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Title: Historical and experimental evidence of sexual selection for war heroism

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Abstract

We report three studies which test a sexual selection hypothesis for male war heroism. Based on evolutionary theories of mate choice we hypothesize that men signal their fitness through displaying heroism in combat. First, we report the results of an archival study on US-American soldiers who fought in World War II. We compare proxies for reproductive success between a control sample of 449 regular veterans and 123 surviving Medal of Honor recipients of WWII. Results suggest that the heroes sired more offspring than the regular veterans. Supporting a causal link between war heroism and mating success, we then report the results of two experimental studies (N 's = 92 and 340). We find evidence that female participants specifically regard men more sexually attractive if they are war heroes. This effect is absent for male participants judging female war heroes, suggesting that bravery in war is a gender specific signal. Finally, we discuss possible implications of our results.

Keywords: intergroup conflict; heroism; aggression; bravery; war; sexual selection

1. Introduction

Although frequency and scale of warfare under ancestral conditions are still subject to scientific debate (Fry and Söderberg, 2013; Keeley, 1996), evolutionary scientists have presented arguments that many aspects of human social behavior might be products of a deep evolutionary history of deadly intergroup conflict in humans (Alexander, 1987; Mathew and Boyd, 2011, 2014; Rusch, 2014a; van Vugt et al., 2007; Wrangham and Glowacki, 2012; Wrangham and Peterson, 1996). Selection pressures entailed by frequent intergroup conflict – which we define as coalitional aggression and defense against out-groups – may have selected, for instance, for such vicious social traits as out-group prejudice, xenophobia and dehumanizing out-groups, but also for virtuous social traits such as altruism, self-sacrifice, bravery, and heroism (Alexander, 1987; Bowles, 2009; Browne, 1999; Choi and Bowles, 2007; Lehmann and Feldman, 2008; Mead and Maner, 2012; Rusch, 2013; van Vugt, 2009). So far, at least two important questions remain unanswered about the origins, evolution, and psychology of intergroup aggression.

The first question is which selection mechanisms are responsible for producing a suite of cognitive and behavioral adaptations for intergroup aggression and the display of heroic behaviors in combat. Previous theories have mainly focused on either individual (Lehmann and Feldman, 2008; Mathew and Boyd, 2011, 2014; Tooby and Cosmides, 2010) or group selected fitness benefits (Bowles, 2006, 2009; Choi and Bowles, 2007) resulting from partaking in intergroup aggression (see de Dreu et al., 2014; Rusch, 2014b for comprehensive reviews).

The second question is why intergroup aggression, at least in humans, is almost exclusively the domain of men, as historical evidence shows (Archer, 2004; Goldstein, 2002; Goldstein, 2001; Keeley, 1996). Relative to women, men not only participate more often in intergroup aggression, they are also more supportive of warfare as a solution to international conflict in opinion polls, hold stronger tribal and parochial attitudes, make more unprovoked

attacks in simulated war games in the laboratory, and contribute more to public goods when there is an intergroup threat (Chang et al., 2011; van Vugt, 2009). This gendered difference in intergroup aggression has been dubbed the ‘male warrior hypothesis’ (Johnson et al., 2006; McDonald et al., 2012; Sell et al., 2009; van Vugt et al., 2007).

Here, we suggest that heroism in warfare – i.e., voluntarily taking disproportionately high risks to act to the benefit of fellow in-group combatants, including displays of aggression towards members of out-groups as well as altruism towards in-groups – may be a sexually selected trait. In short, intergroup conflict offers an arena for men (but not for women) to show off their physical strength, courage, and leadership skills both to same sex rivals (intra-sexual selection) as well as to members of the opposite sex (inter-sexual selection) – here we focus on the latter. Our argument integrates various well-established theoretical perspectives on human evolution, including sexual selection theory, parental investment theory, and costly signaling theory (Buss and Schmitt, 1993; Darwin, 1871; Trivers, 2006; Zahavi, 1975). Importantly, our argument is able to explain why intergroup aggression is almost exclusively the domain of men.

How can men, but not women, use intergroup aggression to signal their qualities as a mate? Sexual selection theory assumes that humans have evolved to (a) signal attractive mate qualities to members of the opposite sex, and (b) pay attention to honest signals from the opposite sex. Thus, both men and women pay specific attention to traits conveying the genetic quality of potential mates. Yet, according to parental investment theory, men and women may be looking for somewhat different traits in potential mates (Roberts and Little, 2008; Trivers, 2006). In looking for mates, men pay more attention to cues of youth and fertility in women, whereas women pay more attention to cues of status, dominance, altruism and commitment in men. Women who pursue short-term sexual liaisons have been found to find men with masculine faces, strong upper bodies, and dominant personalities more sexually appealing,

whereas for long-term relationships they seek out males with provisioning qualities (Barber, 1995; Buss and Schmitt, 1993; Kelly and Dunbar, 2001; von Rueden et al., 2011).

A sexual selection perspective thus suggests that men have evolved a psychology to obtain such desirable mate qualities and to signal to women that they possess these traits. We believe that one domain in which they can signal many of these desirable qualities is through participating in coalitional conflicts with other groups, i.e. warfare. Our argument is that by showing heroism in intergroup conflict heroic males convey that they are in excellent physical shape and possess outstanding personal qualities (Gangestad and Simpson, 2000; Kelly and Dunbar, 2001). Simply taking part in a war effort may not be a strong enough signal, though, as this participation might also be motivated by prospects of direct individual benefits (Rusch, 2014b) or, particularly under modern conditions, participation might even be mandatory and desertion punished by the in-group (Mathew and Boyd, 2014; Sääksvuori et al., 2011). Displaying heroism in combat and surviving this ordeal, however, may be a reliable and costly signal of someone's outstanding mate qualities as it is an honest signal of outstanding physical and psychological attributes.

