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Physically strong men are more militant: a test across four countries

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Abstract

There is substantial evidence from archaeology, anthropology, primatology, and psychology indicating that humans have a long evolutionary history of war. Natural selection, therefore, should have designed mental adaptations for making decisions about war. These adaptations evolved in past environments, and so they may respond to variables that were ancestrally relevant but not relevant in modern war. For example, ancestrally in small-scale combat, a skilled fighter would be more likely to survive a war and bring his side to victory. This ancestral regularity would have left its mark on modern men's intergroup psychology: more formidable men should still be more supportive of war. We test this hypothesis in four countries: Argentina, Denmark, Israel, and Romania. In three, physically strong men (but not strong women) were significantly more supportive of military action. These findings support the hypothesis that modern warfare is influenced by a psychology designed for ancestral war.

INTRODUCTION

By coordinating their actions, animals can greatly increase their effectiveness. However, this coordination has sizeable evolutionary barriers to its evolution; e.g., free riders can parasitize others' investment in collective actions (Delton et. al 2012; Delton & Sell 2014; Ostrom 2010). Nonetheless, coordinated actions do evolve in many species, either via kin selection (e.g. social insects, Hamilton 1964) or through other means still being mapped by evolutionary psychologists and behavioral ecologists (Boyd, Gintis & Bowles 2010; Cosmides & Tooby 1992; Delton et. al 2012; Ostrom 2010; Panchanathan & Boyd 2004). We know that these evolutionary barriers have been overcome, however, because animals evidence these behaviors; e.g., collective hunting is common in some mammals (e.g. Creel & Creel 1995) and is understood as a collective action problem with scavengers as the defectors (see Packer & Ruttan 1988).

Given the widespread importance of aggression in the animal kingdom (Huntingford & Turner 1987), there would have been a selective advantage to organisms that coordinated their aggression toward a common opponent, because such coordination would enhance an individual's own formidability. Provided that evolutionary barriers such as free-riding were overcome, engaging in coalitional aggression would be selected for in species where aggression was common.

Convergent evidence now shows that these preconditions have been met for our own species, and that we come from a long evolutionary history of war (Gat 2015; LeBlanc & Register 2003; Pinker 2011; van der Dennen 1995). Such evidence comes from multiple sources, including: evidence of coalitional killing among chimpanzees (Wrangham & Glowacki 2012), ethnographic surveys of modern societies showing that war is prevalent in virtually all known cultures (Otterbein & Otterbein 1965; Otterbein 1968, 2004), archeological evidence of slaughter and weapon hoarding (Keeley 1996, 1997), and psychological evidence of coalitional thinking (Tooby & Cosmides 2010; Van Vugt, De Cremer & Janssen 2007).

Warfare in chimpanzees

The closest living relatives of our species are the bonobos and chimpanzees. Chimpanzees live in patrilocal groups who compete against rival groups for access to territory and feeding grounds. Aggression is common among chimpanzees and

particularly among chimpanzee males (Wrangham, Wilson & Muller 2006). And like human males (Sell, Hone & Pound 2012), male chimpanzees show evidence of combat design (e.g. males are larger than females, have larger teeth, mature later, and die earlier). Unlike gorillas, bonobos, and orangutans, chimpanzees are known to engage in coalitional aggression with their male allies. These groups patrol their territory and capitalize on temporary asymmetries in group size to eliminate outgroup members.

The mechanisms that give rise to inter-group aggression in chimpanzees appear to have been designed by natural selection to expand territory and get access to food and mates. In short, the propensity for war is part of chimpanzees' evolved nature. We know this because group aggression in chimpanzees bears the hallmark of natural selection: complex functional design (Williams 1966). Features of chimpanzee aggression that illustrate this design include:

- i) coalitional aggressors are composed almost entirely of the sex that benefits the most from increased mating opportunities (i.e. males, Wilson et al. 2014)
- ii) coalitional aggressors frequently exempt adult females from aggression and may focus instead on males and infants (Wrangham & Glowacki 2012; Wilson et al. 2014; though see Pradhan, Pandit & van Schaik 2014)
- iii) lethal aggression is timed to periods of asymmetric fighting ability such as when one group greatly outnumbers another (Wilson et al. 2014), the result being that attackers are rarely seriously injured (Watts et al. 2006)
- iv) the aggression is often preceded by coordinated forays and patrols, often into enemy territory
- v) individual chimpanzee males who would benefit most from increased territory are often the ones who instigate these patrols for their group (e.g. those males who are more likely to mate with parous females patrol more frequently, Watts & Mitani 2001)
- vi) chimpanzee males who are superior fighters, and thus are less likely to be injured during aggressive encounters, are more likely to patrol, e.g. males who were good hunters patrolled more (Watts & Mitani 2001),

and males who are higher in rank travelled further when they visited the periphery of their territory where coalitional aggression was more likely to take place (Wilson et al. 2012).

While our understanding of chimpanzee cognition is limited, these findings suggest that chimpanzee minds (at least those of males) have been designed by natural selection to coordinate lethal aggressive action and exploit asymmetries in power so as to target and eliminate enemy males and infants. The preconditions that resulted in this selective regime were most likely present among human ancestors as well, e.g. patrilocality¹, fission-fusion grouping, territoriality, cognitive mechanisms allowing cooperation and collective actions, male design for aggression, and polygyny (Wrangham & Glowacki 2012; Tooby & DeVore 1987; see also Zefferman & Mathew 2015).

Universality of warfare

How widespread is war among humans? While different definitions of “war” will return different answers, coalitional aggression in the form of feuding or raiding has been found in almost all known cultures (Pinker 2011, Wrangham & Glowacki 2012), and among humans’ earliest civilizations for which we have data (Gat 2015; Keeley 1996, 1997; LeBlanc & Register 2003; Otterbein 2004; van der Dennen 1995). Furthermore, coalitional aggression appears more common in populations whose lifestyles resemble our ancestors’, e.g. both patrilocality and polygyny predict coalitional aggression (Otterbein 1965; 1968), and aggression is far more prevalent among foragers than among modern nation-states (Eisner 2003; Pinker 2011).

