

The Role of Rewards in Motivating Participation in Simple Warfare

Luke Glowacki · Richard W. Wrangham

© Springer Science+Business Media New York 2013

Abstract In the absence of explicit punitive sanctions, why do individuals voluntarily participate in intergroup warfare when doing so incurs a mortality risk? Here we consider the motivation of individuals for participating in warfare. We hypothesize that in addition to other considerations, individuals are incentivized by the possibility of rewards. We test a prediction of this “cultural rewards war-risk hypothesis” with ethnographic literature on warfare in small-scale societies. We find that a greater number of benefits from warfare is associated with a higher rate of death from conflict. This provides preliminary support for the relationship between rewards and participation in warfare.

Keywords Cultural rewards war-risk hypothesis · Warfare · Status · Hunter-gatherers

This paper examines the relationship between warfare and the benefits that warriors receive for their participation. It focuses on simple or primitive warfare, which occurs beneath the “military horizon” (Turney-High 1991) in acephalous non-state societies. Simple warfare is distinguished from modern warfare by a lack of clear military leaders, an absence of explicit punitive sanctions for non-participation, and infrequent occurrences of battles and larger conflicts (Gat 1999; Keeley 1996). It consists of surprise raids, ambushes, feuding, chance encounters, and arranged conflicts between individuals of different communities. Violence is directed toward others not because of that person’s individual identity but because of their membership in a particular group (Durrant 2011; Kelly 2000). Because there are no clear military leaders or explicit punitive sanctions for non-participation, individuals are not forced to join warring parties and can usually cease their participation when they so desire.

The most common type of attack is a raid in which a group of warriors attempts to surprise individuals in a settlement or garden and kill as many as possible. Raiders tend to attack only when they have a substantial advantage owing to surprise, disproportionate

L. Glowacki (✉) · R. W. Wrangham
Department of Human Evolutionary Biology, Harvard University, Peabody Museum,
11 Divinity Avenue, Cambridge, MA 02138, USA
e-mail: Glowacki@fas.harvard.edu

numbers, deception, or differential weaponry (Gat 1999). Such advantages result in a significantly lower mortality risk for attackers than for victims. Despite these advantages, intended victims are still potentially dangerous and attackers are exposed to a risk of serious injury or death (Kelly 2000). Aggressors are sometimes harmed or killed, particularly when those who are attacked mount a successful counterattack or become aware of the raiding party in advance (Burch 2007; Heider 1997; Wrangham and Glowacki 2012). Although aggressors are less likely to be killed than defenders, they risk serious injury and death through their participation in warfare no matter how favorable the odds of a successful attack.

The voluntary participation of warriors in conflict creates a puzzle: from an evolutionary perspective, individuals should avoid conflict when doing so presents a mortality risk. Yet in many simple societies individuals engage in intergroup aggression that is potentially fatal to both the intended victims and themselves. In the absence of explicit punitive sanctions for non-participation, why do individuals participate in conflict when there is a chance they may be seriously injured or killed?

Three main kinds of solution have been offered. First, group selection explanations propose that individuals have evolved to engage in risky behavior on behalf of other group members (Darwin 1871 (2006)). Such self-sacrificial behavior has been called heroism (Smirnov et al. 2007), bravery (Lehmann and Feldman 2008), and parochial altruism (Choi and Bowles 2007). Computational and agent-based models have demonstrated the plausibility of group selection for self-sacrificial behaviors if groups with a greater number of altruistic risk-takers are more successful than other groups in between-group competition (Choi and Bowles 2007; Lehmann and Feldman 2008; Smirnov et al. 2007). Bowles (2009) argued that genetic variance within and between human band-level groups is compatible with genetic group selection from warfare. A recent review of warfare among South American groups suggests that multilevel selection, including group selection, is consistent with the patterns of South American warfare (Walker and Bailey 2013).

Second, cooperation, including participation in raiding parties, can be enforced by the threat of punishment even when actual instances of punishment are rare (Boyd and Richerson 1992; Boyd et al. 2010). The possibility of punishment may be sufficient to make individuals willing to accept higher risks than they would otherwise take. Although simple warfare does not normally include explicit punitive sanctions for non-participation, some societies that practice simple warfare have community-enforced social sanctions for inadequate participation. Sanctions can include ostracism, shunning, ridicule, appropriation of property, and physical punishment (Dozier 1967; Mathew and Boyd 2011; Meggitt 1977; Robbins 1982). Informal social sanctions such as these could in theory motivate participation.

Third, warriors may be incentivized by benefits they may receive from their participation in warfare. Potential benefits include both material items and immaterial, culturally specific rewards. For instance, warriors can capture items of value such as tools, food, livestock, and potential mates, or gain access to captured territory. Warriors can also receive immaterial rewards, including increased status, more allies, preferential access to resources, and earlier age at marriage. Such rewards will vary among cultures. These two kinds of benefits are illustrated in a discussion of warfare in the Solomon Islands: “The usual mode of attack was to surprise the targeted hamlet or village, killing, taking captives, and pillaging. The former added to the prestige of

the attackers while the latter two added to their wealth” (White 1979:112). We term the proposal that such benefits motivate warriors to participate in warfare the “cultural rewards war-risk hypothesis” (Wrangham and Glowacki 2012). We use the term “cultural” to distinguish these kinds of rewards from intrinsically motivating biological rewards. While both material items gained from war and immaterial, culturally specific rewards may motivate warriors to participate in warfare, we do not address the causes of culturally specific rewards and instead investigate only whether those rewards incentivize warriors to participate in intergroup warfare. Within any given group, individuals may be motivated by different benefits: some may be motivated by immaterial cultural rewards, such as status, while others may be motivated by potentially strengthening personal or corporate bonds, or by material benefits such as captured goods. The cultural rewards war-risk hypothesis is not mutually exclusive with group selection and punitive sanctions models. Warriors may be motivated to participate in conflict because of a number of different factors, including the possibility of rewards, punishment, and a parochially altruistic psychology.

Material Rewards Do Not Adequately Explain Individual Motivation for Simple Warfare

Group-Level Rewards

Material rewards can be conferred at the level of the group or the individual. Potentially important material rewards conferred on the group as a whole include increased access to territory and natural resources (Durham 1976; Gat 2000). In some societies resource competition appears to promote warfare. For example, positive correlations have been shown between the frequency of warfare and the unpredictability of natural resources, suggesting that resource competition promotes warfare (Ember and Ember 1992; LeBlanc and Register 2003). In other situations, warfare may actually decrease in periods of resource scarcity (Alvarsson 1989; Witsenburg and Adano 2009), perhaps owing to the energetic costs of raiding; resource-scarce periods can even contribute to the development of peaceful trade relationships and intergroup social networks (Wiessner 2006). In accord with this pattern, in some societies war parties are more likely to travel when environmental conditions are favorable (Murphy 1957; Turton 1979).