Correlational anthropological data already indicate that men's reproductive success is linked to their warrior status. Chagnon, e.g., reports that among the Yanomami, a warrior tribe in the Amazonian rain forest, men who have killed enemies – the “unokias” – have more wives and sire more offspring (Chagnon, 1988; but see Beckerman et al., 2009). Similar observations have recently also been reported for the Nyangatom in East Africa (Glowacki and Wrangham, 2015). Recent evidence from the rural Amazonian community of Conambo in Ecuador shows, furthermore, that the local women there are more sexually interested in male warriors relative to non-warriors (Escasa et al., 2010). For modern societies, a sociological study among Los Angeles youth boy gangs shows that gang members have more sexual liaisons than same age peers (Palmer and Tilley, 1995; also see Pellegrini and Bartini, 2001; Pellegrini and Long, 2003). Finally, an online dating study found that US soldiers are the

second most successful profession to obtain dates, with only highly paid lawyers being more desirable (Hitsch et al., 2010). Given the considerable risks involved and the comparably low salaries of army soldiers, this is quite a surprising finding. Yet, it can be understood if we acknowledge that bravery in warfare is a signal that females have evolved to pay attention to. Our study adds to this literature by showing that heroism seems to have had a similar positive effect on the reproductive success of US-American war heroes from WWII and by presenting causal evidence of a context and gender specific preference of contemporary women for male war heroes.

Our research hypotheses are the following: (1) War heroes enjoy greater reproductive success compared to non-heroic regular soldiers. (2) Women find male warriors more attractive, when they display heroism in warfare. (3) Women show increased attraction to male war heroes; but men are not more attracted to female war heroes.

2. Three studies on the relation between war heroism and sexual attractiveness

We investigated our hypotheses in three studies, combining both archival data and vignette studies. In Study 1, we relied upon an archival dataset which provides a good test of our hypotheses because of its high ecological validity. We studied the reproductive success of real war heroes, surviving recipients of the US Medal of Honor in World War II, to see if there are indications that war heroes enjoy greater reproductive success than regular soldiers. We complement the correlational findings of the archival study with two follow-up scenario studies. These test whether heroism in war causally affects female preferences in mate choice and whether women and men vary in their mate preferences for war heroes. Considering the significant physical risks involved, we hypothesize that, all else being equal, male warriors are deemed sexually more attractive and female warriors sexually less attractive by the opposite sex (see Campbell, 1999).

2.1. Study 1

Materials and methods

To examine the reproductive success of real war heroes, we gathered data on US veterans of WWII (also see Rusch and Störmer, in press). These include all 464 Medal of Honor recipients (as of September 2013) and 449 regular veterans of WWII. There are various reasons for choosing this sample. First, the time difference between today and WWII is long enough. Accordingly, almost all of the veterans have passed away by now, so that their individual reproductive histories are complete. Second, WWII is recent enough, so that a sufficient number of sources with information on individual biographies is available. Third, much of the reproductive phase of these soldiers falls within the time before contraceptives became publicly available in the early 1960s. However, directly after WWII, the US demography showed a sharp rise in birth rates (the ‘baby boom’). We therefore include the birth years of all soldiers in the following analyses to control for this and other potential cohort effects.

We compare war heroes with regular veterans of WWII. This is a valid control group because a majority of the US-American soldiers of WWII were conscribed to conduct their military service in the war (about 61%; Flynn, 1993), and because a large share of all US-American men aged 18-45 at the time served during WWII. A control group of regular American adult males would potentially introduce a sampling bias, because there may be many different reasons, including health issues (which would affect their reproductive success), why these men did not participate in WWII.

Heroes sample: The list of the 464 Medal of Honor recipients of WWII is available from various sources (e.g. history.army.mil). We started by collecting all biographical data available online on these soldiers. Most information was gathered from obituaries and newspaper articles. Of the 464 Medal of Honor recipients, though, only 198 survived WWII.

Of these 198 surviving Medal of Honor recipients we were able to obtain offspring data for 123 (i.e., 62%).

Regular veterans sample: We constructed a reference sample of 449 WWII veterans by searching a huge online database of obituaries, legacy.com, using 'WWII' as the search term. Since this search yielded a huge number of results, we conducted 26 refined searches, one for every letter of the alphabet used as the first letter of the last name, and then sampled that veteran from every results page, whose obituary included most biographical information. Using this sampling method, we found information on the number of offspring for all 449 of these individuals.

Results

We use a generalized linear model to analyze the data. The unit of analysis are surviving veterans of WWII. The dependent variable is number of offspring, assumed to follow a Poisson distribution. We use a logistic link function. The model consists of intercept, year of birth to control for cohort effects, and a dichotomous grouping variable coding whether the individual received the Medal of Honor (Recipient = 1, reference category, N=123) or not (Recipient = 0, N=449). Parameters were scaled based on deviance and a robust estimator was used for the covariance matrix to control for mild violation of the distribution assumption that variances of the dependent variable are equal for both groups (Cameron and Trivedi, 2009). Table 1 shows the results. Estimated means for Medal of Honor recipients ($M = 3.18$, $SE = .17$) and regular veterans ($M = 2.72$, $SE = .08$) indicate that, controlling for birth cohort, the war heroes actually sired more offspring than the regular veterans in the control group.

Insert Table 1 about here

Discussion

The results of Study 1 are supportive of our main hypothesis: war heroes seem to have sired more offspring than regular veterans. This means that displaying heroism in warfare could benefit a man's reproductive success. There are some important limitations of the dataset however. First, there are no records of extramarital children in the database, so we cannot be sure if we have the entire reproductive record of the veterans. Second, because of the nature of the online database used as the source of obituaries, the sample of regular veterans only includes men who died in the years 2000 through 2012 (i.e. men who died at age 74 or older). Perhaps these men were physically fitter than other men from the same cohorts who died before 2000 as participation in war represents a source of selective mortality. This potential bias, however, works in the opposite direction of the effect we analyze here, because longer-lived men potentially have more time to reproduce. Therefore, it is even more noteworthy, that a difference in the number of offspring could be found between these samples of regular veterans and war heroes.