There are, of course, human civilizations that have forgone war for many generations, e.g., the Jains, the Amish, the Lapps. These exceptions are exceedingly rare, however, and tend to exist as subpopulations protected by larger nation-states. The bulk of the evidence indicates that human societies have engaged in group aggression throughout recorded history and before (Pinker 2011).

¹ Though the degree of patrilocality in modern foragers is arguably less than once thought and certainly less than chimpanzees (see Hill et al. 2011). Interestingly, in Hill et al.’s sample of 32 foraging societies, brothers were particularly likely to coreside.

There is also more direct evidence that human psychology, and in particular male psychology, has been shaped by this inter-group conflict. For example, in public goods games males contributed more to their own coalition when they were put in a context of inter-group competition. When women (sampled from the same population) were put in inter-group competition it had little effect on their contributions to their own group (Van Vugt, De Cremer & Janssen 2007). Human prejudice and discrimination aimed at outgroup members is also consistent with the view that the human mind (particularly the male mind) was designed for coalitional aggression (see McDonald, Navarrete & Van Vugt 2012). Perhaps most convincingly, an analysis of the structure of human moral systems shows that they function to regulate coalitional living generally and group conflict in particular (Tooby & Cosmides 2010).

We conclude that a selective regime has been in place favoring designs in men that navigate the costs and benefits of war in ways that increased their reproduction in past environments. In other words, modern men should be designed for ancestral-style warfare (Tooby & Cosmides 1988). Therefore, men who would have been more likely to survive and benefit from war ancestrally should be more supportive of war now. Because modern warfare differs from ancestral warfare, the variables that predict whether a man would have survived and benefited from war may no longer be predictive in a modern industrial society. For example, ancestral weapons were powered by the upper body (Brues 1959) whereas casualties caused by hand-to-hand combat are extremely rare in modern war (e.g. one study of casualties in Iraq showed 56% of the dead were killed by gunshots, 27% died to car bombs or other explosives, 13% to airstrikes, 2% to accidents, and only 2% expired from unknown causes which may have included deaths caused by knives, bayonets, or hand-to-hand combat; Burnham et al. 2006).

Fighting ability and warfare

If natural selection designed mental adaptations to navigate the selection pressures inherent in ancestral warfare, then such mechanisms should regulate an individual's support for war as a function of variables that – ancestrally – predicted the reproductive consequences of advocating for war in that individual and their kin. In the small-scale, technologically-sparse world of ancestral warfare, men with superior fighting ability

would have been more likely to survive a war, to lead his side to victory, and to receive a sizeable portion of the spoils of war (Chagnon 1988; Escasa, Gray & Patton 2010; Van Vugt De Cremer & Janssen 2007). Therefore, men who are better physical fighters today should still favor war as a tactic in resolving group disputes more so than men who are poor fighters (prediction #1). Furthermore, because war has been (and still is) almost exclusively a male activity the relationship between fighting ability and preference for coalitional aggression should be limited to men (prediction #2). Previous research has confirmed these predictions on two samples of US subjects (Sell, Tooby & Cosmides 2009; see also Sell, Hone & Pound 2012). In this paper, we report additional tests of these predictions on men and women from Argentina, Denmark, Israel, and Romania.

Methods

We tested the hypothesis that fighting ability in men (but not women) tracks support for military action in four countries.

Subjects

Argentinean subjects were students at the University of Buenos Aires who were paid for their participation. Israeli subjects were students at Ben Gurion University and the Interdisciplinary Center (IDC) Herzliya, and were either paid or given course credit for their participation. Romanian subjects were students from the West University of Timisoara, who participated for partial fulfilment of their course credit. Danish subjects came from a large nationally representative sample contacted via a survey agency. Subjects were drawn from YouGov Zaperas's standing web panel based on quota sampling such that the sample was nationally representative on sex, age, and geographical location. The response rate was 34%. Experimenters aimed to recruit at least 80 male and 80 female subjects, but recruited more when convenient. Data collection on each sample was completed and closed before data analysis began on that sample.

Table one presents descriptive statistics for all four samples.

Measures

1. Fighting ability

Fighting ability is difficult to measure in an ethical manner. Previous research and theorizing, however, suggests that upper body strength is a good approximation of fighting ability. This is for many reasons. Among them, archaeological evidence shows that upper body strength powered all ancestral weapons (Brues 1959). There is also greater sexual dimorphism in upper body strength than lower body strength or body size generally (Lassek & Gaulin 2009). Furthermore, when subjects estimate others' fighting ability, they produce ratings that more closely track upper body strength than lower body strength, even when estimating fighting ability from the face (Sell et al. 2009) or voice (Sell et al. 2010; Sell 2012). Finally, there are theoretical reasons to believe that fighting ability in men is linked to individual aggression and anger, and it is upper body strength, relative to lower body strength and body size, that is the more powerful predictor of an individual man's anger and aggression (Sell, Tooby & Cosmides 2009; Sell, Eisner & Ribeaud 2016).

Research has shown that flexed biceps circumference is the single most accurate morphological measure of upper body strength in adult males (see Sell et al. 2009, supplemental information). Therefore, upper body strength was operationalized as the circumference of the flexed biceps of the dominant arm (see Petersen et al. 2013). Argentinean, Israeli, and Romanian subjects were measured by the experimenters. The Danish subjects (who provided data via an online survey) were instructed on how to self-measure their flexed biceps circumference or recruit someone to measure their arm for them. Of 1537 Danes who responded to the questionnaire, 803 returned strength measurements (421 males and 372 females).