Although resource competition between groups can have varied consequences for the occurrence of war, in general there is little evidence for group-level resource competition as a motivation for warfare. For example, among the Arapesh, “land was little disputed” (Fortune 1939:24); for the Unangan and Alutiiq of Alaska, “there is no clear evidence of warfare for food and territory” (Maschner and Reedy-Maschner 1998:40). Among the Mundurucu, “The necessity of ever having to defend their home territory was denied” (Murphy 1957:1026). In southeastern Canada, “Neither trespass nor the desire to accumulate land seems to have been cause for war” (Hadlock 1947:211). In western Alaska, “the acquisition of territory seems to have been a motivating factor only rarely” (Burch 2007:27).

Warfare frequently has deleterious consequences for aggressor groups resulting from unintended effects. For instance, the threat of attacks frequently results in large

underused border zones, reducing the availability of productive habitat. Among the Kofyar, “War thus induced . . . the creation of new massive borders in the shape of no-man’s lands. . . . Both sides lost access to important resources” (Netting 1973:173). For the Chippewa, “Warfare . . . had rendered a large region west of Lake Superior unsafe for entry by anyone” (Hickerson 1988:66), and in northern Kenya, “47% of the Turkana district, comprising much of the best grazing land, was virtually unused due to the mere threat of raiding” (Hendrickson et al. 1996:27).

Offensive raiding may also trigger cycles of revenge raids that ultimately harms both groups (Beckerman et al. 2009; Boehm 2011; Boster et al. 2004; Hadlock 1947; Smith 1938). For instance, among many of the groups of eastern North America, “each act of revenge typically begets a fresh desire for revenge from the other side” (Lee 2007:714), which is similar to the cycle of war the Waorani of South America faced: “The problem with retaliatory violence is that . . . the same furious dynamic that might have protected against the initial assault perpetuates the violence. This was the case for the Waorani, who were locked . . . into an endless sequence of revenge killings” (Boster et al. 2004:480). An act of warfare is likely to spark a revenge raid, leading to a cycle of revenge raids and the establishment of unused border zones, and decreasing resource availability. The possible deleterious outcomes for aggressors indicate that expectations of net resource gains from warfare may be unlikely, suggesting that warriors may have other motivations than shared group-level benefits such as access to natural resources.

The idea that group-level rewards motivate simple warfare not only is challenged by ethnographic evidence but also raises a theoretical problem. Since warriors and non-warriors alike share in the receipt of group-level benefits, creating a strong incentive for free-riding, group-level benefits alone are unlikely to account for individual motivation to participate in warfare. Except in cases of extreme resource scarcity or where it is possible for a few individuals to monopolize high-value resources, additional mechanisms are needed to explain why individuals are willing to undertake the risks of warfare.

Individual-Level Material Rewards

Individual material rewards are likewise variable in their occurrence and their significance as motivators for simple warfare. Among the Cherokee “‘it was not plunder they wanted from them [the Creeks] but to go to war with them and cut them off,’ that is, to kill them” (Lee 2007:725). Likewise, “There is no Kutchin tradition . . . of raiding specifically for the purpose of acquiring these valued objects” including captives, loot, and war honors (Slobodin 1960:86). Accounts of Jivaro-Shuar raiding indicate that while they “are avid in their looting of enemies’ homes when the opportunity presents itself, it is clear that . . . certain religious proscriptions hold force in the manner in which the pillaging and destruction of enemy property are conducted” (Jandial et al. 2004:1218).

Even women and slaves were not necessarily desirable. Among the Menominee of Wisconsin, warriors were counseled to surround the village: “rush to the attack. You shall destroy the sleeping enemy with tomahawks and war-clubs. . . . Those who awake shall try to escape but cannot” (Skinner 1911:303). Among the Eskimo of Western Alaska, Burch (2007:19) writes, “the objective . . . was to kill as many of the

enemy as possible: men always, and usually women and children as well,” and among the Kofyar of Nigeria “the rewards of plundering another village were not high” (Netting 1973:172). In the Solomon Islands “the goal [of raids] often was to wipe out or completely disperse the offending group in order to discourage future revenge” (White 1979:112).

We suggest there are two main reasons why warriors may not be primarily motivated by the possibility of looting or capture. First, among many simple societies the few material goods that are vulnerable to theft can be manufactured easily by the attacking group, thereby reducing their value (bows, arrows, digging sticks, etc.). Second, because of the time and effort required to carry stolen goods or coerce a reluctant captive, appropriation of goods or people can increase the chance of lethal retaliation by giving the victimized group more time to regroup and initiate an offensive. This problem may make it impractical and unwise for warriors to burden themselves with goods from the victims. For instance, after the Mundurucu of Brazil launched a successful raid they “then beat a hasty retreat before the enemy could reorganize his forces and summon additional support” (Murphy 1957:1023). Among the Jivaro-Shuar of Ecuador, “In battles in which victory is not overwhelmingly complete, the Jivaro-Shuar often retreat rapidly once the enemy has been killed. . . . They seek to avoid counter-attack” (Jandial et al. 2004:1218). The Eastern Kutchin of Canada made efforts “at even greater speed and security on the return than on the outward march . . . and there are tales of a returning party being overtaken by the enemy” (Slobodin 1960:84).

A notable exception to the generally sparse ethnographic record of plunder as an important motivator in simple warfare is found among pastoralist groups. Pastoralists can amass large amounts of highly valuable transportable wealth in the form of livestock. This makes raiding for livestock both feasible and beneficial, and therefore an important reason for participating in raids (Almagor 1979; Eaton 2008; Ewers 1980). We expect the same logic to apply for groups where the environment and subsistence type render it possible for individuals to amass large amounts of high-value items (Gat 2000).

The Cultural Rewards War-Risk Hypothesis

The cultural rewards war-risk hypothesis focuses on individual-level benefits, especially immaterial cultural rewards, such as increased status, honorific names or titles, or special insignia. Their importance is supported by numerous ethnographic discussions of the status of successful warriors. For instance, among the Bokondini Dani of New Guinea, “Men make their performance during actual warfare their primary means of gaining prestige and power. . . . Men needed fights to become prominent” (Ploeg 1979:170). For the lowland Cree of North America, a “motive for warfare was the prestige that warriors could gain in such raids” (Bishop and Lytwyn 2007:50), and Patton (1996) demonstrated a relationship between ranking as a warrior and status among the Achuar Jivaro and lowland Quichua of the Ecuadorian Amazon. Similarly, Chagnon (1988) showed that warriors who have made enemy kills and undergone a ritual after which they receive a title of *unokai* had greater reproductive success than other men, although this may have been due to wife-capture through participation in warfare.