Another potential bias concerns missing data. We were unable to find offspring data for 75 of the 198 Medal of Honor recipients (38 percent) who survived WWII. We cannot ultimately rule out the possibility that offspring counts differ between this group and the group of soldiers for whom we found offspring data. However, comparing the available data on year of birth yields no significant differences between these two groups (Mann-Whitney-U = 4,364.5, $p = .53$, two-sided). This indicates that those recipients for whom we could not find data on offspring do not systematically differ from the others (i.e., data is presumably missing at random).

An additional bias may be that regular veterans who did not marry or did not reproduce were less likely get an obituary. We controlled for this by comparing only those soldiers who survived WWII and had one child or more (regular veterans: $N=415$, recipients: $N=114$). Results are shown in Table S1. The effect of having received the Medal of Honor

remains significant ($p = .02$, Cohen's $d = .49$; estimated means: $M = 2.97$ ($SE = .08$) for regular veterans and $M = 3.37$ ($SE = .16$) for recipients).

In the SI we also present a more saturated regression model which includes data on race, as well as marital status and education level at the time of enlistment for a subsample of the soldiers ($N=223$) whose official enlistment records are available from the National Archives (aad.archives.gov). This more saturated model again supports our main hypothesis; effect of Medal of Honor: $p = .017$, Cohen's $d = .44$; estimated means: $M = 2.69$ ($SE = .21$) for regular veterans, $M = 3.41$ ($SE = .33$) for recipients. Using this partially available additional data, we also find no systematic differences between those surviving recipients for whom we have data on offspring and those for whom we do not (see SI for further details).

Finally, our archival study, can only yield correlational evidence in favor of our hypothesis. Importantly, we do not have information on the date of birth of the offspring. Therefore we cannot show conclusively that the heroism signal (displaying behavior that lead to receiving a Medal of Honor) precedes increased reproductive success, and thus that heroism in warfare causally influences reproductive success. We therefore followed up on Study 1 with an experimental scenario study, allowing us to investigate whether war heroism causally affects female sexual interest.

2.2. Study 2

Materials and methods

This study was designed to test for effects of engaging in intergroup competition and displays of heroism in three different contexts: war, sports, and business. Ninety-two female university students ($M_{(age)} = 19.55$, $SD_{(age)} = 2.57$) from a large university in the United Kingdom participated. They were randomly assigned to one of three conditions ('no intergroup conflict' vs. 'intergroup conflict' vs. 'intergroup conflict with heroism') in one of three contexts ('war', 'sports', and 'business'). Thus, for each context each participant read

one vignette and every subject in total read and evaluated three vignettes. The order of presentation was randomized so that a systematic interference (e.g. order effects) of the three context conditions can be ruled out.

Sexual interest in the soldier was measured with a scale consisting of two questions: “How attractive, in general, do you find [soldier’s name]?” and “Would you want to go on a date with [soldier’s name]?” Participants answered by means of a 1 (‘not at all’) to 7 (‘very much so’) scale. These questions were averaged to obtain a single attractiveness score (Cronbach’s $\alpha = .86$).

The vignettes for the war context read as follows (for the other vignettes see the SI, Table S4):

No war: “John has been in the military for 5 years now. He is the leader of a unit consisting of 4 men. John and his unit have not yet been to a war zone during their employment in the military. They have stayed in the UK and are responsible for the coordination of military personnel and equipment.”

War: “John has been in the military for 5 years now. He is the leader of a unit consisting of 4 men. John and his unit have been to Iraq recently. When they were there, their main job was the coordination of military personnel and equipment but they have also fought in a number of battles. After six months, John and his unit have returned home safely.”

War with heroism: “John has been in the military for 5 years now. He is the leader of a unit consisting of 4 men. John and his unit have been to Iraq recently. When they were there their main job was the coordination of military personnel and equipment but they have also fought in a number of battles. After six months, John and his unit returned home safely. John was awarded a medal for individual bravery upon his return from Iraq.”

Results

A one-way ANOVA indicates that the difference in females' sexual interest for the soldier between the conditions was significant ($F(2, 89) = 4.36, p = .02, \zeta_p^2 = .09$). Planned contrasts indicate that when the soldier participated in war and showed heroism, women rated him as sexually more attractive ($M = 4.91, SD = 1.18$) than when he went to war with no evidence of heroism ($M = 4.10, SD = 1.39; p = .03$) or did not go to war at all ($M = 3.88, SD = 1.66; p = .006$). Interestingly, there was no difference in sexual attraction between the two conditions without heroism (i.e., the conditions 'war' and 'no war'; $p = .54$), see Figure 1.

We did not obtain a main effect of the heroism manipulation in the sports scenarios ($F(2, 89) = .26, p = .77, \zeta_p^2 = .006$), indicating that the average sexual attractiveness ratings between the three conditions did not reliably differ (No intergroup conflict: $M = 4.42, SD = 1.03$; Intergroup conflict: $M = 4.48, SD = .92$; Intergroup conflict with heroism: $M = 4.26, SD = 1.67$). Similarly, sexual attractiveness ratings between the business scenarios also did not differ significantly ($F(2, 89) = .78, p = .46, \zeta_p^2 = .02$; No intergroup conflict: $M = 4.06, SD = 1.34$; Intergroup conflict: $M = 3.81, SD = 1.45$; Intergroup conflict with heroism: $M = 3.61, SD = 1.32$).

Insert Figure 1 about here

Discussion

Study 2 provides additional support for a sexual selection hypothesis of war heroism. In support of the archival study women consider soldiers who display heroic acts in war more attractive than soldiers who do not. Study 2 also shows that heroism in warfare is a domain specific signal that increases attractiveness of males as a mate. Recall that we did not find evidence of an increased attractiveness of men who are heroic in business or sports. This suggests that heroism only benefits men when it is displayed in the context of warfare. This

comparison should be interpreted with some caution, however. Displaying heroism in a sports or business context may not be comparable to displaying heroism in a war context (as, for instance, sports and business do not entail no such high risks of bodily harm or even death). To address this we included a different control condition in the next study, where we compare between soldiers who showed heroism either in combat or during a disaster operation.