2. Support for warfare

Support for warfare among Argentinean and Danish subjects was measured with four-item scales designed for each country as part of a previous project (see Petersen et al. 2013). Israeli subjects were given a 10-item scale based primarily on the Israeli-Palestinian conflict. Romanian subjects were given a scale originally designed for US subjects (see Sell, Tooby & Cosmides 2009) with items that referred to the US removed. This resulted in a scale with nine items. All scales are reported in Supplemental Online Materials. Sample items include: "Argentina must amass enough military power and (re)take the Falkland Islands by force" (Argentina), "It was wrong of Denmark to go

along with the war in Iraq” (Denmark), “The only way Israel can solve the conflict with the Palestinians is by using force” (Israel), and “When it comes to international conflicts, violence never solves anything” (Romania). Subjects reported their agreement with these statements from 1 (strongly disagree) to 7 (strongly agree).

Data screening

Data was screened for any subjects who were more than 3 standard deviations above or below the mean on measures of physical strength. Treatment of these outliers is detailed below.

1. Argentina

We identified a single outlier whose z-scored biceps circumference was 4.34 SD above the mean; specifically, 46.3cm. This measure was taken by experimenters and is well within the range of plausible measures for male flexed biceps circumference. To minimize the impact of this extreme score, the flexed biceps circumferences of Argentinian subjects (both male and female) were given a square-root transformation. This transformation did not change the significance of any reported test, and worked against our hypothesis (i.e. it decreased the correlation between strength and support for war in males).

Three subjects from Argentina left the support for war questions blank and were removed.

2. Denmark

Unlike Argentinean subjects who were measured by experimenters, the Danish subjects were asked to measure their own biceps or recruit someone to help measure them after reading instructions on how to do this. This meant that outliers could be errors in measurement or reporting. For example, there were three subjects who reported inhumanly low biceps circumferences, e.g. less than 8 cm; these data were removed from analyses. Additionally, two subjects reported biceps circumferences that were inhumanly large: e.g. 250 and 295cm. These subjects were excluded because they were almost certainly data entry errors on behalf of the subjects.

With those outliers removed, there remained 798 subjects. These subjects had their z-scores recomputed because the data entry errors had increased the variance substantially. The new distribution showed 8 subjects with z-scored biceps circumferences that were greater than 3SD or lower than -3SD. Because these subjects were not measured by experimenters, these outliers were removed from analysis. Leaving them in the analysis did not change the significance of any reported test.

Furthermore, subjects from Denmark were allowed to answer “I don’t know” for any of the four questions in the support for war scale. Because five subjects answered “I don’t know” to all four questions, they were also removed from analyses.

3. Israel

There was one Israeli subject who had an extreme score on biceps circumference (i.e., z-score of 3.16). Because this measurement was taken by experimenters, and the score is not very extreme, it is unlikely that it was a measurement error. This outlier was included in analyses; removing him did not change the significance of any test.

4. Romanian

There were no outliers in the Romanian samples.

Table 1: Descriptive statistics and measures

	Argentina	Denmark	Israel	Romania
Sample size	215 (104 female)	785 (364 female)	281 (193 female)	191 (117 female)
Mean age	20.9, SD= 2.9	49.0, SD= 13.7	23.3, SD= 2.2	21.0, SD= 3.6
Support for warfare measure	4 self-report items ($\alpha = .86$)	4 self-report items ($\alpha = .71$)	10 self-report items ($\alpha = .85$)	9 self-report items ($\alpha = .64$)

Results

Results are discussed by hypothesis and summarized in Figure 1.

Figure 1: Strength and Support for War across Four Countries

Note: Scatterplots show flexed biceps circumference regressed on support for war; regression lines and 95% confidence intervals are displayed for both sexes separately.

Hypothesis #1: Are physically strong men more supportive of warfare?

Yes. In three of the four countries, the flexed biceps circumference of men positively predicted their support for warfare (Argentina: $r = 0.20$, $p = .016$; Denmark: $r = 0.11$, $p = .012$; Israel: $r = 0.02$, $p = .42$; Romania: $r = 0.20$, $p = .04$, all one-tailed). See Supplemental Online Materials for more analyses on this hypothesis.

Hypothesis #2a: Is this relationship specific to men?

Yes. Women's physical strength was never a significant predictor of their support for warfare (Argentina: $r = 0.15$, $p = .14$; Denmark: $r = -0.07$, $p = .19$; Israel: $r = -0.03$, $p = .72$; Romania: $r = -0.01$, $p = .94$, all two-tailed).

Hypothesis #2b: Was the correlation in men significantly higher than that of women?

Somewhat. A Fisher's r -to- z transformation test for differences between correlations revealed that the correlation between strength and support for war was significantly higher among men than among women in the large Danish sample ($z = 2.5$, $p = .007$), and marginally significant in the Romanian sample ($z = 1.4$, $p = .08$); though analyses with a more comprehensive measure of upper body strength did reveal a fully significant effect in Romania (see Supplemental Online Materials). The correlations did not differ significantly for subjects in Argentina ($z = 0.42$, $p = .34$) or Israel ($z = 0.38$, $p = .35$, all one-tailed).

Additional analyses and controls

The Danish sample was different from the Argentine, Israeli, and Romanian samples in several respects. The Danish sample was a nationally representative sample, so many older subjects participated (see Table 1). Furthermore, the biceps circumference was reported by the subjects themselves without independent verification by experimenters. This introduces a number of potential confounds that are addressed here.

1. Does age confound the relationship between strength and support for war among Danish subjects?

No. We ran two regression analyses (one for each sex) testing the ability of flexed biceps circumference and age to predict support for war. For men, biceps

circumference remained a small but significant predictor: $\text{Beta} = 0.13, p = .004$ (one-tailed), while age was not predictive: $\text{Beta} = 0.04, p = .62$. For women, biceps circumference was again not predictive: $\text{Beta} = -0.04, p = .40$, while age was a weak but significant predictor, $\text{Beta} = -0.13, p = .01$ (two-tailed) such that older women tended to be less supportive of military action. See Supplemental Online Materials for many additional controls.