Our hypothesis builds on these explanations. We hypothesize that within-group cultural rewards increase the motivation for individuals to take dangerous risks in warfare. Thus we expect that when warriors receive rare or no benefits from their participation, warfare will be rare, primarily opportunistic, and less risky, such as occurs in intergroup violence among chimpanzees where chimpanzees who engage in raids do not suffer casualties (Manson and Wrangham 1991; Wrangham and Peterson 1996). As cultures develop more rewarding bellicosity and individuals have the possibility of receiving more material and immaterial benefits from participation, war is expected to become more frequent and individually risky.

Accordingly we use a sample of ethnographic data to test two predictions of the cultural rewards war-risk hypothesis in the context of simple warfare. First, given that societies vary in the frequency and intensity of war, the cultural war-risk hypothesis predicts variation in the number and kind of benefits warriors can expect to receive. We contrast this with the possibility that there is no relationship between expected benefits from war participation and the risk of death from warfare—for example, if societies are uniformly predisposed to reward warriors. Second, the cultural war-risk hypothesis predicts that the opportunity for warriors to benefit more from their participation in warfare is associated with greater conflict intensity. This contrasts with the possibility that any effect of rewards in motivating warriors is swamped by other factors favoring participation in war, such as the threat of punishment (Boyd et al. 2010) or socialization patterns (Ember and Ember 1994). Using an existing compilation of the risk of death from warfare (Wrangham et al. 2006), we look for any ethnographic evidence that societies with a higher risk of death from warfare had a larger number of rewards for warriors.

Methods

Our analysis uses rates of annual mortality from warfare for ten hunter-gatherer and ten farming societies (Wrangham et al. 2006). Estimates of annual mortality rate from warfare are exceedingly scarce. This sample gives an unbiased selection. We excluded several populations from analysis because of poor ethnographic source materials, the lack of simple warfare, and the possibility of errors in calculated mortality rates. See Table 1 for a list of the excluded societies and reasons for omission.

We assessed societal variation in the number of rewards that warriors can expect to receive for participation in warfare by examining the same ethnographic materials that provided data used to calculate mortality rates in war. For three societies (Chippewa, Yanomamo, and Dugum Dani), we consulted two ethnographies because of a paucity of ethnographic information in the first source. In these cases, the second ethnography was chosen based on whether it covered the group at approximately the same time for which the mortality rates were recorded.

Rewards were coded independently by one of the authors (LG) and by an undergraduate student who was blind to the hypothesis and the data on death rates from warfare. The coding author initially reviewed all source materials and developed categories of possible benefits based on these materials, such as “warriors obtain livestock” or “warriors gain access to natural resources.” Table 2 lists all coded benefits. Benefits may be direct, such as capture of livestock or females, or indirect,

Table 1 Excluded societies and reason for exclusion

Society	Reason for exclusion
Boko Dani	Possible errors in mortality rate calculations
Buin	Possibly errors in mortality rate calculations
Casiguran Agta	Not simple warfare: homicide or feuding
Dobe !Kung	Not simple warfare: homicide or feuding
Dani S. Grand Valley	Lack of ethnographic materials, possible errors in mortality rate calculation
Fiji	Complex warfare, possible errors in mortality rate calculations
Gebusi	Revenge killings, sorcery, not simple warfare
Hewa	Reference not available
Kato	Complex warfare
Kunimaipa	Poor ethnographic materials
Mtetwa	Complex warfare
Tauna Awa	Not simple warfare: homicide or feuding

Table 2 List of possible rewards for warriors and society with that possible benefit present

Warriors obtain livestock: Chippewa, Dugum Dani, Mae Enga, Mohave, Piegan, Mohave, Tauade
Warriors obtain slaves and non-reproductively-active females: Modoc, Mohave, Yanomamo
Warriors obtain reproductively active females: Canadian Eskimo, Murngin, Modoc, Mohave, Telefolmin, Yaghan, Yanomamo
Warriors obtain physical trophies that display raiding success: Chippewa, Dugum Dani, Kalinga, Modoc, Piegan, Tauade,
Warriors are given special distinction in dress or appearance: Canadian Eskimo, Kalinga, Mae Enga, Mohave
Warriors gain access to natural resources: Auyana , Chippewa, Dugum Dani, Manga, Mae Enga, Mohave, Telefolmin,
Warriors obtain other transportable goods such as tools or weapons: Andamanese, Canadian Eskimo, Dugum Dani, Modoc, Telefolmin
Warfare is discussed as a route to increased status: Auyana, Canadian Eskimo, Chippewa, Dugum Dani, Gidjingali, Kalinga, Mae Enga, Manga, Modoc, Mohave, Murngin, Piegan, Tauade, Yanomamo
Warfare is a route for a person to increase their wealth not directly through captured items: Kalinga, Piegan
Warriors are publicly celebrated upon their return from conflict: Dugum Dani, Kalinga, Modoc, Mohave
Warriors gain spiritual powers or access: Murngin
Warriors are more likely to marry well, early, or otherwise perceived as reproductively desirable: Dugum Dani, Kalinga, Manga, Piegan, Tiwi
Warriors are given a special title or name: Kalinga, Piegan
Warriors are more likely to be chosen as allies: Kalinga, Mae Enga, Tiwi
Cannibalism is practiced by warriors: Tauade, Telefolmin, Yaghan

We recorded all mentioned benefits in the reviewed ethnographies and then grouped these benefits into categories based on the kind of benefit, such as livestock or slaves. Each society receives a score of 0 for a specific benefit if no mention of it is made as a possible benefit in that society. If the ethnography discusses warriors in a particular society as being able to receive that benefit, then that society receives a score of 1 for that reward. The scores for each society are then summed to produce the CBW_T (Cultural Benefits for Warriors). The possible total is 14, but no society received a score higher than 8

such as public celebrations of warriors, ritual cannibalism, or special insignia. We attempted to record any category of benefit having material, ritual, or symbolic value.

Using these categories, the coders were instructed to review the source materials to determine whether any of these benefits were indicated in the societies in the sample and provide the appropriate reference for each benefit. In addition, the undergraduate student was asked to indicate any benefits that did not fit within any of the categories. The two coders had strong inter-rater reliability (Weighted Cohen's $\kappa=0.943$, 95% CI: [0.884, 1.003]). Cases of disagreement were resolved by reference to the source material so both coders were in agreement about the final coding.