2.3. Study 3

Study 3 was designed to replicate and extend the findings of Study 2. First, we test whether soldiers need to display heroism during intergroup conflicts (i.e. war heroism) in order to be regarded more attractive by women, or if heroism alone (i.e., heroism not linked to aggression against an out-group), suffices to do so. To test this, we compared a scenario in which the soldier showed heroism in warfare to a scenario in which heroism was displayed by a soldier during a natural disaster operation. Additionally we test whether war heroism is a sex-specific signal. We included male participants in our sample and created scenarios of heroism displayed by either male soldiers or female soldiers. We hypothesize that female war heroes will not be considered sexually more appealing by men.

Materials and methods

A total of 340 participants (181 males, 159 females; $M_{age} = 20.02$, $SD_{age} = 1.61$) from a large Dutch university participated for partial course credit. Participants were randomly assigned to one of four conditions, resulting from orthogonally manipulating warfare (vs. no warfare) and heroism (vs. no heroism). Participant's gender was included in the design by having male participants judge a female soldier and female participants judge a male soldier. The total design was a 2 (heroism) X 2 (intergroup competition) X 2 (gender) quasi-experimental design.

Participants were presented with a short vignette describing a male or female soldier, who was the leader of a small platoon of 4 persons in total. In the intergroup competition conditions it was described this soldier had gone to a warzone and returned unharmed. In the no-intergroup competition conditions the soldier was described as having been to natural disaster areas (e.g. flooded areas). Female participants received a vignette in which the soldier had a typical male name. Male participants read a vignette in which the soldier had a typical female name. Heroism was manipulated by adding to the respective scenarios that on return a decoration was bestowed upon the soldier for his/her actions in the war zone or the natural disaster zone (see the SI for the exact scenarios).

We improved on the reliability of the dependent variable, sexual interest, by expanding it to a five-item scale, containing the two items from Study 2 and three additional items: 1) “To what extent do you think [soldier’s name] is generally attractive?”; 2) “To what extent do you think [soldier’s name] is desirable?”; 3) “To what extent do you think [soldier’s name] is sexually attractive?”; 4) “Would you want to go on a date with [soldier’s name]?”; 5) “Would you want to have a romantic relationship with [soldier’s name]?”, which had an excellent reliability (Cronbach’s $\alpha = .91$).

Results

We used linear regression to analyze the data. All independent variables were effect coded (heroism: -1 = no heroism; 1 = heroism; intergroup competition: -1 no competition; 1 = competition; participant’s gender: -1 = male; 1 = female). A model with three main effects and all higher-order interactions indicated there was a significant three-way interaction ($\beta = .12$, $t(332) = 2.30$, $p = .02$). The main effect of sex was the only other significant effect ($\beta = .32$, $t(332) = 6.22$, $p < .001$), indicating that, in general, female participants considered the soldier more attractive ($M = 3.95$, $SD = 1.20$) than male participants did ($M = 3.11$, $SD = 1.28$).

We proceeded to analyze the three-way interaction by probing two first-order interactions between heroism and intergroup competition. The first-order interaction for female participants was marginally significant ($\beta = .14$, $t(332) = 1.85$, $p = .065$), while the interaction for male participants was not significant ($\beta = -.10$, $t(332) = -1.38$, $p = .17$). Simple slopes analyses indicated that heroism increased the attractiveness of a male soldier as judged by a female participant when it was displayed in a warfare context ($\beta = .23$, $t(332) = 2.11$, $p = .04$), while heroism did not increase the attractiveness of a male soldier in a non-warfare context ($\beta = -.05$, $t(332) = -.50$, $p = .62$).

Insert Figure 2 about here

Discussion

Study 3 provides additional support for our main hypothesis and extends the findings of the previous studies in several ways. First, we replicated the general effect that war heroism increases the perceived mate quality of males who engage in intergroup conflict. We showed that this effect is specific to the gender of the observer and the context in which this signal is displayed.

First, this study showed the gender specificity of the heroism signal because female participants only found war heroes (of the opposite sex) more attractive. Indeed, male participants did not rate a female soldier who displayed heroism as more attractive. This provides evidence for the hypothesis that sex differences in intergroup conflict can have an evolutionary origin, as only males seem to benefit from displaying heroism in intergroup conflict.

Second, we again showed that heroism is a domain-specific signal, as displayed heroism only had an effect on attractiveness in a setting of intergroup conflict. Indeed, soldiers who displayed heroism were only considered to be more attractive when they

displayed heroism in a warfare context and not in another context which is frequently associated with the army (helping out during and after natural disasters). This adds additional and more decisive evidence for our hypothesis that heroism is a positive signal in a warfare context only to our findings from Study 2, in which we showed that heroism did not increase the perceived attractiveness of a potential mate outside a military context. Study 3 shows that, even in a military context, heroism only increases the perceived attractiveness of a mate when displayed in combat.

3. General Discussion

In three studies we provide converging support for a sexual selection hypothesis of (male) war heroism. First, archive data on US Medal of Honor recipients in WWII suggest that war heroes have greater reproductive success than regular veterans. Second, two experimental vignette studies show that women are more sexually interested in men who engage in heroic acts. This effect is domain-specific and sex-specific: The effects are only found in the warfare scenarios and they are only found for male war heroes, not for female war heroines.

We combined different methodologies to increase the validity of our results. First, archival data is high in ecological validity. At the same time, it is not possible to make causal inferences based on archival data and the possibility of confounding factors can be problematic when drawing conclusions. In order to compensate the methodological shortcomings of the archival study, we complemented its results with two experiments. Experiments, although not so high in ecological validity, allow for causal conclusions. Moreover, due to the nature of random assignment, confounding variables are of much less concern in experiments. Importantly for the present paper, both methodologies converge on the same conclusion: males who display heroism in intergroup conflicts receive reproductive benefits compared to males who do not display heroism.

