

Scars for war: evaluating alternative signaling explanations for cross-cultural variance in ritual costs

Richard Sosis^{a,b,*}, Howard C. Kress^b, James S. Boster^b

^aDepartment of Sociology and Anthropology, The Hebrew University of Jerusalem, Mount Scopus, 91905, Jerusalem, Israel

^bDepartment of Anthropology, U-2176, University of Connecticut, Storrs, CT 06269-2176, USA

Initial receipt 29 October 2005; final revision received 2 February 2007

Abstract

While males in many societies endure traumatic and painful rites, in other societies male rites are mild or completely absent. To explain these cross-cultural differences, we use data collected from the Human Relations Area Files electronic databases (eHRAF) to test two sets of hypotheses derived from signaling theory. If costly male rites serve to signal mate quality, they would be expected to correlate with the intensity of mating competition. If they serve to signal group commitments, they would be expected to be associated with the importance of overcoming problems of collective action. Our results support the latter set of hypotheses: males in societies that engage in warfare endure the costliest rites. Moreover, we show that whether wars are fought within cultural groups or against other cultural groups is an important determinant of whether or not male rites result in permanent visible marks, such as ritual scars. We argue that costly male rites signal commitment and promote solidarity among males who must organize for warfare.

© 2007 Elsevier Inc. All rights reserved.

Keywords: Cooperation; Costly signaling theory; Ritual; Religion; Warfare

1. Introduction

Evolutionary researchers have increasingly turned their attention toward understanding the adaptive significance of religious behaviors (for reviews, see Bulbulia, 2004a; Sosis & Alcorta, 2003). One of the significant challenges these scholars face is explaining the willingness of religious adherents to perform acts that appear to entail significant somatic and reproductive costs. These costs seem particularly acute among male rites, which can include repeated subincisions, skin hangings, exposure to fire, teeth pullings, and other traumas. However, not all communities impose such demands on their boys and men; some are totally devoid of male rites and others may require nothing more than the acquisition of clandestine teachings. Why do societies vary so broadly in the ritual costs they demand of their males?

Several researchers have previously tested evolutionary hypotheses aimed at explaining the cross-cultural distribu-

tion of various initiation and puberty rites, including scarification and tattooing (Low, 1979; Ludvico & Kurland, 1995; Singh & Bronstad, 1997).¹ Motivated by the logic of sexual selection and Zahavian signaling theory (Hamilton & Zuk, 1982; Zahavi, 1975), these studies examined whether males and females use scarification as a form of mating competition in which performers signal their resistance to pathogens, willingness to endure pain, or overall genetic quality. Their results are largely unresponsive or inconclusive, suggesting the need to explore alternative explanations. With this goal in mind, here we examine whether costly male rites serve to reliably signal group commitments.

Anthropologists have long maintained that one of the primary functions of ritual is the promotion of group solidarity (e.g., Durkheim, 1995 [1912]; Rappaport, 1999). Some researchers have argued that social bonding is not an end in itself but a means to facilitate intra-group cooperation. Irons (2001, 2004), for example, posits that the primary

* Corresponding author. Department of Sociology and Anthropology, The Hebrew University of Jerusalem, Mount Scopus, 91905, Jerusalem, Israel.

E-mail address: richard.sosis@uconn.edu (R. Sosis).

¹ Various researchers not working within a selectionist framework have also conducted analyses aimed at explaining the cross-cultural distribution of initiation and puberty rites (e.g., Paige & Paige, 1981; Schlegel & Barry, 1980; Whiting, Kluckholm, & Anthony, 1958; Young, 1965).

adaptive benefit of religious behavior is its ability to foster cooperation and overcome problems of collective action that humans have faced throughout their evolutionary history. He emphasizes that the costliness of ritual actions enables them to serve as honest signals of commitment to the group because only those who are committed to the group's beliefs and goals will be willing to incur the time, energetic, and opportunity costs of ritual performance. In other words, individuals pay the costs of ritual performance, but by doing so they demonstrate their commitment and loyalty to the group and can thus achieve a net benefit from successful collective action.

Building upon Irons's ideas and Cronk's (1994) original insights, several researchers have employed recent developments in signaling theory to explain the emergence and stability of ritual behavior under broad environmental circumstances (Bulbulia, 2004b; Sosis, 2003, 2004). To evaluate these arguments, Sosis and colleagues (Sosis, 2000a; Sosis & Bressler, 2003; Sosis & Ruffle, 2003, 2004; Ruffle & Sosis, 2007) examined the role of ritual behavior in overcoming the inherent collective action problems of cooperative labor that communal societies confront. Their results showed that the frequency of participation in costly ritual behavior was correlated with individual levels of cooperation, and among religious communes, commune longevity was correlated with the costliness of ritual demands. While these studies focused on how communities resolve the free-rider dilemmas surrounding cooperative resource acquisition and consumption, throughout our evolutionary history individuals have faced an array of other collective action problems, most notably warfare (Alexander, 1987; Keeley, 1996; Wrangham & Peterson, 1996). Research has yet to untangle the relative importance of these various collective action problems in providing the ecological stimulus that favored the selection of costly ritual behavior. Nor has research begun to evaluate alternative signaling explanations of ritual behavior, namely, whether rituals serve to advertise mate quality or intra-group commitment. Here we take the first step toward addressing both of these questions. In contrast to the pioneering studies by Low and others (cited above), we focus solely on males and examine a broad spectrum of rituals that they perform across societies. We defer an analysis of female rites for future research because we assume that the determinants of ritual costs vary according to the ecological problems that rituals emerge to solve. Distinct mating strategies and gender roles in activities such as resource acquisition and inter-group conflict suggest that the salient ecological problems for males and females are likely to differ.

2. What do male rites signal?

2.1. Group commitment

Bliege Bird and Smith (2005) outline four necessary conditions for the evolutionary stability of a costly signaling

system² in a population: (1) there is within-group variance in some unobservable attribute; (2) observers can benefit from reliable information about this variance; (3) higher-quality signalers can benefit from accurately broadcasting this information, but lower-quality signalers have the potential to achieve benefits at the expense of recipients through deception; and (4) the cost or benefit to the signaler of sending the signal is correlated with the signaler's quality. Sosis (2005, 2006) has argued that religious behaviors meet these conditions: (1) the intensity of religious beliefs varies within communities and this variance is unobservable; (2) individuals benefit from accurate information about this variance because intensity of belief is related to one's commitment to the group and its goals, committed members being more likely to be cooperators and thus preferred social partners; (3) religious groups offer various benefits for members that are mutually provided and are at risk of exploitation by those not committed to group goals; and (4) the cost or benefit of ritual performance is weighed against opportunity costs that are expected to be higher for skeptics than for believers since believers will have genuinely forsaken many behaviors deemed unsuitable by religious doctrine, while skeptics will not have abandoned these behaviors.³ Thus, religious behavior can be understood as a costly signal that reliably advertises the unobservable condition of religious belief and group commitment. The time, energetic, material, and opportunity costs of religious activity serve to deter those who lack sufficient belief from displaying the signal, consequently increasing trust and solidarity among signaling group members. High-quality signalers, in other words those committed to the group, are assumed to realize reproductive gains via increased reputational status and group-wide benefits achieved through successful collective action.