Each society was scored by its total number of recorded "cultural benefits for warriors," or CBW_T . For instance, if the only benefits for warriors in a given society were that they were likely to take slaves and marry better than non-warriors, then that society would receive a composite score of 2. Our method thus allows inter-society comparisons by indexing the number of pathways by which warriors might benefit from participation in intergroup aggression.

To assess the contribution of group-level benefits we examined the relationship between the number of benefits from war and death rates when benefits of increased access to natural resources were removed. This reduced index (CBW_I) thus excluded the group-level benefit of territory but retained the other benefits listed in Table 2.

Results

The estimated annual mortality rate due to death from warfare ranged from zero among the Semai to 1,000 per 100,000 per year among the Piegan. The mean annual death rate due to war for the entire sample ($n=20$) was 356 ± 252 deaths per 100,000/year, with a median death rate of 320. The rate tended to be lower for foragers (262 ± 293 , $n=10$; median=164) than for farmers (451 ± 169 , $n=10$; median=440) (Mann–Whitney $U=20$, $n=10$, 10 , $p=0.023$), consistent with earlier results (Wrangham et al. 2006).

The total number of benefits (CBW_T) that warriors might receive from participating in war ranged from 0 among the Semai to a maximum of 8 among the Kalinga (Table 3). For the entire sample ($n=20$), the mean CBW_T score was 3.6 ± 2.3 , with a median of 3.5. CBW_T tended to be lower for foragers (2.5 ± 2.2 , $n=10$; median=2.0) than for farmers (4.5 ± 2.0 , $n=10$; median=4.7; independent samples t -test: $t_{18}=-2.33$, $p=0.032$) (Table 4). Group-level benefits did not contribute much to CBW_T . Thus when access to natural resources is removed, mean CBW_I was 3.25 ± 2.2 , $n=20$. Like CBW_T , CBW_I was lower for foragers (2.5 ± 2.2 , $n=10$) than for farmers (4.0 ± 2.1 , $n=10$) though the difference did not reach significance (independent samples t -test: $t_{18}=-1.5$, $p=0.139$). Of note, among foraging groups in our sample, competition over natural resources was not indicated as being a proximate factor contributing to conflict.

The most common possible reward in our sample was increased prestige (found in 14 societies), followed by access to natural resources (8 farming societies) and female capture (7 societies).

CBW_T scores were positively correlated with mortality rates from war (Fig. 1; Spearman's rank correlation $r_s=0.626$, $n=20$, $p=0.003$). CBW_I remained positively

Table 3 Society, subsistence type, location, mortality rate (from Wrangham et al. 2006), and CBW score

Group	Subsistence	Location	Deaths per 100 k per year	CBW _T , CBW _I Score	Sources for CBW Scores
Semai	H	Malaysia	0	0,0	(Dentan 1968)
Andamanese	H	India	20	1,1	(Mann 2001)
Canadian Eskimo	H	Canada	100	4,4	(Graburn 1969)
Gidjingali	H	Australia	148	1,1	(Hiatt 1965)
Tiwi	H	Australia	160	2,2	(Hart and Pilling 1979)
Yaghan	H	Tierra del Fuego	169	2,2	(Cooper 1917)
Mohave	F	N. America	230	7,6	(Stewart 1971)
Yurok	H	California	240	0,0	(Kroeber 1971)
Yanomamo	F	Venezuela	290	3,3	(Chagnon 1990; Early and Peters 1990)
Mae Enga	F	New Guinea	320	5,4	(Meggitt 1977)
Tauade	F	New Guinea	320	4,4	(Hallpike 1977)
Murngin	H	Australia	330	3,3	(Warner 1931)
Auyana	F	New Guinea	420	2,1	(Robbins 1982)
Modoc	H	N. America	450	6,6	(Ray 1963)
Manga	F	New Guinea	460	3,2	(Pflanz-Cook and Cook 1979)
Dugum Dani	F	New Guinea	480	7,6	(Heider 1997, 2006)
Kalinga	F	Philippines	600	8,8	(Dozier 1967)
Telefolmin	F	New Guinea	640	4,3	(Morren 1984)
Chippewa	F	N. America	750	4,3	(Hickerson 1988; Peers 1994)
Piegan	H	N. America	1000	6,6	(Ewers 1980)

correlated with death rates (Spearman $r_s=0.532$, $n=20$, $p=0.016$). Among the subset of foragers the correlation using CBW_T was also positive (Spearman $r_s=0.632$, $n=10$, $p=0.05$). For farming societies the correlation between CBW_T and war death rate was positive but not significant (Spearman $r_s=0.093$, $n=10$, $p=0.799$).

We also tested the relationship between group-level benefits and mortality rates from warfare, probing whether the possibility of group-level benefits was associated with an increased mortality rate. We found no association between group-level benefits and an increased mortality rate due to warfare (independent samples t -test: $t_{18}=-1.55$, $p=0.138$).

Discussion

Although various authors have found evidence that warriors obtain rewards from raiding (Chagnon 1988; Patton 2000), to our knowledge this paper presents the first quantitative test of the cultural rewards war-risk hypothesis. We tested two predictions

Table 4 Subsistence, mortality rates,^a and CBW scores^b

Foragers	Mean Mortality Rate=261.7±292.6, <i>n</i> =10 Median Mortality Rate: 164	Mean CBW Score=2.5±2.2, <i>n</i> =10 Median CBW Score: 2.0
Farmers	Mean Mortality Rate=451±169, <i>n</i> =10 Median Mortality Rate: 440	Mean CBW Score=4.5±2.0, <i>n</i> =10 Median CBW Score: 4.7
Complete sample	Mean Mortality Rate=356±252, <i>n</i> =20 Median Mortality Rate:320	Mean CBW Score=3.6±2.3, <i>n</i> =20 Median CBW Score: 3.5
Differences between foragers and farmers	Mortality rates (Mann–Whitney $U=20$, $p=.023$)	CBW scores (Independent Samples t -test: $t_{18}=-2.33$, $p=.032$)