Evolutionary accounts of the origins of warfare and intergroup conflict have focused on direct material benefits (Glowacki and Wrangham, 2013; Tooby and Cosmides, 2010), punishment (Mathew and Boyd, 2011, 2014), group selected benefits (Bowles, 2006, 2009; Choi and Bowles, 2007) and xenophobic cultural norms (Mead and Maner, 2012). Our studies highlight the importance of an additional factor: mating benefits for men associated with participating in warfare (Chagnon, 1988; Glowacki and Wrangham, 2015). Raids, battles, and ambushes in ancestral environments, and wars in modern environments, may provide an arena for men to signal their physical and psychological strengths. Furthermore, to the extent that they behave heroically during these conflicts these signals provide honest information. Of course, women may not always witness these heroic acts in person, but such information is likely to be widely communicated within a tribal community, particularly when the actions of male warriors are outstandingly brave (Escasa et al., 2010). Exemplary evidence of such reputation systems is provided, e.g., by the existence of special titles for battlewise warriors in a number of tribal societies such as the Yanomano and the Nyangatom (Chagnon, 1988; Glowacki and Wrangham, 2015).

What about war heroism among women? In light of the physical dangers and reproductive risks involved, participating in intergroup aggression might not generally be a viable reproductive strategy for them and so women tend not to participate much in active physical fighting in wars (Browne, 1999; Goldstein, 2001; Taylor et al., 2000). Although there is no doubt that women show aggression and heroism in other domains (Archer, 2009; Johnson, 1996), bravery in combat may not be a suitable domain for them to show their mate qualities (Archer, 2009; Campbell, 1999). Nevertheless, our research suggests that women do contribute to warfare and intergroup conflict indirectly. Via their mate preferences women shape men's behaviors in wars. More research on this question is definitely needed, though.

Future studies could examine, for instance, if the actual presence of women in combat increases men's motivation to behave heroically. Unbalanced sex ratios – proportions of men

to women – in a society could also influence men's propensity to engage in warfare. We suggest that men are more prone to act heroically when there is a male-biased sex ratio in a society (Schacht et al., 2014).

Additional research questions are whether women's preferences for war heroes vary with fluctuations in the menstrual cycle or with individual differences, for instance, in the extent to which they pursue short-term versus long term sexual strategies (Gildersleeve et al., 2014). Additionally, do women find war heroes more attractive if their heroism is displayed in the form of aggressive actions such as killing enemies, or altruistic actions like saving the lives of injured comrades (Rusch, 2013)? It is noteworthy that the Congressional Medal of Honor does not discriminate between these two types of heroic acts. We therefore could not investigate this question with the current dataset.

Finally, future research should investigate why war heroes are deemed more attractive. Are war heroes for instance deemed to be more physically attractive compared to regular soldiers? Or is their appeal due to perceptions of increased social status? Thus, women may be attracted to war heroes primarily for their provisioning benefits. Alternatively, women may find war heroes more attractive because they provide protection. It must be noted that we found an effect of heroism on sexual attractiveness using scenarios only (without visual information on what the protagonists looked like). This suggests that women may have a mental representation of war heroes: they might associate war heroism with, for instance, higher social status or higher physical attractiveness. An opposite mechanism through which male heroes may increase their number of offspring, though, is that females might be afraid of retribution by dominant males. Although this remains an empirical question, we believe, however, that our scenario studies provide evidence for our hypothesis that women perceive war heroism as a costly signal of positive mate qualities, because we measured their desire to voluntarily engage in a sexual relationship. Future research must, nevertheless, investigate

whether these mental representations are present, what these exactly comprise of, and how they influence sexual attractiveness judgments.

The main conclusion from our studies is that war heroism likely benefits men because it increases their sexual attractiveness and as a result, their reproductive success. Our findings suggest that the role of sexual selection must not be ignored in understanding the roots of warfare and why men fight.