As Irons (2001) notes, if religious behaviors signal commitment to the group, individuals who have the most to gain from signaling their group loyalties should be the ones who exhibit the highest intensity of ritual performance. These individuals may have the most to gain because they either receive a higher fraction or are in greater need of the

² To clarify a potential point of confusion, here we are discussing the stability conditions for costly signals, not impossible to fake signals, i.e., indices. Unlike indices, such as vocal-signal frequency indicating physical size, stable costly signals can be faked, but they are generally reliable because it is not in the interest of deceivers to pay the costs of sending a false signal.

³ There are alternative ways in which signaling theory could be applicable to religious behavior. For example, if the benefits received are delayed, signal costs could indicate long-term group commitment since those faking commitment would generally not be willing to pay ritual costs because they will not remain in the group long enough to receive the delayed benefits of group membership (E.A. Smith, personal comment). Sosis (2006) offers additional ways in which signaling theory could be applicable to religious behavior, and future work will need to evaluate these possibilities. Here we assume that one of these alternatives captures the selective pressures operating on religious behavior, although we are not yet in a position to determine which alternative is the most accurate.

collective benefits, or they are at greater risk of being mistaken for a free-rider, possibly as a result of personal history (e.g., converts) or some phenotypic trait (e.g., skin color). While there is often intra-group variance in ritual performance, religious doctrines or group norms establish minimum levels of ritual performance required for group membership (Sosis, 2003). Groups that face the greatest risk of exploitation by free-riders, owing to inherent challenges in distinguishing committed group members from free-riders, should on average require and exhibit higher levels of ritual costs than groups that face lower risk of exploitation by free-riders. Likewise, if ritual requirements safeguard the benefits of group membership, required ritual costs should be higher in groups that offer greater benefits to their members. In other words, if facilitating cooperation is the general ecological problem that rituals emerge to solve, those groups that confront the most significant challenges of collective action (owing to difficulties in distinguishing members from free-riders or defending substantial group benefits) will require the most demanding rituals of their community members in order to deter free-riders from exploiting the benefits attained through collective action.

If male rites serve to signal group commitment and enhance male solidarity, we would expect group size and genetic relatedness to independently impact the costliness of ritual activities. Specifically, larger groups will face greater free-rider problems (Olson, 1965) and they will therefore experience increased selective pressures favoring costlier rites that can deter free-riders. *Ceteris paribus*, we expect groups composed of related male kin, such as patrilineal societies, to have less costly male rites than communities composed of unrelated males because closely related males have expectations of solidarity on the basis of their kin ties, and should therefore be less dependent on independent costly signals of commitment. The impact of group size and relatedness on the costliness of male rites should be considerable regardless of the types of cooperative activities that males must pursue.

Irons (1996) mentions two primary categories of collective action problems that religious behaviors may have evolved to solve: resource acquisitions and warfare. Cooperative hunting and concomitant band-wide food sharing pose widely recognized free-rider problems and most anthropological research on these topics has been aimed at explaining how groups manage these problems (e.g., Alvard & Nolin, 2002; Gurven, 2004; Sosis, 2000b). This literature, however, has not examined the possibility that collective rituals might facilitate these activities by enhancing intra-group trust and commitment. If costly ritual actions promote cooperation, we may expect the costliness of male rites across societies to be correlated with the importance among males of cooperative resource acquisition and consumption.

Warfare and group-defense likely pose even greater free-rider problems than these collective activities, owing to high mortality risks. As Pinker (1997) observes, “A war party

faces the problem of altruism par excellence. Every member has an incentive to cheat by keeping himself out of harm’s way and exposing others to greater risk” (p. 626). The ethnographic literature on warfare is replete with examples of men who defect en route to an attack or raid (e.g., Chagnon, 1997).⁴ When defending against an attack, shirking may be harder to detect or punish, and therefore also common. Whether attacking or defending, each individual who defects places the remaining group members at greater risk of injury or death. Thus, when warfare is frequent within a society, reliable signals of intra-group commitment that increase solidarity, such as ritual performance, should be highly favored by selective mechanisms.⁵

The types of rituals that will be favored as signals of commitment will depend upon the nature of warfare prevalent within a society.⁶ In societies in which internal warfare (fought within a cultural grouping) is common, intermarriage is frequent and communities continually fission and fuse; thus an enemy one day may be an ally the next (Chagnon, 1997; Keeley, 1996; Otterbein, 1968).⁷ Because of the mobility of individuals across groups and consequent shifting of alliances, individuals within communities that engage in frequent internal warfare should not be willing to submit to rituals that leave permanent markers, such as tattoos or scars, which can signal group identity. Such markers might hinder their ability to create or join new groups, or at least minimize their credibility amongst new group members. Warfare fought against other cultural groups, referred to as external warfare, poses an alternative problem. Groups engaged in external warfare are concerned about uniting unrelated males and fielding as large a combat unit as possible. However, when imbalances of power occur within a region, smaller groups are at risk of their members defecting to larger and more powerful groups. For these communities, permanent markers would serve to minimize the ability of men to abscond to another group.

⁴ Chagnon (1988) also demonstrates that reproductive gains can be achieved through warfare, which may minimize the collective action problem of warfare for some men. All potential warriors confront their own expected payoffs (some probabilistic distribution) based on their fighting skills. Skilled warriors may face payoffs that resemble coordination games, whereas others may perceive high incentives for defection.

⁵ There are conditions, such as sustaining many casualties or difficulty in recruiting warriors, under which warfare frequency might be negatively correlated with signal costs (A. Cimino, personal comment), especially if the costs of defection (to others) are low. We assume that the costs of defection are generally high, hence our expectation that warfare frequency is positively correlated with signal costs.

⁶ Otterbein (1994, p. 37) defines war as “armed combat between two political communities...when political communities within the same cultural unit engage in warfare, this is considered to be internal war. When warfare occurs between political communities, which are not culturally similar, this is referred to as external war.”

⁷ As Thorpe (2003, p. 149) remarks concerning the Yanomamo, “those they kill are often relatives in closely related villages with whom they have good relations at other times” (also see Ferguson, 2001).

Although all warfare is dangerous, we believe that external warfare ultimately poses greater risks than internal warfare. Internal warfare threatens the lives of individuals; external warfare threatens the continuation of one's entire kin group and community (e.g., Harner, 1972). Because of the greater inclusive fitness costs associated with defection in external warfare, as well as the costliness of permanent markers, we expect external warfare to elicit costlier signals of commitment than internal warfare. Societies that engage in both internal and external warfare will face tradeoffs in the costliness of their commitment signals, especially their willingness to submit to permanent markers, and we therefore expect them to maintain rites at an intermediate level of costliness between societies with only external or internal warfare.

2.2. Mate quality

As mentioned above, rather than signaling group commitment, male rites may serve to advertise mate quality. Returning to Bliege Bird and Smith's conditions for the evolutionary stability of a costly signal, it is clear that if ritual behaviors signal mate quality, or characteristics associated with mate quality, they also meet these necessary conditions. For example, consider the argument that scarification or tattoos signal pathogen resistance: (1) males vary in their resistance to pathogens; (2) since this variance is likely to correlate with the benefits males can provide directly to mates (e.g., resource acquisition, protection), as well as the quality of jointly produced offspring (to the extent this resistance is heritable), females benefit from accurate knowledge about this variance; (3) males who have high pathogen resistance can increase their mating opportunities by accurately broadcasting this information, but men who are less resistant can benefit if they are able to deceive females about their level of resistance; and (4) the cost to males of exposing themselves to pathogens through ritual tattoos and lacerations is negatively correlated with their resistance to pathogens. Alternatively, male rites may also be signaling ability to endure pain or other aspects of mate quality.