2. Did self-measurement render Danish subjects' biceps circumference measurements inaccurate?

Danish subjects were instructed visually and verbally on how to measure their biceps. They were encouraged to get help from a family member or roommate if possible. Subjects reported whether they did the measurements themselves or had help from another. This enables us to test the robustness of the effects by looking specifically at subjects who presumably had the more accurate biceps circumference measurements (i.e. those who received help with the measurement). We split our data set between those subjects who measured their own biceps (308 females and 315 males) and those who received help with the measurements (62 females and 108 males) and reran the correlation analyses.

Correlations between support for war and biceps circumference for males replicated in both sub-samples; those who measured themselves ($r = 0.12, p = .017$, one-tailed) and those who were measured by others ($r = 0.15, p = .06$, one-tailed). Correlations for females remained non-significant for those who measured themselves: $r = -0.07, p = .26$ and those who were measured by others: $r = -0.11, p = .41$, two-tailed.

Danish subjects were also asked how confident they were in their measurements of their own biceps. Answers were given from 1 (very uncertain) to 7 (very certain). There is no reason to believe there is a linear relationship between this uncertainty and the subjects' biceps circumference (i.e. subjects who were uncertain could have erred to make their biceps larger or smaller). Therefore, regression analyses to control for this difference would be inconclusive. Instead, we truncated the sample to only those subjects who reported being very certain that their measurement was accurate (i.e. those subjects who reported 7 on the 7-point scale). Among this smaller sample (139 females and 168 males), the correlation between support for war and biceps

circumference was still significant for men, $r = 0.14$, $p = .033$, (one-tailed)². The correlation for women remained nonsignificant and slightly negative, $r = -0.12$, $p = .14$ (two-tailed).

Taken together, this evidence suggests that the self-measured biceps circumference of Danish subjects was accurate enough to reveal a real relationship between physical strength and support for war among men. Additional analyses on the Danish sample shows that the effect was robust to basic control variables as well, e.g. body size, socioeconomic status, exercise. See the Supplemental Online Materials for details.

Discussion

A substantial body of evidence indicates that humans have a long evolutionary history of war. This is a profound discovery, because it informs us of a potent selection pressure that was active on our lineage. A selection pressure of this magnitude can be expected to have greatly impacted the evolved human psychology. In short, men should be designed for war (McDonald, Navarrete & Van Vugt 2012; Tooby & Cosmides 2010; Van Vugt, De Cremer & Janssen 2007; see also Sugiyama 2014).

If so, we can generate testable hypotheses about how the male mind responds to intergroup aggression, and predict some of the variables that explain individual differences in proneness to such aggression. One such hypothesis is that physically stronger men, who, ancestrally, would have incurred lower costs and derived higher benefits from war, would today be more likely to support war. This hypothesis was confirmed across three of the four tested countries, and replicates what was previously found in two samples of US college students (Sell, Tooby & Cosmides 2009) and a sample of Hollywood actors (Sell, Hone & Pound 2012). Specifically, measures of upper body strength predicted support for warfare in men but not women.

No correlation was found between strength and support for war among Israeli men. There are a number of potential explanations for this null effect. One, it may simply be a Type II error, as our Israeli sample was made up mostly of women (there were only 88 males compared to 193 females). This explanation is not likely though, as the effect was

² Selecting only subjects who rated their confidence as 6 or 7 (out of 7) increased the sample size to 278 males and the correlation remained significant at $.10$, $p = .043$, one-tailed. Doing a median split on confidence produced exactly the same results because a score of 6 was the median.

not even approaching significance. Another possibility is that Israeli men are much more likely to have military experience than men in our other samples, and so their internal sense of their own fighting ability may have been set by martial skills that were not assessed in our study and not known to other subject populations (e.g. accuracy of firearm shooting may contribute to a man's sense of fighting ability, and would be known among Israelis but not, for example, the typical Romanian student). It is also possible that the Israeli-Palestinian conflict is different than the kinds of military actions measured in other populations. For example, the survival of Israel is threatened by its enemies, while the same cannot be meaningfully said of Argentina or Denmark. Men may respond differently to wars of survival (or defensive wars generally) than to offensive or optional wars. Unfortunately, the current data set does not allow for testing between these alternatives.

Excepting the Israeli data, the correlation between upper body strength and support for war (among men) has now been found in two samples of US college students, Hollywood actors, students in Argentina and Romania, and in a nationally representative sample of Danes. This indicates a robust effect. However, despite this, the effect sizes for all samples were small. This may be because the measures of fighting ability were inexact. For example, the effect was larger in a US sample in which upper body strength was measured via weight-lifting machines (i.e. $r = 0.28$; see Sell, Tooby & Cosmides 2009). Our measures of support for war were also abstract and may not be ideally suited for evoking ancestral predilections for war; e.g., some subjects may not identify with the country they reside in, or may have loyalties to political parties whose stances on war they feel obligated to support. Additionally, war adaptations in men may include circuits designed to benefit warriors even if the individual is not likely to fight (i.e. gratitude for warriors is common to human nature and often instantiated in cultural rituals, Pinker 2011). These circuits may lead weaker men who are at particular risk from enemies to value warriors who protect them, dulling the correlation between fighting ability and support for war; this explanation would predict that weaker males are more likely to support defensive wars, which could explain the lack of effect in Israel. Finally, the theory predicts that these effect sizes should be small, because fighting ability (even comprehensively measured) is only one predictor of the likely costs and benefits of ancestral wars. Coalitional support, the strength of one's

allies and family, the resources to be acquired in victory, the opportunity costs of war, the benefits of reconciliation, and many other factors likely calibrate an individual's willingness to engage in coalitional aggression. That said, the theory predicts that more ecologically valid stimuli and more comprehensive measures of fighting ability will magnify the effects found here, and if they fail to do so the hypothesis should be rejected.