References

- Alexander RD. The biology of moral systems. Hawthorne, N.Y: A. de Gruyter; 1987.
- Archer J. Sex Differences in Aggression in Real-World Settings: A Meta-Analytic Review. *Review of General Psychology* 2004;8(4):291–322. (doi: 10.1037/1089-2680.8.4.291).
- Archer J. Does sexual selection explain human sex differences in aggression? *Behav. Brain Sci.* 2009;32(3-4):249–311. (doi: 10.1017/S0140525X09990951).
- Barber N. The evolutionary psychology of physical attractiveness: Sexual selection and human morphology. *Ethol. Sociobiol.* 1995;16(5):395–424. (doi: 10.1016/0162-3095(95)00068-2).
- Beckerman S, Erickson PI, Yost J, Regalado J, Jaramillo L, Sparks C et al. Life histories, blood revenge, and reproductive success among the Waorani of Ecuador. *Proc. Nat. Acad. Sci. USA* 2009;106(20):8134–9. (doi: 10.1073/pnas.0901431106).
- Bowles S. Group Competition, Reproductive Leveling, and the Evolution of Human Altruism. *Science* 2006;314(5805):1569–72. (doi: 10.1126/science.1134829).
- Bowles S. Did Warfare Among Ancestral Hunter-Gatherers Affect the Evolution of Human Social Behaviors? *Science* 2009;324(5932):1293–8. (doi: 10.1126/science.1168112).
- Browne KR. The relevance of sex differences in risk-taking to the military and the workplace. *Behav. Brain Sci.* 1999;22(2):218–9. (doi: 10.1017/S0140525X99271816).
- Buss DM, Schmitt DP. Sexual Strategies Theory: An evolutionary perspective on human mating. *Psychol. Rev.* 1993;100(2):204–32. (doi: 10.1037/0033-295X.100.2.204).
- Cameron AC, Trivedi PK. *Microeconometrics using Stata*. College Station, Tex: Stata Press; 2009.
- Campbell A. Staying alive: Evolution, culture, and women's intrasexual aggression. *Behav. Brain Sci.* 1999;22:203–52.
- Chagnon NA. Life Histories, Blood Revenge, and Warfare in a Tribal Population. *Science* 1988;239(4843):985–92. (doi: 10.1126/science.239.4843.985).
- Chang L, Lu HJ, Li H, Li T. The Face That Launched a Thousand Ships: The Mating-Warring Association in Men. *Pers. Soc. Psychol. Bull.* 2011;37(7):976–84. (doi: 10.1177/0146167211402216).
- Choi J, Bowles S. The Coevolution of Parochial Altruism and War. *Science* 2007;318(5850):636–40. (doi: 10.1126/science.1144237).
- Darwin C. *The descent of man and selection in relation to sex*. London: John Murray; 1871.
- de Dreu CKW, Balliet D, Halevy N. Parochial Cooperation in Humans: Forms and Functions of Self-Sacrifice in Intergroup Conflict. *Advances in Motivation Science* 2014;1. (doi: 10.1016/bs.adms.2014.08.001).
- Escasa M, Gray PB, Patton JQ. Male traits associated with attractiveness in Conambo, Ecuador. *Evol. Hum. Behav.* 2010;31(3):193–200. (doi: 10.1016/j.evolhumbehav.2009.09.008).
- Flynn GQ. *The draft, 1940-1973*. Lawrence, Kan: University Press of Kansas; 1993.
- Fry DP, Söderberg P. Lethal Aggression in Mobile Forager Bands and Implications for the Origins of War. *Science* 2013;341(6143):270–3. (doi: 10.1126/science.1235675).
- Gangestad SW, Simpson JA. The evolution of human mating: Trade-offs and strategic pluralism. *Behav. Brain Sci.* 2000;23:573–644. (doi: 10.1017/S0140525X0000337X).

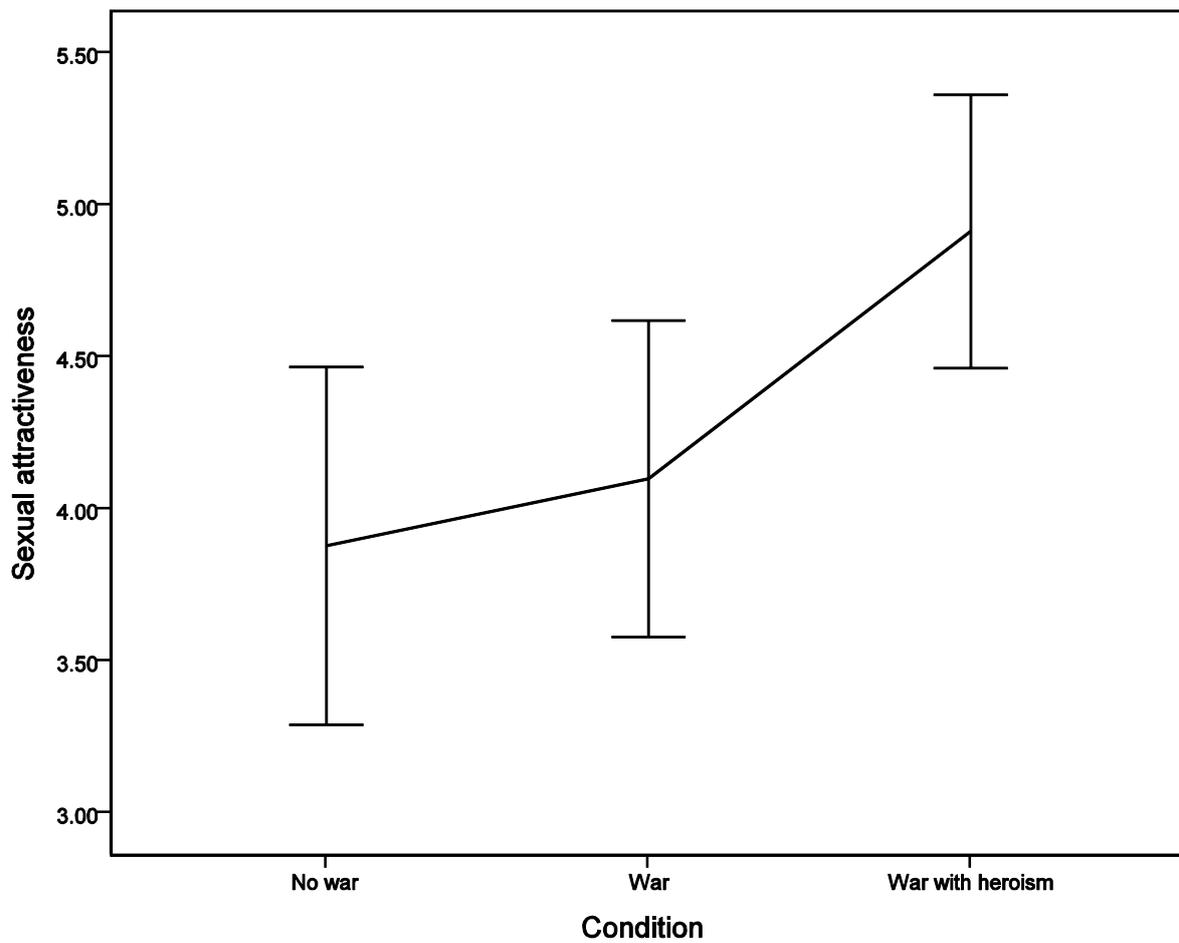
- Gildersleeve K, Haselton MG, Fales MR. Do Women's Mate Preferences Change Across the Ovulatory Cycle? A Meta-Analytic Review. *Psychol. Bull.* 2014. (doi: 10.1037/a0035438).
- Glowacki L, Wrangham R. Warfare and reproductive success in a tribal population. *Proc Natl Acad Sci USA* 2015;112(2):348–53. (doi: 10.1073/pnas.1412287112).
- Glowacki L, Wrangham RW. The Role of Rewards in Motivating Participation in Simple Warfare. *Hum. Nat.* 2013;24(4):444–60. (doi: 10.1007/s12110-013-9178-8).
- Goldstein AP. *The psychology of group aggression*. Chichester, West Sussex, New York: J. Wiley; 2002.
- Goldstein JS. *War and gender: How gender shapes the war system and vice versa*. Cambridge: Cambridge University Press; 2001.
- Hitsch GJ, Hortaçsu A, Ariely D. What makes you click? Mate preferences in online dating. *Quant. Mark. Econ.* 2010;8(4):393–427. (doi: 10.1007/s11129-010-9088-6).
- Johnson DD, McDermott R, Barrett ES, Cowden J, Wrangham RW, McIntyre MH et al. Overconfidence in wargames: experimental evidence on expectations, aggression, gender and testosterone. *Proc. R. Soc. B* 2006;273(1600):2513–20. (doi: 10.1098/rspb.2006.3606).
- Johnson RC. Attributes of carnegie medalists performing acts of heroism and of the recipients of these acts. *Ethology and Sociobiology* 1996;17(5):355–62. (doi: 10.1016/S0162-3095(96)00059-3).
- Keeley LH. *War before civilization: The myth of the peaceful savage*. New York: Oxford University Press; 1996.
- Kelly S, Dunbar RIM. Who dares wins: Heroism versus altruism in women's mate choice. *Hum. Nat.* 2001;12(2):89–105. (doi: 10.1007/s12110-001-1018-6).
- Lehmann L, Feldman MW. War and the evolution of belligerence and bravery. *Proc. R. Soc. B* 2008;275(1653):2877–85. (doi: 10.1098/rspb.2008.0842).
- Mathew S, Boyd R. Punishment sustains large-scale cooperation in prestate warfare. *Proc. Nat. Acad. Sci. USA* 2011;108(28):11375–80. (doi: 10.1073/pnas.1105604108).
- Mathew S, Boyd R. The cost of cowardice: punitive sentiments towards free riders in Turkana raids. *Evol. Hum. Behav.* 2014;35(1):58–64. (doi: 10.1016/j.evolhumbehav.2013.10.001).
- McDonald MM, Navarrete CD, van Vugt M. Evolution and the psychology of intergroup conflict: the male warrior hypothesis. *Philos. Trans. R. Soc. B* 2012;367(1589):670–9. (doi: 10.1098/rstb.2011.0301).
- Mead N, Maner J. When Me versus You Becomes Us versus Them: How Intergroup Competition Shapes Ingroup Psychology. *Soc. Pers. Psychol. Compass* 2012;6(8):566–74. (doi: 10.1111/j.1751-9004.2012.00447.x).
- Palmer CT, Tilley CF. Sexual access to females as a motivation for joining gangs: An evolutionary approach. *J. Sex Res.* 1995;32(3):213–7. (doi: 10.1080/00224499509551792).
- Pellegrini AD, Bartini M. Dominance in Early Adolescent Boys: Affiliative and Aggressive Dimensions and Possible Functions. *Merrill-Palmer Q.* 2001;47(1):142–63. (doi: 10.1353/mpq.2001.0004).
- Pellegrini AD, Long JD. A sexual selection theory longitudinal analysis of sexual segregation and integration in early adolescence. *J. Exp. Child Psychol.* 2003;85(3):257–78. (doi: 10.1016/S0022-0965(03)00060-2).