If male rites signal mate quality we expect the intensity of these rites to increase as the competition for mates increases. Societies that permit polygyny offer males greater potential reproductive success than monogamous societies and consequently there is greater competition for female parental investment, as well as greater variance in male reproductive success. In stratified polygynous societies, this competition will be manifested in resource displays, and wealthy males are likely to out-compete poorer males (e.g., Gaulin & Boster, 1990; Irons, 1979). However, in non-stratified polygynous societies, where males do not compete through resource competition, ritual signaling is likely to be a more important mechanism to communicate mate quality.

3. Hypotheses

In sum, the above arguments suggest the following hypotheses.

3.1. Demography and kinship

1. The costliness of a society's male rites will be positively correlated with community size.
2. Patrilocal societies will have less costly male rites than societies in which males reside among unrelated men.

3.2. Resource acquisition and sharing

3. The costliness of a society's male rites will be positively correlated with the importance of male cooperative resource acquisition.
4. The costliness of a society's male rites will be positively correlated with the intensity of food sharing.

3.3. Warfare

5. The costliness of a society's male rites will be positively correlated with the frequency of warfare.
6. The type of warfare a society engages in will be a significant predictor of the costliness of male rites. Societies with external warfare only will have the most costly male rites, followed by societies with both external and internal warfare, then societies with internal warfare only, and societies without warfare will maintain the least costly male rites.
7. Societies with external warfare will require their males to bear more permanent markers than societies without external warfare.
8. Societies with internal warfare only will require their males to endure less permanent markers than societies without internal warfare only.

3.4. Mating

9. Males in polygynous societies will perform costlier male rites than males in nonpolygynous societies.
10. Males in nonstratified polygynous societies will perform costlier male rites than males in polygynous stratified societies.

4. Methods

To examine variation in the costs of male rites, we used the Probability Sample File (PSF) found in eHRAF, the web-based version of the Human Relations Area Files. The PSF includes 60 of the 90 societies available in eHRAF and is designed to offer a broad temporal and geographic sample of world cultures that controls for cultural contact between societies (Ember & Ember, 1998).

Eighteen undergraduate anthropology majors at the University of Connecticut were recruited to collect data in eHRAF on male ritual behavior. They were randomly assigned cultures from the PSF and instructed to read the appropriate ethnographic literature from eHRAF on each

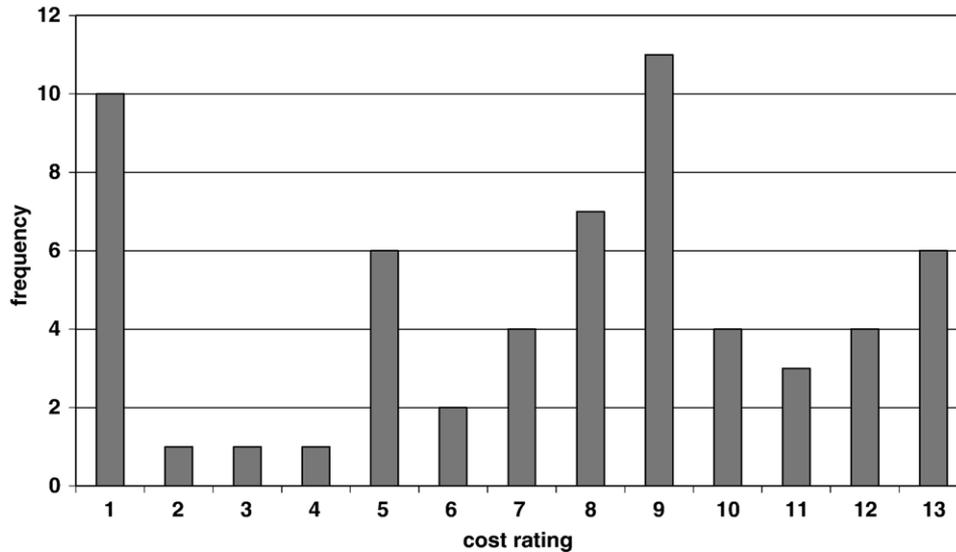


Fig. 1. Frequency distribution of cost ratings ($N=60$).

society to determine the presence or absence of 19 male rites, including tattooing, scarification, piercing, circumcision, subincision, teeth pulling, body painting, and learning secret knowledge.⁸ We did not limit data collection to puberty or initiation rites; students documented all rituals that were exclusively performed by males.⁹ All students were ignorant of the hypotheses being tested.

From these data we wrote brief descriptions of the male rites performed in each society. We offer two examples of society descriptions representing the extreme ends of the costliness distribution¹⁰:

Eastern Toraja: In this society, boys are subincised (a cut along the bottom of the penis) yearly beginning at 6 years old and ending at 15. Around age 12, boys are circumcised in a public ritual. Young boys have their ears pierced by their mothers. There is a public initiation rite into manhood where boys are cut on their arms, hands, and legs, as well as, burned on the torso and arms. Boys cannot show any pain during the public ceremonies. Men paint their bodies daily.

Pawnee: Men paint their faces in this society.

A panel of four graduate students rated each society description, assigning a score of 1 to the societies with the least costly rites and 4 to those societies whose males

⁸ We included in our analyses only those rites that are expected to be performed by all men. Furthermore, we did not exclude rites performed on boys too young to refuse to participate. In these cases, it is not the child but rather the father or other male kin who may be signaling their quality, or the quality of their genetic line.

⁹ We chose to focus on all male rites because we expect that it is the full suite of required rituals that offer a signal. For example, one who successfully endures an initiation rite only to ignore subsequent ritual requirements is not effectively signaling high group commitment or mate quality.

¹⁰ All society descriptions are available from the authors upon request.

engage in the costliest rites. Inter-rater agreement was fairly high (average Spearman $r=0.72$ of all six combinations, range=0.66–0.81). Graduate students were also ignorant of the hypotheses, as well as ignorant of the names of the societies they were rating. A composite score was calculated by summing the ratings of the graduate students and subtracting by 3 to produce a score ranging between 1 and 13 (mean=7.38, S.D.=4.86). For example, the Eastern Toraja received the maximum composite score of 13 (all students rated as 4) and the Pawnee received the minimum composite score of 1 (all students rated as 1). Fig. 1 presents the distribution of costliness rankings for the 60 societies in our sample.

Students coded the frequencies of external and internal warfare for five levels following Ember and Ember (1992). Owing to our small sample size and our lack of confidence about the ability of HRAF materials to accurately offer fine distinctions (e.g., whether war occurred once every year or once every 2 years), data were collapsed to create variables for the presence and absence of internal and external warfare, respectively. Data were also recorded on the time period during which the original author collected information on warfare and whether or not the rituals described in the files occurred during the same observation period. Our descriptions of male ritual activity within each society describe only the time period for which we have warfare data and thus do not reflect the full history of each culture.

Students also coded for five levels of male cooperative resource production and consumption, and collected data on socialization for cooperation following the coding schema of Poggie (1995). For reasons discussed above, these codes were all collapsed to create dichotomous variables.