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REFERENCES

- Boyd, R., Gintis, H., & Bowles, S. (2010). Coordinated punishment of defectors sustains cooperation and can proliferate when rare. *Science*, 328(5978), 617-620.
- Brues, A. (1959). The spearman and the archer—an essay on selection in body build. *American Anthropologist*, 61(3), 457-469.
- Burnham, G., Doocy, S., Dzens, E., Lafta, R., & Roberts, L. (2006). The human cost of the war in Iraq: A mortality study, 2002-2006. Center for International Studies, Massachusetts Institute of Technology.
- Chagnon, N. A. (1988). Life histories, blood revenge, and warfare in a tribal population. *Science*, 239(4843), 985-992.
- Cosmides, L., & Tooby, J. (1992). Cognitive adaptations for social exchange. *The adapted mind*, 163-228.
- Creel, S., & Creel, N. M. (1995). Communal hunting and pack size in African wild dogs, *Lycaon pictus*. *Animal Behaviour*, 50(5), 1325-1339.
- Delton, A. W., Cosmides, L., Guemo, M., Robertson, T. E., & Tooby, J. (2012). The psychosemantics of free riding: dissecting the architecture of a moral concept. *Journal of personality and social psychology*, 102(6), 1252.

- Delton, A. W., & Sell, A. (2014). The co-evolution of concepts and motivation. *Current directions in psychological science*, 23(2), 115-120.
- Eisner, M. (2003). Long-term historical trends in violent crime. *Crime and Justice*, 83-142.
- Escasa, M., Gray, P. B., & Patton, J. Q. (2010). Male traits associated with attractiveness in Conambo, Ecuador. *Evolution and Human Behavior*, 31(3), 193-200.
- Gat, A. (2015). Proving communal warfare among hunter-gatherers: the Quasi-Rousseauan error. *Evolutionary anthropology*, 24, 111-126.
- Hamilton, W. D. (1964). The genetical evolution of social behaviour. II. *Journal of theoretical biology*, 7(1), 17-52.
- Hammerstein, P. (2003). Genetic and cultural evolution of cooperation. MIT press.
- Hill, K. R., Walker, R. S., Božičević, M., Eder, J., Headland, T., Hewlett, B., Hurtado, M. A., Marlowe, F., Wiessner, P. & Wood, B. (2011). Co-residence patterns in hunter-gatherer societies show unique human social structure. *Science*, 331(6022), 1286-1289.
- Huntingford, F. A., & Turner, A. K. (1987). *Animal conflict*. London: Chapman.
- Keeley, L. H. (1996). *War before civilization*. Oxford University Press.
- Keeley, L. H. (1997). Frontier warfare in the Early Neolithic. *Troubled Times: Violence and Warfare in the Past*, 4, 303.
- Lassek, W.D., & Gaulin, S. (2009). Costs and benefits of fat-free muscle mass in men: Relationship to mating success, dietary requirements, and natural immunity. *Evolution and Human Behavior*, 30, 322-328
- LeBlanc, S. A., & Register, K. E. (2003). *Constant battles: The myth of the peaceful, noble savage*. Macmillan.
- McDonald, M. M., Navarrete, C. D., & Van Vugt, M. (2012). Evolution and the psychology of intergroup conflict: the male warrior hypothesis. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, 367(1589), 670-679.

- Ostrom, E. (2010). Collective action and the evolution of social norms. *Journal of Economic Perspectives*, 14(3), 137-158.
- Otterbein, K. F., & Otterbein, C. S. (1965). An eye for an eye, a tooth for a tooth: A cross-cultural study of feuding. *American Anthropologist*, 67(6), 1470-1482.
- Otterbein, K. F. (1968). Internal War: A Cross-Cultural Study. *American Anthropologist*, 70(2), 277-289.
- Otterbein, K. F. (2004). *How war began*. Texas A&M University Press.
- Packer, C. & Ruttan, L. (1988). The evolution of cooperative hunting. *American Naturalist*, 132(2), 159-198.
- Panchanathan, K., & Boyd, R. (2004). Indirect reciprocity can stabilize cooperation without the second-order free rider problem. *Nature*, 432(7016), 499-502.
- Petersen, M.B, Sznycer, D., Sell, A., Tooby, J., Cosmides, L. (2013). The ancestral logic of politics: Upper body strength regulates men's assertion of self-interest over income redistribution. *Psychological Science*, 24(7), 1098-1103.
- Pinker, S. (2011). *The better angels of our nature: Why violence has declined*. Penguin.
- Pradhan, G. R., & Pandit, S. A. (2014). Why do chimpanzee males attack the females of neighboring communities?. *American journal of physical anthropology*, 155(3), 430-435.
- Sell, A. (2012). Evolved cognitive adaptations. In J. Vonk & T. Shackelford (eds.), *The Oxford Handbook of Comparative Evolutionary Psychology*. Oxford University Press.
- Sell, A., Bryant, G., Cosmides, L., Tooby, J., Sznycer, D., von Rueden, C., Krauss, A. & M. Gurven (2010). Adaptations in humans for assessing physical strength and fighting ability from the voice. *Proceedings of the Royal Society*, 277, 3509-18.
- Sell, A., Cosmides, L., Tooby, J., Sznycer, D., von Rueden, C. & Gurven, M. (2009). Human adaptations for the visual assessment of strength and fighting ability from the body and face. *Proceedings of the Royal Society*, 276, 575-584.