- Roberts SC, Little AC. Good genes, complementary genes and human mate preferences. *Genet.* 2008;134(1):31–43. (doi: 10.1007/s10709-008-9254-x).
- Rusch H. Asymmetries in altruistic behavior during violent intergroup conflict. *Evol. Psychol.* 2013;11(5):973–93.
- Rusch H. The evolutionary interplay of intergroup conflict and altruism in humans: a review of parochial altruism theory and prospects for its extension. *Proceedings of the Royal Society B: Biological Sciences* 2014a;281(1794):20141539. (doi: 10.1098/rspb.2014.1539).
- Rusch H. The Two Sides of Warfare: An Extended Model of Altruistic Behavior in Ancestral Human Intergroup Conflict. *Hum. Nat.* 2014b;25(3):359–77. (doi: 10.1007/s12110-014-9199-y).
- Rusch H, Störmer C. An Evolutionary Perspective on War Heroism. *Militaire Spectator* in press.
- Sääksvuori L, Mappes T, Puurtinen M. Costly punishment prevails in intergroup conflict. *Proc. R. Soc. B* 2011;278(1723):3428–36. (doi: 10.1098/rspb.2011.0252).
- Schacht R, Rauch KL, Borgerhoff Mulder M. Too many men: the violence problem? *Trends Ecol. Evol.* 2014;29(4):214–22. (doi: 10.1016/j.tree.2014.02.001).
- Sell A, Cosmides L, Tooby J, Sznycer D, von Rueden C, Gurven M. Human adaptations for the visual assessment of strength and fighting ability from the body and face. *Proc. R. Soc. B* 2009;276(1656):575–84. (doi: 10.1098/rspb.2008.1177).
- Taylor SE, Klein LC, Lewis BP, Gruenewald TL, Gurung RAR, Updegraff JA. Biobehavioral responses to stress in females: Tend-and-befriend, not fight-or-flight. *Psychol. Rev.* 2000;107(3):411–29. (doi: 10.1037/0033-295X.107.3.411).
- Tooby J, Cosmides L. Groups in Mind: The Coalitional Roots of War and Morality. In: Høgh-Olesen H, editor. *Human morality and sociality: Evolutionary and comparative perspectives*. Basingstoke: Palgrave Macmillan; 2010. p. 191–234.
- Trivers RL. Parental investment and sexual selection. In: Campbell BG, editor. *Sexual selection and the descent of man: The Darwinian pivot*. New Brunswick (U.S.A.): AldineTransaction; 2006. p. 136–179.
- van Vugt M. Sex Differences in Intergroup Competition, Aggression, and Warfare. *Ann. New York Acad. Sci.* 2009;1167(1):124–34. (doi: 10.1111/j.1749-6632.2009.04539.x).
- van Vugt M, Cremer D de, Janssen DP. Gender Differences in Cooperation and Competition: The Male-Warrior Hypothesis. *Psychol. Sci.* 2007;18(1):19–23. (doi: 10.1111/j.1467-9280.2007.01842.x).
- von Rueden C, Gurven M, Kaplan H. Why do men seek status? Fitness payoffs to dominance and prestige. *Proc. R. Soc. B* 2011;278(1715):2223–32. (doi: 10.1098/rspb.2010.2145).
- Wrangham RW, Glowacki L. Intergroup Aggression in Chimpanzees and War in Nomadic Hunter-Gatherers. *Hum. Nat.* 2012;23(1):5–29. (doi: 10.1007/s12110-012-9132-1).
- Wrangham RW, Peterson D. *Demonic males: Apes and the origins of human violence*. Boston: Houghton Mifflin; 1996.
- Zahavi A. Mate selection – A selection for a handicap. *J. Theor. Biol.* 1975;53(1):205–14. (doi: 10.1016/0022-5193(75)90111-3).