Data on all other independent variables were obtained from the World Cultures CD (Gray, 1999). All independent variables and coding schemes are presented in Table 1. To test our hypotheses, we conducted ANOVAs with the

Table 1
Coding schema for independent variables

Independent variable	Coding schema	Analyses
Overall frequency of warfare	1=rare or absent 2=warfare seems to occur once every 3 to 10 years 3=warfare seems to occur once every 2 years 4=occurs at least once a year 5=constant warfare	0=if category 1 or 2 1=if category 3, 4, or 5
Frequency of external warfare	1=rare or absent 2=warfare seems to occur once every 3 to 10 years 3=warfare seems to occur once every 2 years 4=occurs at least once a year 5=constant external warfare	0=warfare absent 1=warfare present
Frequency of internal warfare	1=rare or absent 2=warfare seems to occur once every 3 to 10 years 3=warfare seems to occur once every 2 years 4=occurs at least once a year 5=constant internal warfare	0=warfare absent 1=warfare present
Socialization for cooperation	1=socialization mentioned but cooperation not mentioned 2=cooperation mentioned as part of a suite of socialization values 3=cooperation is discussed as the most important of values 4=cooperation is clearly identified as the primary social value	0=if category 1 or 2 1=if category 3 or 4
Subsistence type	1=foraging 2=horticulture 3=pastoral 4=agriculture	0=nonforaging 1=foraging
Cooperative production	1=male labor done individually 2=male cooperative production limited to the family 3=some male cooperative production occurs outside the family 4=medium levels of nonfamilial male cooperative production 5=high levels of nonfamilial male cooperative production	0=if category 1, 2, or 3 1=if category 4 or 5
Food sharing	1=food acquired by males is never shared 2=food acquired by males is only shared during festivals/special occasions 3=some food acquired by males is regularly shared outside the family 4=medium levels of food sharing 5=most food acquired by males is regularly shared outside the family	0=if category 1, 2, or 3 1=if category 4 or 5
Polygyny	0=polygyny absent 1=polygyny present	
Social stratification	0=social stratification absent 1=social stratification present	
Residence pattern	1=patrilocal 2=matrilocal 3=ambilocal 4=avunculocal 5=neolocal 6=matrilocal–neolocal 7=ambilocal or neolocal 8=patrilocal–neolocal	0=if categories 2–7 1=if category 1 or 8
Descent pattern	1=patrilineal 2=matrilineal 3=ambilineal 4=bilateral	0=if categories 2–4 1=if category 1
Community size	1 ≤ 50 2 ≤ 100 3 ≤ 200 4 ≤ 500 5 ≤ 1000 6 ≤ 5000 7 ≤ 50,000 8 > 50,000	1 ≤ 200 2 ≤ 1000 3 ≤ 5000 4 > 5000
Region	1=Africa 2=Asia 3=Europe 4=Middle East 5=North America 6=Oceania 7=South America 8=Central America and Caribbean	1=Africa 2=Asia 3=Americas and Caribbean 4=Oceania

Table 2
Data for primary variables in analyses*

Society	Region	Community size	Residence pattern	Socialization for cooperation	Subsistence type	Cooperative production	Food sharing	Polygyny	Social stratification	Overall warfare frequency	Cost rating
Akan	1	2	0	0	1	1	.	1	1	1	7
Amhara	1	2	1	0	0	0	0	0	1	1	7
Andamans	2	1	0	0	1	0	0	0	0	1	11
Aranda	4	1	0	0	1	1	1	1	0	1	12
Aymara	3	3	1	0	0	0	0	1	0	1	5
Azande	1	2	.	.	0	0	0	1	1	1	9
Bahia Brazil	3	4	1	0	0	1	0	0	1	0	1
Bemba	1	2	0	0	0	0	0	1	0	0	7
Blackfoot	3	1	0	1	1	1	1	1	0	1	13
Bororo	3	1	0	0	1	1	1	1	0	1	11
Central Thai	2	4	0	1	0	1	0	1	1	0	1
Chukchee	2	1	1	0	1	0	1	1	0	0	9
Chuuk	4	2	0	1	0	0	1	1	0	0	7
Copper Inuit	3	1	0	1	1	1	1	1	0	0	1
Dogon	1	2	1	0	0	0	0	1	1	1	8
Eastern Toraja	2	2	1	1	0	1	0	1	1	1	13
Ganda	1	2	1	0	0	1	0	1	1	1	1
Garó	2	2	0	0	0	0	0	0	0	0	9
Guarani	3	1	0	0	0	1	0	1	0	1	9
Hausa	1	4	1	0	0	1	0	1	1	1	11
Highland Scotts	.	4	0	0	0	0	0	0	1	0	1
Hopi	3	3	0	1	0	0	0	1	0	1	8
Iban	2	4	0	0	0	0	0	1	0	1	9
Ifugao	2	3	0	1	0	0	0	1	0	1	9
Iroquois	3	3	0	1	0	1	1	1	1	1	5
Kanuri	1	4	0	0	0	1	1	1	1	1	12
Kapauku	2	2	1	0	0	0	1	1	0	1	9
Khasi	2	4	0	1	0	.	.	0	1	0	9
Klamath	3	1	1	1	0	1	1	1	0	1	12
Kogi	3	1	1	1	0	0	1	1	0	0	5
Korea	2	2	1	1	0	1	1	1	1	1	2
Kuna	3	3	0	1	0	1	1	0	0	0	1
Kurds	.	4	1	0	0	1	0	1	1	0	6
Lau Fijians	4	4	1	0	0	0	1	1	0	1	10
Lozi	1	3	0	1	0	1	0	1	1	1	8
Lybian Bedouins	1	1	1	0	0	0	0	1	0	1	6
Maasai	1	2	1	1	0	0	1	1	0	1	13
Mataco	3	1	0	1	1	1	1	0	0	0	9
Mbuti	1	1	1	1	1	1	1	1	0	1	10
Ojibwa	3	2	0	0	0	1	1	1	0	1	5
Ona	3	1	0	0	1	1	1	1	0	1	13
Pawnee	3	2	0	0	0	1	1	1	1	1	1
Saami	.	1	0	1	0	1	1	0	0	0	1
Santal	2	2	1	0	0	.	1	1	0	0	10
Saramka	3	2	1	0	0	1	1	1	0	0	9
Serbs	.	4	1	0	0	0	0	0	1	0	5
Shluh	1	3	1	1	0	0	0	1	1	1	5
Singhalese	2	3	0	1	0	1	1	1	1	0	1
Somali	1	3	0	1	0	0	0	1	0	1	8
Taiwan Hokki	2	4	1	1	0	0	0	0	1	1	4
Tarahumarans	3	2	0	0	0	1	0	1	0	0	3
Tikopia	4	3	1	0	0	1	1	1	1	1	9
Tiv	1	3	1	1	0	1	0	1	0	1	13
Tlingit	3	1	0	1	1	1	0	1	1	1	12
Trobriands	4	2	0	0	0	1	1	0	1	0	1
Tukano	3	1	1	0	0	1	1	1	0	1	8
Tzeltal	3	4	0	1	0	0	0	0	1	1	8
Wolof	1	2	1	1	0	1	1	1	1	1	8
Yakut	2	2	0	0	0	1	1	1	0	0	13
Yanoama	3	2	0	0	1	0	1	1	0	1	10

* See Table 1 for variable definitions.

Table 3
ANOVA of cost ratings by foraging and measures of cooperation

Independent variable	F-ratio	p value
Foraging	5.44	.02
Cooperative production	0.23	.64
Foraging×Cooperative production	0.10	.75
Foraging	6.16	.02
Food sharing	0.28	.60
Foraging×Food sharing	0.32	.57
Foraging	5.91	.02
Socialization for cooperation	0.35	.56
Foraging×Socialization for cooperation	0.33	.57

costliness rating of each society as the dependent variable. The primary data used in our analyses are presented in Table 2, and the bars on all figures indicate standard errors.