- Sell, A., Eisner, M. & D. Ribeaud (2016). Bargaining power and adolescent aggression: the role of fighting ability, coalitional strength, and mate value. *Evolution and Human Behavior*, 37(2), 105-116.
- Sell, A., Hone, L. & N. Pound (2012). The importance of physical strength to human males. *Human Nature*, 23, 30-44.
- Sell, A., Tooby, J., & Cosmides, L. (2009). Formidability and the logic of human anger. *Proceedings of the National Academy of Science*, 106(35), 15073-78.
- Sugiyama, M. S. (2014). Fitness costs of warfare for women. *Human Nature*, 25(4), 476-495.
- Tooby, J., & Cosmides, L. (1988). The evolution of war and its cognitive foundations. *Institute for evolutionary studies technical report*, 88(1), 1-15.
- Tooby, J., & Cosmides, L. (2010). Groups in mind: The coalitional roots of war and morality. *Human morality and sociality: Evolutionary and comparative perspectives*, 91-234.
- Tooby, J. & DeVore, I. (1987). The reconstruction of hominid behavioral evolution through strategic modeling. *The Evolution of Human Behavior: Primate Models*, edited by WG Kinzey, 183-237.
- van der Dennen, J. M. G. (1995). The origin of war: The evolution of a male-coalitional reproductive strategy, Vols. 1 & 2. Origin Press.
- Van Vugt, M., De Cremer, D., & Janssen, D. P. (2007). Gender differences in cooperation and competition the Male-Warrior hypothesis. *Psychological science*, 18(1), 19-23.
- Watts, D. P. and J. C. Mitani (2001). "Boundary patrols and intergroup encounters in wild chimpanzees." *Behaviour* **138**(3): 299-327.
- Watts, D., Muller, M., Amsler, S., Mbabazi, G. & Mitani, J. (2006). Lethal intergroup aggression by chimpanzees in the Kibale National Park, Uganda. *American Journal of Primatology*, 68, 161-180.
- Williams, G. C. (1966). *Adaptation and natural selection*. Princeton University Press.

Wilson, M.L., Kahlenberg, S.M., Wells, M., & R.W. Wrangham (2012). Ecological and social factors affect the occurrence and outcomes of intergroup encounters in chimpanzees. *Animal behaviour*, 83, 277-291.

Wrangham, R. W., & Glowacki, L. (2012). Intergroup aggression in chimpanzees and war in nomadic hunter-gatherers. *Human Nature*, 23(1), 5-29.

Wilson, M. L., Boesch, C., Fruth, B., Furuichi, T., Gilby, I. C., Hashimoto, C., ... & Lloyd, J. N. (2014). Lethal aggression in Pan is better explained by adaptive strategies than human impacts. *Nature*, 513(7518), 414-417.

Zefferman, M. R., & Mathew, S. (2015). An evolutionary theory of large-scale human warfare: Group-structured cultural selection. *Evolutionary Anthropology: Issues, News, and Reviews*, 24(2), 50-61.

SUPPLEMENTAL ONLINE MATERIALS

for

Physically strong men are more militant: a test across four countries

Section 1: Support for War measures

The following scales are the English translations of the support for war measures reported in the main text. Higher scores indicate more support for war; items marked with (R) are reverse-coded.

1. Argentina

It is vital for Argentina to have a strong military to solve conflicts of interests with neighboring countries

Argentina must amass enough military power and (re)take the Falkland Islands by force

It's important to have strong armed forces to defend our resources from the aspirations [note: in the sense of scheming] of other countries

It is desirable that the Argentine armed forces be stronger than they are currently

2. Denmark

It was wrong of Denmark to go along with the war in Iraq (R)

It is important that Denmark has a strong military

Europe should build a strong military to deter an aggressive Russia

Denmark is better with diplomacy than with military force (R)

3. Israel

The only way Israel can solve the conflict with the Palestinians is by using force.

When it comes to the conflict with the Palestinians, the only realistic option is negotiation. (R)

The harder you hit the Palestinians, the better they will treat us.

Bombing operations in Palestinian territories in which innocent civilians are killed are immoral. (R)

The only language the Palestinians understand is the language of force.

Only after we impose sufficient human and material losses on the Palestinians will they treat us decently.

Hitting the Palestinians is a terrible mistake—they will only hit us harder. (R)

The Israeli armed forces must be given a larger proportion of the national budget than is currently the case.

Every time a missile fired from the Gaza strip hits Israeli territory, Israel should cut off the electricity supply to Gaza.

Every Palestinian attempt to kill member(s) of the Israeli armed forces should lead to a harsh Israeli response, even if that harms innocent Palestinian civilians.

4. Romania

In most cases I agree with the phrase, “Peace not War.” (R)

When countries respond to force with force it only causes more problems in the long run. (R)

A good way for a country to protect itself is to fight harder and stronger than the opposing country.

Wars in general promote terrorism. (R)

When it comes to international conflicts, violence never solves anything. (R)

The military can solve problems for our country.

We need a strong military.

To deter violence, a country needs a strong military.

Going to war is always wrong. (R)

Section 2: Supplemental analyses on the Danish sample

The sample from Denmark was part of a larger survey of a nationally representative sample, and as such the data set contained a number of additional variables that allow us to test the specificity of the link between upper body strength and support for warfare. The following variables were measured and available for analysis:

1. Age. Subjects reported their age in years.
2. Height. Subjects reported their height in centimeters
3. Weight. Subjects reported their weight in kilograms
4. Amount of exercise. Subjects reported their weekly hours of exercise.
5. Self-reported attractiveness. Subjects reported their physical attractiveness relative to 100 other members of their age and sex.
6. Socioeconomic Status #1 (Education): "What is the highest education you completed at this time?" This item used the following scale that was treated as interval in analyses:
 1. Primary school (Grundskole/folkeskole)
 2. Middle school (Mellemskole/realeksamen)
 3. High school (Almengymnasial uddannelse, Studentereksamen/HF)
 4. Commercial Secondary education (Erhvervsgymnasial uddannelse (HH/HTX/HHX))
 5. Vocational education (Erhvervsfaglig uddannelse EFG)
 6. Higher education under 3 years (Kort videregående uddannelse under 3 år)
 7. Medium further education 3-4 years, i.e. Bachelor's degree (Mellemlang videregående uddannelse 3-4 år)
 8. Long higher education 5+ years, i.e. Master's degree (Lang videregående uddannelse 5 år eller mere)
 9. Doctoral, i.e. PhD (Forskeruddannelse)
7. Socioeconomic Status #2 (Personal annual income): Reported as intervals of 100,000 Krone per annum from 1 to 11, i.e. 2 = 200,000 to 299,999 kr.; 5 = 500,000 to 599,999; 11 = over 1,000,000.
8. Socioeconomic Status #3 (Household annual income): Reported as above.
9. Household size. Subjects reported the number of persons (including children) living in their home.