Table 1: Generalized linear model analysis of data on offspring

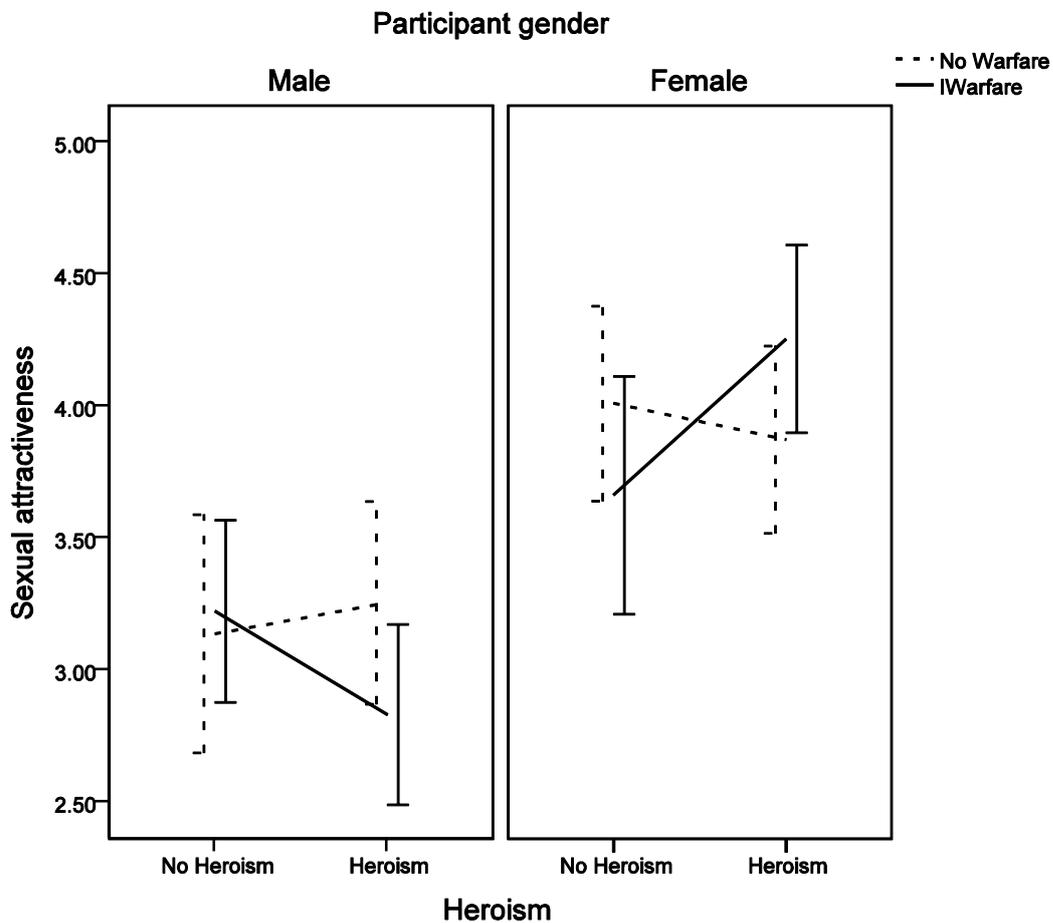
<i>Parameter</i>	<i>B</i>	<i>SE</i>	<i>Log Odds Ratio</i>	<i>Cohen's d</i>	<i>Wald χ^2</i>	<i>p-Value</i>
(Intercept)	-49.72 (-68.89 – -30.55)	9.78	.00	.00	25.84	< .001
Recipient = 0	-.16 (-.28 – .04)	.06	.87 (.76 – .97)	.48 (.42 – .53)	6.41	= .011
Year of birth	.03 (.02 – .04)	.01	1.03 (1.02 – 1.04)	.57 (.56 – .57)	27.01	< .001

Notes: Scale = 1.118 calculated based on deviance. Dependent variable is number of offspring. In brackets: 95% Wald confidence intervals. See the SI for a more detailed model.

Figure 1: Mean sexual attractiveness ratings in Study 2

Note: Mean sexual attractiveness ratings of male soldiers (by female participants) in different intergroup conflict scenarios, in Study 2. Errors bars represent 95% confidence intervals.

Figure 2: Mean sexual attractiveness and physical prowess ratings by context and sex of participants in Study 3



Note: Mean sexual attractiveness ratings of female and male participants contingent upon intergroup competition and hero status in Study 3. Errors bars represent 95% confidence intervals.