5. Results

5.1. Regional effects

The 60 societies which comprise the PSF are categorized into eight regions: Africa ($n=16$), Asia ($n=14$), South America ($n=10$), North America ($n=8$), Oceania ($n=5$), Central America and Caribbean ($n=3$), Europe ($n=3$), Middle East ($n=1$). To assess regional effects, we collapsed North, South, Central America, and Caribbean into one category and ignored societies from Europe and the Middle East because of their low representation in the dataset. We found no relationship between region and our costliness ratings ($F_{3,56}=0.31, p=.818$). Nor did we find any relationship between region and any of our independent variables (polygyny, cooperative labor, food sharing, foraging, patrilocality, community size, social stratification, or warfare; analyses not shown). One concern was that certain ritual practices are associated with specific regions. Indeed, we found genital mutilations to be more common in Africa

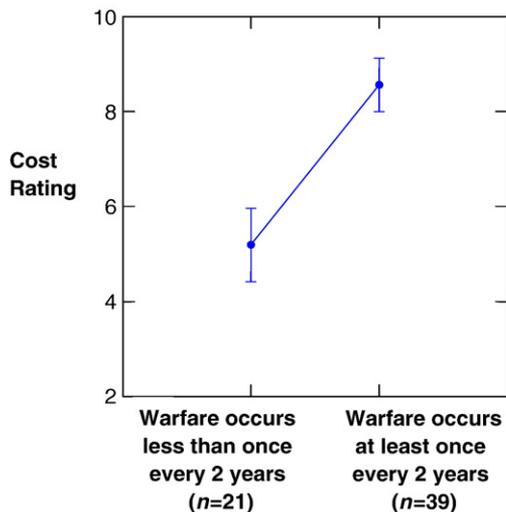


Fig. 2. Cost ratings by overall warfare frequency ($F=12.45, df=1, p<.001$).

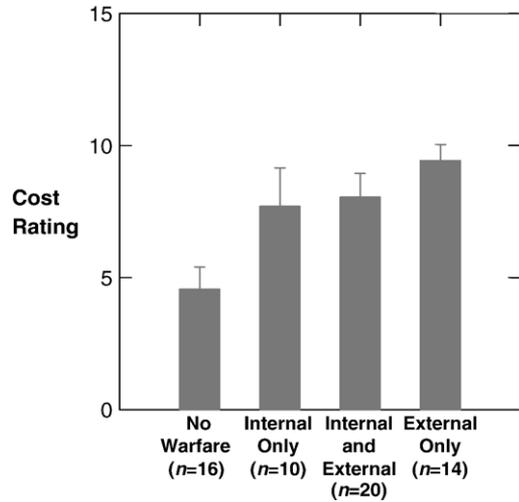


Fig. 3. Cost ratings by type of warfare.

(81.3%) and Oceania (60.0%) than in Asia (21.4%) and the Americas (0%). We also found piercing to be more common in Oceania (40.0%) and the Americas (33.3%) than in Asia (7.1%) and Africa (0%). However, there were no significant regional effects associated with any other rituals in our dataset (scarification, tattooing, ingestion of toxic substances, isolation, and painting).

5.2. Patrilocality and community size

Contrary to our expectation, nonpatrilocal societies do not have costlier male rites than patrilocal societies ($F_{1,59}=0.27, p=.61$). As a related hypothesis, we examined whether patrilineal descent was associated with the costliness of male rituals, but also found no relationship ($F_{1,60}=0.40, p=.53$). Costliness of rituals did not vary either with community size. There was a nonsignificant negative trend (opposite of our prediction) of the natural log of community size estimates in our sample and the costliness of male rites ($F_{3,60}=1.25, p=.30$).

5.3. Cooperative production, food sharing, and socialization for cooperation

None of our measures of cooperative resource acquisition and consumption are predictors of the costliness of male rites: cooperative production ($F_{1,58}=0.20, p=.66$), food sharing ($F_{1,58}=0.37, p=.55$), and socialization for cooperation ($F_{1,59}=0.12, p=.73$). Reliance on cooperative production and consumption strategies is likely to vary by subsistence type. We assume foragers maintain higher levels of cooperation than agriculturalists, pastoralists, and horticulturalists in order to overcome the considerable

Table 4
ANOVA of cost ratings by external and internal warfare ($N=60$)

Independent variable	F-ratio	p value
External	7.86	.01
Internal	0.89	.35
External×internal	5.90	.02

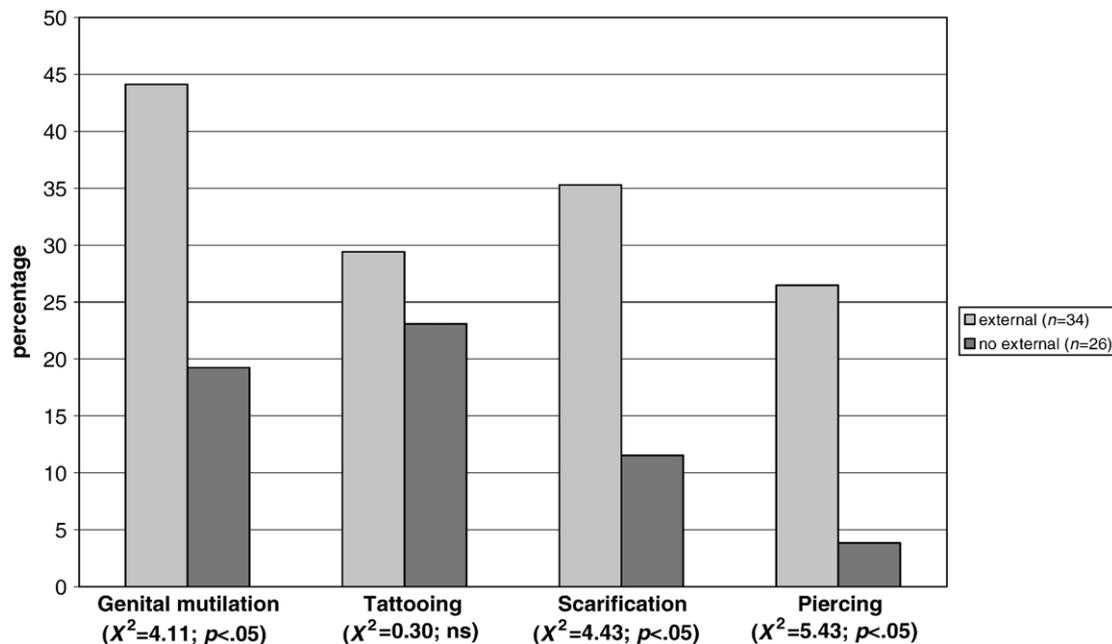


Fig. 4. Frequencies of permanent markers by presence and absence of external warfare.

variance they often face in daily meat returns. Our data indicate that foragers do indeed share food more extensively than nonforagers ($F_{1,58}=5.20, p=.03$), yet they do not significantly differ from other subsistence groups in their reliance on cooperative production ($F_{1,58}=1.66, p=.20$) or socialization for cooperation ($F_{1,59}=0.03, p=.85$). Foragers do exhibit costlier ritual signals than nonforagers ($F_{1,60}=6.63, p=.01$), and foraging remains a significant predictor of the costliness of male rites in independent ANOVA models with cooperative production, food sharing, and socialization for cooperation, while these other measures of cooperation remain insignificant (see Table 3).