^a Annual deaths due to conflict per 100,000 persons per year

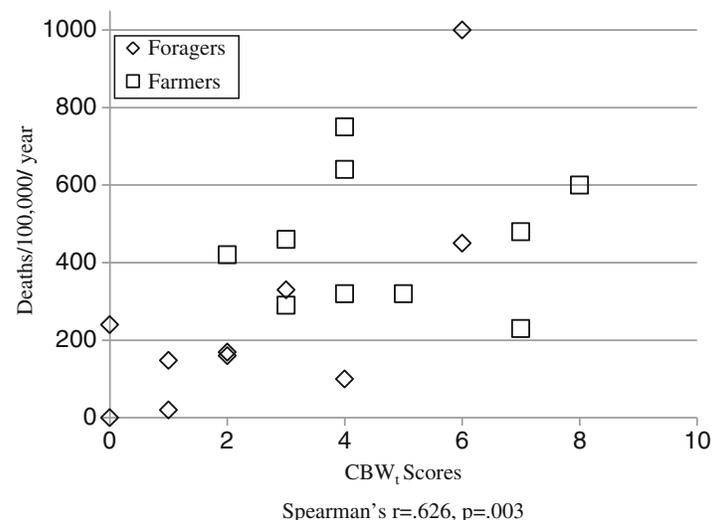
^b Total number of kinds of benefits possible to warriors

using a preexisting dataset on simple warfare in which the level of individual risk from participation in warfare had been indexed by the rate of mortality in war.

First, the number of benefits explicitly documented by ethnographers varied among 20 small-scale societies from 0 to 8, with a mean of 3.6 ± 2.3 . Fewer rewards were reported for warriors in foraging societies than in farming societies. Our data thus suggest that among small-scale societies cultural rewards for success in war vary widely.

Second, the number of reported benefits from war was higher in societies that experienced a higher mortality rate in war. The correlation was present in both the full sample and the ten foraging societies, but it was not significant in farming societies when analyzed independently, perhaps owing to small sample size. The positive association of number of rewards with mortality rate supports the hypothesis that warriors in small-scale societies are incentivized to participate in war by the possibility of benefits they may receive.

Interpretive caution is necessary given the nature of the available data. For example, six of our 20 societies are located in New Guinea, a region renowned for high rates of intergroup warfare. (Our New Guinea societies' war-related mortality rates range from 340 to 640 deaths per 100,000 per year among the Mae Enga and

**Fig. 1** CBW score and mortality rate due to warfare

Telefolmin, respectively.) In addition, the ethnographic record provides only a limited, non-systematic account of warfare in a given society. The estimated mortality rates might reflect an anomalous period or region, or observer error. More quantitative datasets on warfare among small-scale societies would make it possible to test these hypotheses with greater certainty.

Additional concerns arise with the benefits themselves. Benefits may be present that are not mentioned in the ethnographies, and the diversity of benefits within any society is not necessarily a good measure of net reward value for a successful warrior. We were not able to rank the relative importance or frequency of rewards for participation in warfare because most ethnographic source materials did not provide rich enough detail to allow systematic determinations of the importance or frequency of various benefits. Some benefits, such as wife capture, may have had more value to warriors while others may have been insignificant. Some warriors may be motivated by only one type of benefit, such as status, while others may be motivated by alternative benefits. Some benefits that elude quantification may also be important for motivating warriors, such as the strengthening of personal bonds or the corporate group.

There are also possible confounds among the relationships between the variables. For instance, an ethnographic account may state that successful warriors have higher social status and more wealth than non-warriors. This society would be given a CBW_T score of 2. However, the increase in wealth may not result directly from participation in warfare but from the higher status obtained from warfare. These overlapping pathways to reproductive success are a concern with many attempts to determine the predictors of fitness (von Rueden et al. 2008).

Increased status was the most common benefit for warriors in our sample. Status may provide an especially important incentive because of its close relationship to reproductive success (Chagnon 1988; Cronk 1991; Hill 1984; Hopcroft 2006; von Rueden et al. 2011). Since status is an important predictor of reproductive success, societies that accord men status for their contributions in war create an especially clear motivation for participation in warfare.

Warfare as a route to increased status has implications for understanding variation among men in participation in intergroup conflict. Because of the strong association between status and reproductive success, status-seeking behavior should be especially intense among groups in which there is greater reproductive competition. Young males generally face the greatest reproductive competition (Wilson and Daly 1985), which might explain why most raiding parties consist largely of young men (Almagor 1979; Hadlock 1947; Lee 2007). Participating in conflict provides a means for men to distinguish themselves, even when doing so involves taking large mortality risks.

The relationship between status for warriors and reproductive success also accounts for how differences in demographic factors contribute to inter-individual participation in warfare. Some individuals have lower predicted lifetime reproductive success than average for their age cohort because of factors such as differences in parental wealth or status. These individuals have more incentive to engage in status-seeking behaviors as a pathway to increase their future reproductive success. This relationship has been supported through laboratory studies showing that young individuals from demographically disadvantaged backgrounds or individuals with perceived lower social status tend to be more risk-prone (Ermer et al. 2008; Wang et al. 2009).

There is some quantitative ethnographic support as well. Among the Cheyenne Plains Indians, war chiefs had significantly higher mortality rates than peace chiefs, raising the question of why an individual would become a war chief. This seemingly maladaptive behavior appears to have been a strategy taken by individuals with low familial wealth to increase their reproductive prospects (Dunbar 1991). Similarly, in a study of cattle raiders among the Kuria of Tanzania, Fleisher and Holloway (2004) found that most cattle thieves were young men who were “sister-poor.” These cattle raiders tended to come from families having few daughters and thus insufficient incoming bridewealth payments to allow the young men to afford their own bridewealth payments. Thus cattle raiding among the Kuria may have been a strategy used by “sister-poor” males to obtain enough wealth for marriage. These examples illustrate that the rewards gained from warfare are relative to the individual recipient’s demographic background and future reproductive opportunities.

In sum, the cultural war-risk hypothesis is supported by ethnographic data from simple warfare. Societies in which warriors can benefit more have higher mortality rates from conflict, suggesting that benefits incentivize participation. The importance of cultural rewards for certain demographic groups accounts for variation in participation in warfare and may explain why both younger and demographically disadvantaged men participate more than other men.

