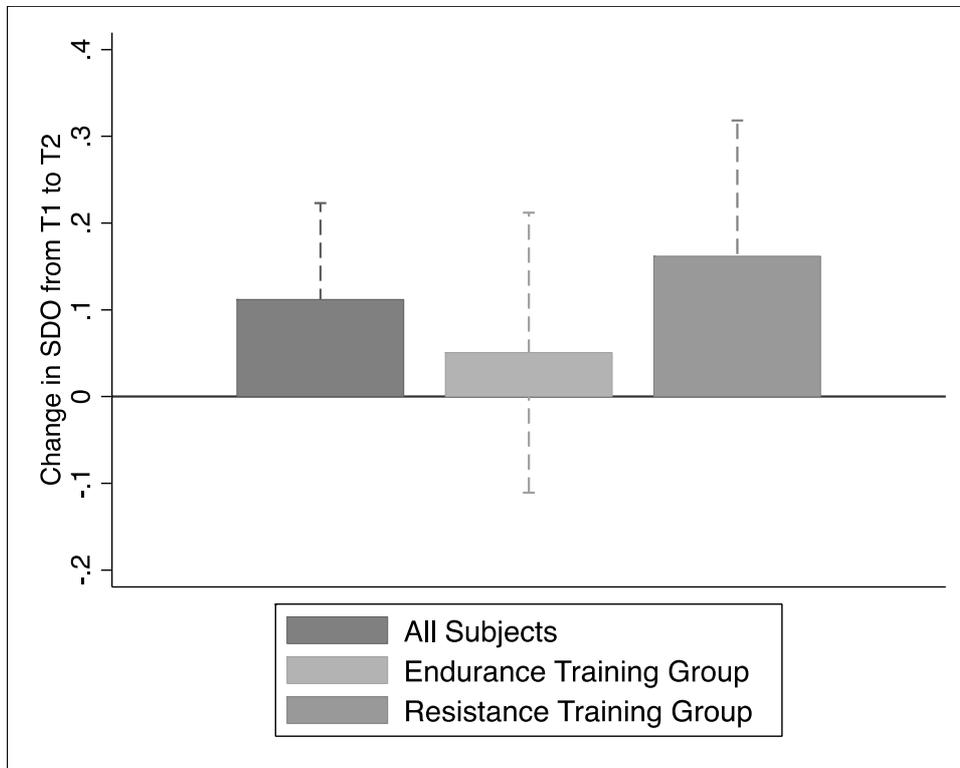


Figure 3: Changes in Social Dominance Orientation from before to after a 2 months period of physical training. Bars are observed changes and dashed lines are 95 percent Confidence Intervals.



Note: The figure is a re-analysis of data from Nissen (2015). SDO was measured on scales from 1-6 in both Time 1 (T1) and Time 2 (T2).