5.4. Warfare

Overall, warfare frequency is the most significant predictor of ritual costs in our dataset ($F_{1,60}=12.47, p<.001$; Fig. 2). The costliness of male rites for societies in which warfare is present is significantly higher than in societies without warfare ($F_{1,60}=7.33, p=.009$); this relationship holds for both external warfare ($F_{1,43}=11.49, p=.002$) and internal warfare ($F_{1,39}=5.95, p=.02$). Fig. 3 indicates a trend in the predicted direction: males in societies that engage in external warfare only perform the costliest rites, followed by societies that engage in external and internal warfare, internal warfare only, and, lastly, no warfare ($F_{3,60}=5.36, p=.003$). However, the differences between internal warfare only, internal and external warfare, and external warfare only are not significant. Table 4 shows that there is an interaction effect between internal and external warfare; when external warfare is present the presence of internal warfare does not impact the costliness of rituals.

We predicted that societies with external warfare would have costlier rites than societies with internal warfare because we expect permanent markers (which are assumed to be very costly) to be more prevalent among societies with external warfare and nonpermanent markers to be more prevalent among societies with internal warfare only. Our data offer four categories of permanent markers: genital mutilations (circumcisions and subincisions), tattoos, scarifications, and piercings.¹¹ Fig. 4 shows that all of these permanent markers are more prevalent when external warfare is present in a society than when it is not; only tattooing is not significant. Our data offer three categories of nonpermanent markers, or specifically, ritual activity that does not leave a permanent visible result: body and face painting, ingestion of toxic substances, and periods of isolation. Fig. 5 shows that all of these nonpermanent markers are more prevalent in societies that engage in internal warfare only than in those that do not.

5.5. Polygyny

Polygynous societies have costlier male rites than nonpolygynous societies ($F_{1,60}=6.01, p=.017$) and nonstratified societies have costlier male rites than stratified societies ($F_{1,60}=6.85, p=.011$). There is no interaction effect between these variables ($F_{3,60}=.06, p=.81$). Polygyny, however, does not remain a significant predictor of ritual

¹¹ We did not include teeth pulling and filing in the analysis because, although damaging teeth is permanent, those who did not witness the ritual would be unable to distinguish natural teeth loss and decay from the ritual act. In addition, only five societies ritually pulled or filed teeth. Consistent with our predictions though, four of these societies engaged in external warfare.

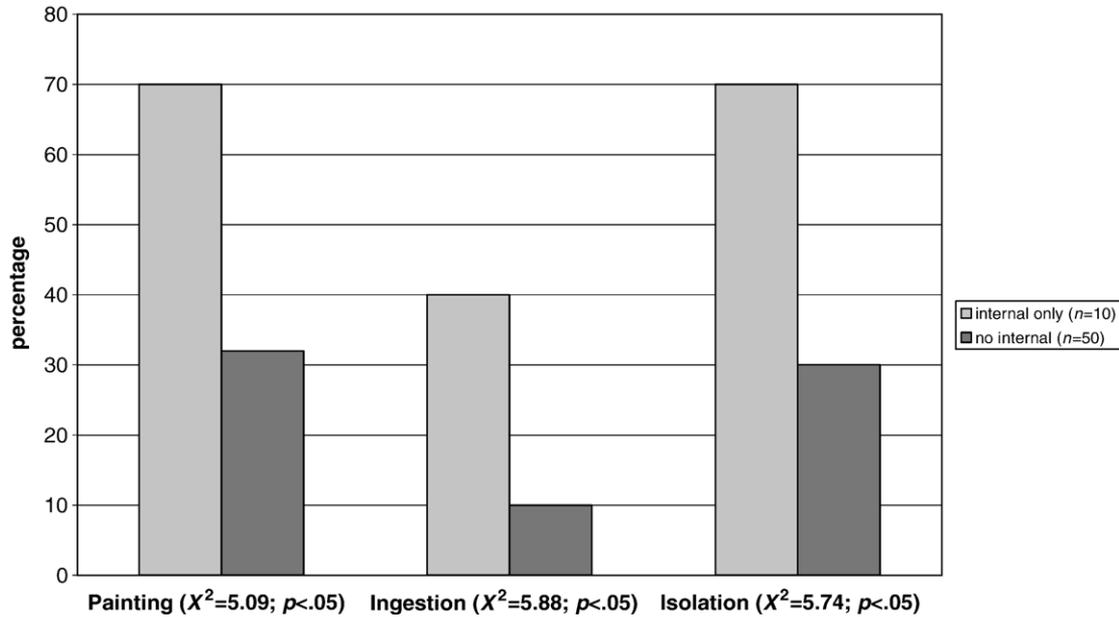


Fig. 5. Frequencies of nonpermanent rites by presence and absence of internal warfare.

costs when controlling for subsistence type ($F_{2,60}=1.03$, $p=.31$) or overall warfare frequency ($F_{2,60}=1.60$, $p=.21$). Social stratification remains a significant negative predictor when controlling for warfare ($F_{2,60}=10.26$, $p=.002$) but not subsistence type ($F_{2,60}=0.76$, $p=.39$).

6. Discussion

Our results suggest that nonstratified foraging societies that engage in warfare maintain the costliest male rites. Moreover, the types of warfare in which communities engage influence the costs and variety of rituals performed. External warfare is associated with permanent markers, whereas internal warfare is associated with ritual activities that do not leave permanent visible signs. While polygynous groups exhibit costlier rites than nonpolygynous groups, this relationship is not significant when subsistence type or warfare frequency is included in the model, suggesting that male rites do not vary as a function of mating competition. Ember and Ember (1992) have shown that warfare frequency is a predictor of polygyny. Nonetheless, among polygynous societies in our sample, warfare frequency remains a significant predictor of the costliness of male rites ($F_{1,47}=5.24$, $p=.027$). Among nonpolygynous societies, high levels of warfare are also associated with costlier rites, but this difference is not significant (average costliness rating 7.5 vs. 4.1; $n=13$, $t=1.75$, $p=.12$).

Contrary to our prediction, patrilocal residence is not related to ritual costs, even controlling for internal warfare frequency, which has been shown to be correlated with patrilocal residence in other cross-cultural research (Ember & Ember, 1971).¹² Community size is not a significant predictor either of variance in ritual costs. Small communities may actually have costlier rites than larger ones ($F_{1,60}=3.39$, $p=.07$),

although when controlling for overall warfare frequency this relationship is not significant ($F_{2,60}=1.52$, $p=.22$). In our analyses, community size served as a proxy for the size of the group that could potentially engage in collective action. Future work will require more accurate measures and will need to examine the relationship between ritual costs, group size, and political systems. Societies such as nation-states and chiefdoms, which tend to have large community sizes, can coerce participation in warfare or other collective activities through legitimate punishment threats (e.g., fines, imprisonment). Thus, contrary to our original prediction, these communities may be less dependent on ritual signs of commitment than small egalitarian societies because they can effectively punish defectors.

Cooperative production, food sharing, and socialization for cooperation were not significant predictors of variance in ritual costs either, although foragers exhibit costlier rites than nonforagers, which is marginally significant when controlling for overall warfare frequency ($F_{2,60}=3.27$; $p=.07$). We suspect that cooperative production and food sharing are unrelated to ritual costs because in these pursuits reciprocity can be employed to prevent free-riders from accruing long-term benefits. In contrast, the life and death stakes men face during each act of warfare or defense demand a commitment mechanism that does not solely rely on expectations of future cooperation, since men may not be alive to reciprocate. Costly rituals offer such a mechanism,

¹² In our data, a 2×2 Pearson chi-square model did not reveal a significant relationship between the presence and absence of internal warfare and patrilocal residence ($\chi^2=2.13$, $df=1$, $p=.145$). However, analyzing the originally coded internal warfare data (five-point scale, see Table 1) indicates a strong relationship between internal warfare frequency and patrilocal residence ($F_{1,59}=8.95$, $p=.004$).

which may explain why they are associated with warfare but not resource acquisition and consumption.