Bivariate correlations showed high correlations between weight and flexed bicep circumference for both women ($r = 0.64, p < 10^{-39}$) and men ($r = .37, p < 10^{-14}$); and between annual income and household income (women: $r = .64, p < 10^{-39}$; $r = .79, p < 10^{-84}$). To remove this collinearity, the two income measures were z-scored and combined into a single income measure for inclusion in regression analyses. Because flexed bicep

circumference was a key predictor variable, weight was eliminated rather than merged.³

Was the effect of flexed biceps circumference on support for war robust to basic controls? To test this, simultaneous linear regressions were run separately for men and women predicting support for war from biceps circumference and the control variables. The results are summarized in Table – S1. Flexed biceps circumference was the only significant predictor in men, and had an effect size slightly larger than the zero-order bivariate correlation reported in the main text. In women, both age and education were negative predictors of support for war.

Of interest, self-reported attractiveness was not a predictor of support for war in either men or women. This fails to replicate (at least in this sample) an effect first found on US college students in Sell, Tooby & Cosmides (2009), in which physically attractive women were more supportive of military action. Controlling for subject age did not restore this effect. Furthermore, truncating the Danish sample to only young women in the age range of the original US study (less than 25) did not produce a significant effect, i.e. the correlation between attractiveness and support for war in Danish women under 25 was $-.03, p = .88$, two-tailed.

Table S1: Linear Regression predicting support for war among Danes

Predictor	Men (n=367)	Women (n=282)
Flexed biceps circum.	$\beta = 0.14, p = .009$	$\beta = -0.01, p = .88$
Age	$\beta = 0.07, p = .22$	$\beta = -0.18, p = .01$
Height	$\beta = 0.06, p = .29$	$\beta = -0.03, p = .62$
Exercise	$\beta = 0.06, p = .28$	$\beta = 0.007, p = .90$
Attractiveness	$\beta = -0.06, p = .24$	$\beta = -0.05, p = .40$
Education	$\beta = -0.06, p = .30$	$\beta = -0.14, p = .03$
Income	$\beta = 0.05, p = .40$	$\beta = 0.07, p = .88$
Household size	$\beta = 0.07, p = .19$	$\beta = -0.02, p = .73$

N = 367 for men, 282 for women. All p -values are two-tailed for consistency.

Section 3: Sex differences in support for war

It is difficult to predict whether men or women should be more supportive of war based on our initial evolutionary analysis of the selection pressures inherent in group conflict. Men certainly paid a higher price for warfare (though women's price was substantial as

³ For completeness, z-scored weight and z-scored flexed bicep circumference were combined. This combined variable predicted support for war in men $r = .13, p = .004$, one-tailed. It did not predict support for war in women, $r = -0.04, p = .48$, two-tailed. Including both weight and flexed biceps circumference in the regression analysis reported in Table S1 reduced the effect of flexed biceps circumference to marginal significance for men, $\beta = 0.10, p = .08$, two-tailed (though fully significant with a one-tailed test). The effect of weight on support for war was non-significant, $\beta = 0.08, p = .18$ for men. Flexed biceps circumference remained non-significant for women ($\beta = -0.07, p = .42$), as did weight ($\beta = 0.12, p = .15$)

well, see Sugiyama 2014), but men also received the most benefits for victory (Escasa, Gray & Patton 2010; Tooby & Cosmides 1988, 2010; Van Vugt, De Cremer & Janssen 2007). More detailed hypotheses could be derived about women's response to warfare, e.g. age, child-rearing status, marital status and other factors likely predicted the costs of warfare to a given woman (Sugiyama 2014). However, our data are inadequate to test these particular hypotheses. For completeness, we test for simple sex differences between men and women in support for warfare in four cultures.

Table SI-2: Sex differences in support for war in four cultures

	Men's support	Women's support	Independent samples t-test, 2-tailed
Argentina	M = 3.58; SD = 1.78	M = 3.29; SD = 1.59	$t(213) = 1.23, p = 0.22$
Denmark	M = 3.22; SD = 1.40	M = 2.77; SD = 1.19	$t(783) = 4.89, p < 0.0001$
Israel	M = 3.58, SD = 1.15	M = 3.36, SD = 1.15	$t(279) = 1.52, p = 0.13$
Romania	M = 3.60; SD = 0.90	M = 3.80, SD = 0.74	$t(189) = -1.74, p = .08$

Results show no consistent pattern across men and women. Only one sample (the Danes) showing a significant effect, specifically men being more supportive of warfare than women. Additional analyses on the Danish sample showed that this sex difference was robust to controls for age, education, and income.

Section 4: Additional analyses on the Romanian sample

The Romanian sample was modeled on an earlier study of US college students (Sell, Tooby & Cosmides 2009) and contained two additional measures of upper body strength validated in that study: self-reported ("I am stronger than ___% of others of my age and sex"), and a measure of chest strength using a Rolyan Hydraulic hand dynamometer with its handle inverted (see Sell et al. 2009 supplemental information). These three measures of strength on Romanian subjects were extremely reliable for men (Cronbach's $\alpha = .81, N=3$), and somewhat reliable for women (Cronbach's $\alpha = .52, N=3$). These items were z-scored and then averaged into a single measure of upper body strength. Removing any one of the three measures decreased this reliability for both men and women.