Group Selection and Punishment Models Revisited

Group selection models maintain that risk-taking in warfare occurs because of a parochially altruistic psychology whereby individuals are motivated to take risks for other group members (Bowles 2009; Choi and Bowles 2007; Lehmann and Feldman 2008; Smirnov et al. 2007). Group selection models face several significant challenges. First, they fail to explain why humans should face stronger group selection than chimpanzees given similar levels of intergroup hostility and genetic differentiation between groups (Langergraber et al. 2011; Wrangham et al. 2006). This is compounded by the prevalence of female and child capture in simple warfare (present in 7 of the 20 societies in our sample), which suggests that successful raiding may sometimes increase the gene flow between groups, thereby decreasing the between-group genetic differentiation necessary for group selection. Second, group selection arguments maintain that humans are motivated to take self-sacrificial risks for other group members, yet acts of overt self-sacrifice are rare in simple warfare, especially among nomadic hunter-gatherers (Wrangham and Glowacki 2012). For example, in the accounts of warfare reviewed for this paper, among non-militarized groups we found no mention of overt self-sacrificial behavior for others. The Andamanese, who perhaps best exemplify the fighting ethos of foraging warriors in simple societies, are described as having a “want of true courage or daring” (Mann 1975:135) when engaging in warfare. Among militarized groups such as the Cheyenne and Comanche, such acts of bravery did occur but were the exception. Finally, group selection models are silent on intra- and inter-individual differences in risk-taking in warfare. Group selection models maintain that humans inherited a parochially altruistic tendency but do not explain why participation in warfare varies with sex, age, and demographic background. These challenges raise questions about the plausibility of group selection models for explaining risk-taking in human warfare.

According to punitive sanctions models, the possibility of community-enforced punitive sanctions (Boyd et al. 2010; Boyd and Richerson 1992) motivates warriors to participate in conflict. The punitive sanctions hypothesis is consistent with the cultural rewards war-risk hypothesis, and it may be important in some contexts. In some societies men who do not participate are subject to ridicule or other punishment (Dozier 1967; Mathew and Boyd 2011; Meggitt 1977; Robbins 1982). Whether punitive sanctions are sufficiently widespread to provide a general model of risk-taking in war is uncertain. Specific social sanctions for inadequate participation for offensive raiding are exceedingly rare in the ethnographic record, and there are clear examples that challenge their importance. For instance, among the Modoc Indians of California, each man had almost “complete freedom . . . to accept or reject an invitation to join a war party. Most men ordinarily reject such calls” (Ray 1963:136). Among the Dugum Dani of New Guinea, “Not every Dani man goes to battle. Some are always there. Some never go. No leader has the power to force a man to participate, and there is not even any obvious social pressure” (Heider 1997:101), while among the Plains Indians, “membership in war parties never lost its voluntary character” (Smith 1938:438). In many cases warriors may face sanctions from elders not for lack of participation in warfare but for *going* to war (Almagor 1979; Girke 2008; Hadlock 1947; Lee 2007; Sagawa 2010; Warner 1931). In one instance, young raiders were punished for *planning* a raid: “approximately 150 young Daasanach wanted to go to war. . . . The plans of attack were disclosed and all the other age-sets cooperated together to beat the youngest men with sticks and made them withdraw their plan” (Sagawa 2010:101). These examples suggest that socially sanctioned punishment for non-participation is not necessary to explain the risk-taking that occurs in simple warfare.

Conclusion

Our analysis showed that the availability of greater benefits for warriors accounts for variation in conflict intensity in simple warfare. This result supports the cultural rewards war-risk hypothesis: warriors are motivated to participate in warfare because of the possibility of rewards. We suggest that intrinsic cultural factors such as the degree to which status competition is important for males or the extent to which warriors are lauded may be an important determinant of the prevalence of war in a given society and the degree to which warriors take risks through their participation in warfare.

Acknowledgments We thank Ralph Montilio of Tozzer Library for his generous assistance in locating references. We thank Padmini Iyer and four anonymous reviewers for comments and suggestions.

References

- Almagor, U. (1979). Raiders and elders: A confrontation of generations among the Dassanetch. In K. Fukui, D. Turton, & H. Kokuritsu Minzokugaku (Eds.), *Warfare among East African herders: Papers presented at the first international symposium, National Museum of Ethnology, Osaka, September, 1977* (pp. 119–145). Suita, Osaka: National Museum of Ethnology.

- Alvarsson, J.-A. (1989). *Starvation and peace or food and war? (Uppsala Research Reports in Cultural Anthropology)*. Uppsala, Sweden: Dept. of Cultural Anthropology at the University of Uppsala.
- Beckerman, S., Erickson, P. I., Yost, J., Regalado, J., Jaramillo, L., Sparks, C., et al. (2009). Life histories, blood revenge, and reproductive success among the Waorani of Ecuador. *Proceedings of the National Academy of Sciences of the United States of America*, 106(20), 8134–8139.
- Bishop, C. A., & Lytwyn, V. P. (2007). “Barbarism and ardour from the tenderst years”: Cree-Inuit warfare in the Hudson Bay region. In R. J. Chacon & R. G. Mendoza (Eds.), *North American indigenous warfare and ritual violence* (pp. 30–57). Tucson: University of Arizona Press.
- Boehm, C. (2011). Retaliatory violence in human prehistory. *British Journal of Criminology*, 51(3), 518–534.
- Boster, J. S., Yost, J., & Peek, C. (2004). Rage, revenge, and religion: honest signaling of aggression and nonaggression in Waorani coalitional violence. *Ethos*, 31(4), 471–494.
- Bowles, S. (2009). Did warfare among ancestral hunter-gatherers affect the evolution of human social behaviors? *Science*, 324(5932), 1293–1298.
- Boyd, R., & Richerson, P. J. (1992). Punishment allows the evolution of cooperation (or anything else) in sizable groups. *Ethology and Sociobiology*, 13(3), 171–195.
- Boyd, R., Gintis, H., & Bowles, S. (2010). Coordinated punishment of defectors sustains cooperation and can proliferate when rare. *Science*, 328(5978), 617–620.
- Burch, E. S. J. (2007). Traditional native warfare in western Alaska. In R. J. Chacon & R. G. Mendoza (Eds.), *North American indigenous warfare and ritual violence* (pp. 11–29). Tucson: University of Arizona Press.
- Chagnon, N. (1988). Life histories, blood revenge, and warfare in a tribal population. *Science*, 239(4843), 985–992.
- Chagnon, N. (1990). Reproductive and somatic conflicts of interest in the genesis of violence and warfare among tribesmen. In J. Haas (Ed.), *The anthropology of war* (pp. 77–104). Cambridge: Cambridge University Press.
- Choi, J.-K., & Bowles, S. (2007). The coevolution of parochial altruism and war. *Science*, 318(5850), 636–640.
- Cooper, J. M. (1917). *Analytical and critical bibliography of the tribes of Tierra del Fuego and adjacent territory (Smithsonian Institution. Bureau of American Ethnology. Bulletin 63)*. Washington DC: US Government Printing Office.
- Cronk, L. (1991). Wealth, status, and reproductive success among the Mukogodo of Kenya. *American Anthropologist*, 93(2), 345–360.
- Darwin, C. (2006). The descent of man and selection in relation to sex (originally published in 1871). In E. O. Wilson (Ed.), *From so simple a beginning: The four great books of Charles Darwin*. New York: W.W. Norton.
- Dentan, R. (1968). *The Semai: A nonviolent people of Malaya*. New York: Holt, Rinehart, and Winston.
- Dozier, E. P. (1967). *The Kalinga of northern Luzon, Philippines*. New York: Holt, Rinehart and Wilson.
- Dunbar, R. I. M. (1991). On sociobiological theory and the Cheyenne case. *Current Anthropology*, 32(2), 169–173.
- Durham, W. H. (1976). Resource competition and human aggression, Part I: a review of primitive war. *Quarterly Review of Biology*, 51(3), 385–415.
- Durrant, R. (2011). Collective violence: an evolutionary perspective. *Aggression and Violent Behavior*, 16(5), 428–436.
- Early, J. D., & Peters, J. F. (1990). *The population dynamics of the Mucajai Yanomama*. San Diego: Academic Press.
- Eaton, D. (2008). The business of peace: raiding and peace work along the Kenya-Uganda border (Part 1). *African Affairs*, 107(427), 89–110.
- Ember, C. R., & Ember, M. (1992). Resource unpredictability, mistrust, and war: a cross-cultural study. *Journal of Conflict Resolution*, 36(2), 242–262.
- Ember, C. R., & Ember, M. (1994). War, socialization, and interpersonal violence: a cross-cultural study. *Journal of Conflict Resolution*, 38(4), 620–646.
- Ermer, E., Cosmides, L., & Tooby, J. (2008). Relative status regulates risky decision making about resources in men: evidence for the co-evolution of motivation and cognition. *Evolution and Human Behavior*, 29(2), 106–118.
- Ewers, J. C. (1980). *The horse in Blackfoot Indian culture, with comparative material from other Western tribes (Classics of Smithsonian Anthropology)*. Washington: Smithsonian Institution Press.
- Fleisher, M. L., & Holloway, G. J. (2004). The problem with boys: Bridewealth accumulation, sibling gender, and the propensity to participate in cattle raiding among the Kuria of Tanzania. *Current Anthropology*, 45(2), 284–288.