Our analyses further demonstrated that permanent markers are more common when external warfare is prevalent, and rites that do not leave permanent signs are more common when internal warfare is prevalent. These findings should be interpreted cautiously, however, since we were unable to control for overall warfare frequency. All societies that engaged in external warfare also experienced high frequencies of overall warfare, whereas only 40% of those societies that engaged in internal warfare only were reported to sustain high levels of overall warfare. Since overall warfare frequency is positively correlated with ritual costs (see above) and permanent markers are assumed to be costlier than rites that do not leave visible signs, our results may be spurious. We believe the consistent pattern found across every ritual category we examined provides evidence for our predictions concerning warfare type and marker permanence; however, a dataset with greater variance in the relevant variables is needed to further explore these predictions.

It is also important to clarify that our results do not demonstrate that costly male rites genuinely signal the group commitments of individuals. As [Maynard Smith and Harper \(2003\)](#) explain, for a signal to classify as a Zahavian handicap the net benefits for displaying the signal must be higher for a high-quality individual (in our case, someone strongly committed to the group) than a low-quality individual (someone weakly committed to the group). This could mean that the costs are higher for low-quality individuals, that the benefits are higher for high-quality individuals, or both. Obviously, this would be extremely difficult if not impossible to rigorously assess in an HRAF study. Here we offer no precise measures of benefits (we assume benefits accrue from status and successful collective action) and costs were measured by outsiders on a relative scale, and not in a currency that is directly related to fitness (discussed further below). Indeed, given the rigorous standards of evidence needed, with the exception of several foraging studies ([Bliege Bird, Smith, & Bird, 2001](#); [Smith, Bliege Bird, & Bird, 2003](#)), few costly signals have been convincingly demonstrated in the human evolutionary literature. Nonetheless, our goal here was to explain variance in the costliness of male rites and signaling theory offered clear and testable predictions, as well as a compelling interpretation of our findings.

We believe that costly male rites are an adaptive response that emerges among warring communities to reduce free-riding and promote cooperation during warfare (cf. [MacNeill, 2004](#)). However, our analyses cannot entirely eliminate alternative hypotheses, and indeed, it would be imprudent to assume that one causal variable is responsible for a set of behaviors as complex as male rituals. For example, scars and paint may serve to make their bearers look fierce or, alternatively, they may help distinguish friends from foes on the battlefield. Even if warfare is the

primary selective force for the evolution of costly male rites, the solidarity achieved through ritual actions may also impact other collective endeavors. Likewise, although our results did not support the hypothesis that costly male rites serve to signal mate quality, male rites may be one of the many arenas in which females evaluate males even if this is not their main function.¹³

The ethnographic literature on “failed” rites is instructive and suggests that costly male rites do indeed serve multiple functions. For example, while [Crocker and Crocker \(1994\)](#) interpret Canela ear piercing as symbolizing the importance of obedience in a quasi-military society, Canela men claim that pierced ears attract women. During the ear piercing ceremony boys must remain motionless and show no pain, or they will be publicly shamed, thus reducing their mating prospects. In his cross-cultural survey on manhood, [Gilmore \(1990\)](#) describes how women regard males who failed to correctly perform rigorous initiation rites as unsuitable mates, whereas men consider such individuals to be unreliable and untrustworthy. Aside from illustrating that rites may serve multiple functions, these examples suggest that coerced initiations might have different signaling value than those which are willingly performed, or at least correctly performed, even if begrudgingly. Coercion and improper expression of suffering, however, do not always result in a failed signal of commitment (e.g., [Bulbulia, in press](#); [Rappaport, 1999](#)). In many boyhood rituals, such as subincision or circumcision, since the father (or male kin) rather than the boy is the signaler, expressions of pain are often tolerated and even expected ([Paige & Paige, 1981](#)). Moreover, once a marker exists, opportunity costs for out-group activities increase, thus enhancing the signal value of the marker ([Iannaccone, 1992](#)).

We interpret the relationship between ritual costs and warfare in our data as support for the claim that free-riding during warfare is the foremost collective action problem that costly male rites are designed to cope with. Alternatively, it could be argued that male ritual violence is actually a cause, rather than a consequence, of warfare. In other words, rather than a mechanism to create male solidarity, ritual violence during childhood produces violent men, and one manifestation of this violence is warfare. In several cross-cultural studies, Chick and colleagues ([Chick & Loy, 2001](#); [Chick, Loy, & Miracle, 1997](#)) found an association between socialization for aggressiveness and warfare frequency, although no causal relationship could be determined in these studies either (also see [Ember & Ember, 1994](#)). One limitation of this argument, however, is that it cannot account for the relationships we predicted and found between external warfare and permanent ritual markers and internal warfare and rituals that do not leave permanent

¹³ [Johnstone and Norris \(1993\)](#) similarly argue that badges that honestly signal status and serve to settle contests may also be used by females when choosing a mate.

visible marks. Future work should aim to distinguish between these causal interpretations, possibly exploring whether ritual costs are correlated with the frequency of male intra-group violence against women or other men, as would be expected if ritual violence causes boys to become aggressive men.

This discussion raises an additional question: If ritual violence is not a cause of warfare (but the converse, as we believe), why are male rites so violent and traumatic? Signaling theory may explain variation in ritual costs, but it cannot explain how the specific form of ritual costs varies across environments. Many rituals entail high energetic and material costs (dancing, charity, etc.), but most of the male rites considered here are physically dangerous and painful. To explain why, we need to consider the proximate mechanisms that underpin these behaviors. In contrast to the positive affect induced by ecstatic religious ritual, such as dance and chanting, the male rites described in our data evoke intense negative affective responses, including fear, pain, and awe. While both positive and negative affect rituals appear to promote solidarity, the neuropsychological impacts of these different ritual forms offer some insight as to why male initiation, puberty, and other rites are emotionally startling rather than pleasing (Alcorta, 2006; Alcorta & Sosis, 2005). Increased activation of the amygdala through fear, pain, and alterations in body state, can result in the conditioned association of arbitrary stimuli with heightened emotional significance (Damasio, 1994). Through frightening and painful rites, religious symbols can acquire deep emotional significance that subsequently unites individuals who shared the experience. The emotional impact of these rites, many of which occur during critical developmental stages, has profound long-term effects on memory and is motivationally powerful (Alcorta & Sosis, 2005; McCauley & Lawson, 2002; Whitehouse, 2000). The superior ability of traumatic rituals to create enduring emotional bonds, in comparison to positive-affect rituals, may explain why traumatic rituals are associated with warfare, which even when frequent is unpredictable and can occur many years after the ritual experience. Our results suggest that these rituals generate solidarity between men and serve as reliable indicators of group commitment, thus reducing the likelihood that men will defect when there is war.

7. Conclusion

This study is a modest step toward understanding cross-cultural variance in the costs of male ritual behavior. We have made little effort to understand the psychology underlying these behaviors, but this will need to be addressed in future research. Future work must also extend these analyses to female ritual behavior, which we suspect often signals commitments to mates rather than to the larger group (e.g., Knight, Power, & Watts, 1995; Strassmann, 1996). In addition, evolutionary research on religion must

further examine how individuals weigh various ritual costs across currencies, a problem that has also arisen in other tests of the costly signaling theory of ritual (e.g., Sosis & Bressler, 2003). Estimating fitness costs of ritual activities is challenging for both researchers and ritual participants. It is unclear how individuals determine, for example, how much costlier a ritual back scar is than a week of isolation or a day of fasting. Here we used judgments of graduate students who had not performed the rituals they were asked to rate, but ideally we need to evaluate how ritual performers and nonperformers differ in their judgments about ritual costs, which will offer insights into the proximate psychology of ritual behavior.