One male subject had a compression strength score that was 3.1 standard deviations above the mean, but his flexed biceps circumference confirmed that he was a strong man (2.5 SD above the mean). Therefore, he was included in the analyses. Removing him did not change the significance of any result.

Using this new composite measure of physical strength allowed us to re-test our hypotheses.

Results

The bivariate correlations are graphed in Fig. 1. Again, like the sole biceps measure, upper body strength measured as a composite of biceps, self-report, and chest compression was a significant predictor of support for war in males (Romania: $r = 0.22$, $p = .03$, one-tailed), confirming hypothesis #1. It was not a predictor of support for war in women (Romania: $r = -0.10$, $p = .29$, two-tailed), confirming hypothesis #2. Furthermore, a Fisher's r -to- z transformation test for differences between correlations revealed that the correlation between upper body strength and support for war was significantly higher among men than among women ($z = 2.14$, $p = .02$), confirming hypothesis 2b.

Figure 1: Composite Strength and Support for War in Romanian sample

Note: Scatterplots show upper body strength regressed on support for war; regression lines and 95% confidence intervals are displayed for both sexes separately.

The bivariate correlations between the three subcomponents of strength and support for war are presented in table SI-3, along with the composite strength measure.

Table SI-3: Bivariate correlations between strength and support for war in Romania

	Men	Women	Fisher r -to- z test
Compression Strength	$r = 0.14$, $p = 0.23$	$r = 0.04$, $p = 0.97$	$z = .67$, $p = .50$
Flexed biceps circum.	$r = 0.20$, $p = 0.09$	$r = -0.01$, $p = 0.94$	$z = 1.41$, $p = .16$
Self-reported strength	$r = 0.21$, $p = 0.08$	$r = -0.15$, $p = 0.10$	$z = 2.41$, $p = .02$
Combined strength	$r = 0.22$, $p = 0.06$	$r = -0.10$, $p = 0.29$	$z = 2.14$, $p = .03$

$N = 74$ for men, 117 for women. All p -values are two-tailed for consistency.

Two of the three individual strength measures were significant predictors of support for war in men (one-tailed, $p < .05$). Again, no measure showed a fully significant effect for women, and the one that was marginally significant was a negative correlation (i.e. women who reported themselves to be physically strong were slightly less likely to support war). Hypothesis 2b showed less support, as the correlation for males was significantly larger than the correlation for females only in the case of self-reported

strength, though for flexed biceps circumference it was marginally significant ($p = .08$, one-tailed). The composite strength measure, as reported above, is a significantly better correlate of males' support for war than females' support for war.

Section 5: Discussion of height and flexed biceps circumference

While flexed biceps circumference was a robust predictor of support for war in males across three of the four tested countries, height was not a predictor in the one country it was tested in: Denmark. In previous research on US subjects, height significantly predicted support for war in only one of the two samples (see supplemental information for Sell et al. 2009; *PRS-B*). If height were a good predictor of fighting ability, the theory tested in this paper would predict that height correlate significantly with support for war in men. Why did it not?

Male height *is* a predictor of fighting ability, but it is unclear how good of a predictor it is. Reasons that height would likely impact fighting ability include its relationship to arm reach, leg length and hence speed, and leverage. Empirically, it is known that height is highly related to female mate choice such that taller men are universally seen as more attractive (Stulp et al. 2013), though it is not clear that this is because of height's role in fighting as opposed to it being an indicator of energy reserves, immune system competence, or other qualities important to mate choice mechanisms. There is also a pronounced sexual dimorphism in height with men being on average about five inches taller than women, and many such sex differences are likely combat adaptations (see Sell, Hone & Pound 2012). Finally, when assessing fighting ability or physical strength from photographs of men, subjects credit taller men as being better fighters even when controlling for actual physical strength (Sell et al. 2009). In other words, taller men look stronger even if they are not.

On the other hand, there are good reasons to believe that height is not a great predictor of fighting ability, particularly compared to upper body strength. For one, estimates of formidability from photos and voices do show that taller men are rated as more formidable, but this effect is reliably smaller than that of actual strength (reviewed in Sell 2012); in other words, a tall weak man is seen as less formidable than a short strong man. Secondly, evolutionary psychologists have argued that fighting ability should calibrate certain personality variables, and these researchers have found that strength (particularly upper body strength) in men is a better predictor of personality than height or weight (see Lukaszewski 2013; Sell, Tooby & Cosmides 2009, Supplemental Information; Sell, Eisner & Ribeaud 2016; though see also Archer & Thanzami 2007). Thirdly, when adolescent males self-reported their fighting ability, it is highly correlated with self-reported strength ($r = .77$), but only moderately predicted by self-reported height ($r = .31$) (Sell, Eisner & Ribeaud 2016, unpublished analysis). Additional unpublished data on Tsimane foragers in Ecuador show that peer-ratings of fighting ability track height less well than measures of upper body strength (measured either with compression devices or flexed biceps circumference). Finally, professional fighting sports use weight rather than height classes even though both can be measured objectively and without deception. It is widely assumed in fighting sports that height is an advantage, but not nearly as much as weight.

Thus, while height is a predictor of fighting ability, it should not be particularly surprising that small effects of physical strength would not replicate well with this tangential measure.

NEW REFERENCES

Archer, J., & Thanzami, V. (2007). The relation between physical aggression, size and strength, among a sample of young Indian men. *Personality and Individual Differences*, 43(3), 627-633.

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*, 27(4), 328-345.

Stulp, G., Buunk, A. P., Kurzban, R., & Verhulst, S. (2013). The height of choosiness: mutual mate choice for stature results in suboptimal pair formation for both sexes. *Animal Behaviour*, 86(1), 37-46.