- Fortune, R. F. (1939). Arapesh warfare. *American Anthropologist*, (n.s.), 41(1), 22–41.
- Gat, A. (1999). The pattern of fighting in simple, small-scale prestate societies. *Journal of Anthropological Research*, 55(4), 563–583.
- Gat, A. (2000). The Human motivational complex: evolutionary theory and the causes of hunter-gatherer fighting, Part I: Primary somatic and reproductive causes. *Anthropological Quarterly*, 73(1), 20–34.
- Girke, F. (2008). The Kara-Nyangatom war of 2006–07: Dynamics of escalating violence in the tribal zone. In E.-M. Bruchaus & M. Sommer (Eds.), *Hotspot Horn of Africa revisited: Approaches to make sense of conflict* (pp. 192–207). Berlin: LIT Verlag.
- Graburn, N. H. H. (1969). *Eskimos without igloos: Social and economic development in Sugluk*. Boston: Little, Brown.
- Hadlock, W. S. (1947). War among the Northeastern Woodland Indians. *American Anthropologist*, 49(2), 204–221.
- Hallpike, C. R. (1977). *Bloodshed and vengeance in the Papuan mountains: The generation of conflict in Tauade society*. Oxford: Clarendon.
- Hart, C. W. M., & Pilling, A. R. (1979). *The Tiwi of North Australia*. New York: Holt, Rinehart and Winston.
- Heider, K. G. (1997). *Grand Valley Dani: Peaceful warriors*. Fort Worth: Harcourt Brace College Publishers.
- Heider, K. G. (2006). *The Dugum Dani: A Papuan culture in the highlands of West New Guinea*. New Brunswick, NJ: Aldine/Transaction.
- Hendrickson, D., Mearns, R., & Armon, J. (1996). Livestock raiding among the pastoral Turkana of Kenya: redistribution, predation, and the links to famine. *IDS Bulletin*, 27(3), 17–30.
- Hiatt, L. R. (1965). *Kinship and conflict: A study of an aboriginal community in northern Arnhem Land*. Canberra: Australian National University.
- Hickerson, H. (1988). *The Chippewa and their neighbors: A study in ethnohistory*. Prospect Heights, IL: Waveland Press.
- Hill, J. (1984). Prestige and reproductive success in man. *Ethology and Sociobiology*, 5(2), 77–95.
- Hopcroft, R. L. (2006). Sex, status, and reproductive success in the contemporary United States. *Evolution and Human Behavior*, 27(2), 104–120.
- Jandial, R., Hughes, S. A., Aryan, H. E., Marshall, L. F., & Levy Michael, L. (2004). The science of shrinking human heads: tribal warfare and revenge among the South American Jivaro-Shuar. *Neurosurgery*, 55(5), 1215–1221.
- Keeley, L. H. (1996). *War before civilization*. New York: Oxford University Press.
- Kelly, R. C. (2000). *Warless societies and the origin of war*. Ann Arbor: University of Michigan Press.
- Kroeber, A. L. (1971). Yurok national character. In R. F. Heizer & M. A. Whipple (Eds.), *The California Indians: A source book* (pp. 385–423). Berkeley: University of California Press.
- Langergraber, K., Schubert, G., Rowney, C., Wrangham, R., Zommers, Z., & Vigilant, L. (2011). Genetic differentiation and the evolution of cooperation in chimpanzees and humans. *Proceedings of the Royal Society B: Biological Sciences*, 278(1717), 2546–2552.
- LeBlanc, S. A., & Register, K. E. (2003). *Constant battles: The myth of the peaceful, noble savage* (1st ed.). New York: St. Martin's Press.
- Lee, W. E. (2007). Peace chiefs and blood revenge: Patterns of restraint in Native American warfare, 1500–1800. *Journal of Military History*, 71(3), 701–741.
- Lehmann, L., & Feldman, M. W. (2008). War and the evolution of belligerence and bravery. *Proceedings of the Royal Society B: Biological Sciences*, 275(1653), 2877–2885.
- Mann, E. H. (1975). *Aboriginal inhabitants of the Andaman Islands*. Delhi: Sanskaran Prakashak.
- Mann, E. H. (2001). *The aboriginal inhabitants of the Andaman Islands*. New Delhi: Mittal.
- Manson, J. H., & Wrangham, R. W. (1991). Intergroup aggression in chimpanzees and humans. *Current Anthropology*, 32(4), 369–390.
- Maschner, H., & Reedy-Maschner, K. L. (1998). Raid, retreat, defend (repeat): the archaeology and ethnohistory of warfare on the north Pacific Rim. *Journal of Anthropological Archaeology*, 17, 19–51.
- Mathew, S., & Boyd, R. (2011). Punishment sustains large-scale cooperation in prestate warfare. *Proceedings of the National Academy of Sciences of the United States of America*, 108(28), 11375–11380.
- Meggitt, M. J. (1977). *Blood is their argument: Warfare among the Mae Enga tribesmen of the New Guinea highlands*. Palo Alto, Calif.: Mayfield.
- Morren, G. E. B. J. (1984). Warfare on the Highland Fringe of New Guinea: The case of the Mountain Ok. In R. B. Ferguson (Ed.), *Warfare, culture, and environment* (pp. 169–207, Studies in anthropology). Orlando, Fla.: Academic Press.

- Murphy, R. F. (1957). Intergroup hostility and social cohesion. *American Anthropologist*, 59(6), 1018–1035.
- Netting, R. (1973). Fighting, forest, and the fly: some demographic regulators among the Kofyar. *Journal of Anthropological Research*, 29(3), 164–179.
- Patton, J. Q. (1996). *Thoughtful warriors: Status, warriorship, and alliance in the Ecuadorian Amazon*. PhD dissertation, University of California, Santa Barbara.
- Patton, J. Q. (2000). Reciprocal altruism and warfare: A case from the Ecuadorian Amazon. In L. Cronk, N. Chagnon, & W. Irons (Eds.), *Adaptation and human behavior: An anthropological perspective*. New York: Aldine de Gruyter.
- Peers, L. (1994). *The Ojibwa of western Canada, 1780–1870*. St. Paul: Minnesota Historical Society Press.
- Pflanz-Cook, S., & Cook, E. (1979). Manga pacification. In M. Rodman & M. Cooper (Eds.), *The pacification of Melanesia* (pp. 179–198). Ann Arbor: University of Michigan Press.
- Ploeg, A. (1979). The establishment of the Pax Neerlandica in the Bokondini area. In M. Rodman & J. M. Cooper (Eds.), *The pacification of Melanesia* (pp. 161–177). Ann Arbor: University of Michigan Press.
- Ray, V. (1963). *Primitive pragmatists: The Modoc Indians of northern California*. Seattle: University of Washington.
- Robbins, S. (1982). *Auyana: Those who held onto home (Anthropological Studies in the Eastern Highlands of New Guinea; v. 6)*. Seattle: University of Washington Press.
- Sagawa, T. (2010). Automatic rifles and social order amongst the Daasanach of conflict-ridden East Africa. *Nomadic Peoples*, 14(1), 87–109.
- Skinner, A. (1911). War customs of the Menomini Indians. *American Anthropologist*, 13(2), 299–312.
- Slobodin, R. (1960). Eastern Kutchin warfare. *Anthropologica*, (n.s.), 2(1), 76–94.
- Smirnov, O., Arrow, H., Kennett, D., & Orbell, J. (2007). Ancestral war and the evolutionary origins of “heroism.” *Journal of Politics*, 69(4), 927–940.
- Smith, M. W. (1938). The war complex of the Plains Indians. *Proceedings of the American Philosophical Society*, 78(3), 425–464.
- Stewart, K. (1971). Mohave warfare. In R. F. Heizer & M. A. Whipple (Eds.), *The California Indians: A source book* (pp. 431–444). Berkeley: University of California Press.
- Turney-High, H. H. (1991). *Primitive war: Its practices and concepts* (2nd ed.). Columbia: University of South Carolina Press.
- Turton, D. (1979). War, peace, and Mursi identity. In K. Fukui, D. Turton, & H. Kokuritsu Minzokugaku (Eds.), *Warfare among East African herders* (pp. 179–210, *Senri ethnological studies* 3). Suita, Osaka: National Museum of Ethnology.
- von Rueden, C., Gurven, M., & Kaplan, H. (2008). The multiple dimensions of male social status in an Amazonian society. *Evolution and Human Behavior*, 29(6), 402–415.
- von Rueden, C., Gurven, M., & Kaplan, H. (2011). Why do men seek status? Fitness payoffs to dominance and prestige. *Proceedings of the Royal Society B-Biological Sciences*, 278, 223–2232.
- Walker, R. S., & Bailey, D. H. (2013). Body counts in lowland South American violence. *Evolution and Human Behavior*, 34(1), 29–34.
- Wang, X. T., Kruger, D. J., & Wilke, A. (2009). Life history variables and risk-taking propensity. *Evolution and Human Behavior*, 30(2), 77–84.
- Warner, W. L. (1931). Murngin warfare. *Oceania*, 1(4), 457–494.
- White, G. (1979). War, peace, and piety in Santa Isabel, Solomon Islands. In M. Rodman, & M. Cooper (Eds.), *The Pacification of Melanesia* (pp. 109–139, ASAO monograph ; no. 7). Ann Arbor: University of Michigan Press.
- Wiessner, P. (2006). From spears to M-16s: testing the imbalance of power hypothesis among the Enga. *Journal of Anthropological Research*, 62, 165–191.
- Wilson, M., & Daly, M. (1985). Competitiveness, risk-taking, and violence: the young male syndrome. *Ethology and Sociobiology*, 6(1), 59–73.
- Witsenburg, K., & Adano, W. R. (2009). Of rains and raids: violent livestock raiding in northern Kenya. *Civil Wars*, 11(4), 514–538.
- Wrangham, R., & Glowacki, L. (2012). Intergroup aggression in chimpanzees and war in nomadic hunter-gatherers. *Human Nature*, 23(1), 5–29.
- Wrangham, R., & Peterson, D. (1996). *Demonic males: Apes and the origins of human violence*. Boston: Houghton Mifflin.
- Wrangham, R., Wilson, M. L., & Muller, M. N. (2006). Comparative rates of violence in chimpanzees and humans. *Primates*, 47(1), 14–26.

Luke Glowacki is a PhD candidate in human evolutionary biology at Harvard University. His doctoral research with nomadic pastoralists in Ethiopia focuses on understanding variation between individuals in contributions to collective action problems.

Richard Wrangham (PhD, Zoology, Cambridge 1975) has studied the Kanyawara community of chimpanzees in Kibale National Park, Uganda, since 1987. He taught biological anthropology at the University of Michigan (Ann Arbor) from 1981 to 1989 and subsequently at Harvard University. His most recent book is *Catching Fire: How Cooking Made Us Human* (Basic Books, 2009).