Religious behavior has often been cited as a cause of warfare; here we have explored the converse, that warfare can be a cause of extreme religious behavior. We recommend caution in applying our results to understand current geopolitical trends and the complex relationship between religious fundamentalism and warfare. We do believe that signaling theory can provide insights into the rise of religious fundamentalism (Sosis, 2003) and its association with warfare, terrorism, and militia movements, but we are not claiming that warfare is a determinant of contemporary fundamentalism. We would argue, however, that the cooperation and intra-group trust achieved through costly ritual behavior enhances the ability of religious groups to organize for acts of terror and war (Atran, 2002; Johnson, in press; Sosis & Alcorta, in press). This is a vital area of research that is ripe for evolutionary investigation.

Acknowledgments

We thank Candace Alcorta, Rebecca Bliege Bird, Joseph Bulbulia, Aldo Cimino, Dominic Johnson, Frank Marlowe, Eric Alden Smith, and two anonymous reviewers for very helpful comments on earlier drafts of this manuscript. We also thank the following students for their invaluable help on this project: Erin Anderson, Leon BenRimon, Casey Callahan, Jackie Chan, Erica Colls, Israel Cordero, Susie Divietro, Joseph Filush, Rebecca Floor, Amanda Garibaldi, Heather Law, Miriam Lee, Anna Liamzon, Sarah Mallory, Colleen Morris, Jaclyn Nadeau, Vanessa Nielan, Christopher Nyberg, Reshma Oka, James Seeth, John Shaver, and Asha Shipman.

References

- Alcorta, C. (2006). Religion and the life course. In P. McNamara (Ed.), *Where God and man meet: The neurology of religious experience* (pp. 55–79). Westport, CT: Praeger.
- Alcorta, C., & Sosis, R. (2005). Religion, emotion, and symbolic ritual: The evolution of an adaptive complex. *Human Nature, 16*, 323–359.
- Alexander, R. (1987). *The biology of moral systems*. Hawthorne, NY: Aldine de Gruyter.
- Alvard, M., & Nolin, D. (2002). Rousseau's whale hunt? Coordination among big-game hunters. *Current Anthropology, 12*, 136–149.
- Atran, S. (2002). *In Gods we trust: The evolutionary landscape of religion*. Oxford: Oxford University Press.

- Bliege Bird, R., & Smith, E. (2005). Signaling theory, strategic interaction, and symbolic capital. *Current Anthropology*, 46, 221–248.
- Bliege Bird, R., Smith, E., & Bird, D. (2001). The hunting handicap: Costly signaling in human foraging strategies. *Behavioral Ecology and Sociobiology*, 50, 9–19.
- Bulbulia, J. (2004a). Religious costs as adaptations that signal altruistic intention. *Evolution and Cognition*, 10, 19–38.
- Bulbulia, J. (2004b). Area review: The cognitive and evolutionary psychology of religion. *Biology and Philosophy*, 18, 655–686.
- Bulbulia, J. (in press). Free love: Religious solidarity on the cheap. In J. Bulbulia, et al. (Eds.), *The evolution of religion: Studies, theories, and critiques*. Collins Family Foundation.
- Chagnon, N. (1988). Life histories, blood revenge, and warfare in a tribal population. *Science*, 239, 985–992.
- Chagnon, N. (1997). *Yanomamo*. Fortworth, TX: Harcourt Brace College Publishers.
- Chick, G., & Loy, J. (2001). Making men of them: Male socialization for warfare and combative sports. *World Cultures*, 12, 2–17.
- Chick, G., Loy, J., & Miracle, A. (1997). Combative sport and warfare: A reappraisal of the spillover and catharsis hypotheses. *Cross-Cultural Research*, 31, 249–276.
- Crocker, W., & Crocker, J. (1994). *The Canela: Bonding through kinship, ritual, and sex*. New York: Harcourt Brace.
- Cronk, L. (1994). Evolutionary theories of morality and the manipulative use of signals. *Zygon: Journal of Religion and Science*, 29, 81–101.
- Damasio, A. R. (1994). *Descartes' error: Emotion, reason, and the human brain*. New York: Avon Books.
- Durkheim, E. (1995 [1912]). *The elementary forms of religious life*. New York: Free Press.
- Ember, C. R., & Ember, M. (1992). Resource unpredictability, mistrust, and war. *Journal of Conflict Research*, 36, 242–262.
- Ember, C. R., & Ember, M. (1994). War, socialization, and interpersonal violence. *Journal of Conflict Research*, 38, 620–646.
- Ember, C. R., & Ember, M. (1998). Cross-cultural research. In H. R. Bernard (Ed.), *Handbook of methods in cultural anthropology* (pp. 647–687). Walnut Creek, CA: AltaMira.
- Ember, M., & Ember, C. R. (1971). The conditions favoring matrilineal versus patrilineal residence. *American Anthropologist*, 73, 571–594.
- Ferguson, R. (2001). Materialist, cultural and biological theories on why Yanomami make war. *Anthropological Theory*, 1, 99–116.
- Gaulin, S. J. C., & Boster, J. S. (1990). Dowry as female competition. *American Anthropologist*, 92, 994–1005.
- Gilmore, D. (1990). *Manhood in the making*. New Haven, CT: Yale University Press.
- Gray, J. P. (1999). A corrected ethnographic atlas. *World Cultures*, 10, 24–136.
- Curven, M. (2004). To give and to give not: The behavioral ecology of human food transfers. *Behavioral and Brain Sciences*, 27, 243–283.
- Hamilton, W. D., & Zuk, M. (1982). Heritable true fitness and bright birds: A role for parasites. *Science*, 218, 384–387.
- Harner, M. (1972). *The Jivaro: People of the sacred waterfalls*. Garden City, NY: Natural History Press.
- Iannaccone, L. (1992). Sacrifice and stigma: Reducing free-riding in cults, communes, and other collectives. *Journal of Political Economy*, 100, 271–291.
- Irons, W. (1979). Cultural and biological success. In N. Chagnon & W. Irons (Eds.), *Evolutionary biology and human social behavior: An anthropological perspective* (pp. 257–272). North Scituate, MA: Duxbury.
- Irons, W. (1996). Morality, religion, and evolution. In W. M. Richardson & W. Wildman (Eds.), *Religion and science: History, method, and dialogue* (pp. 375–399). New York: Routledge.
- Irons, W. (2001). Religion as a hard-to-fake sign of commitment. In R. Nesse (Ed.), *Evolution and the capacity for commitment* (pp. 292–309). New York: Russell Sage Foundation.
- Irons, W. (2004). An evolutionary critique of the created co-creator concept. *Zygon: Journal of Religion and Science*, 39, 773–790.
- Johnson, D. (in press). Gods of war: The adaptive logic of religious conflict. In J. Bulbulia, et al. (Eds.), *The evolution of religion: Studies, theories, and critiques*. Collins Family Foundation.
- Johnstone, R., & Norris, K. (1993). Badges of status and the cost of aggression. *Behavioral Ecology and Sociobiology*, 32, 127–134.
- Keeley, L. (1996). *War before civilization: The myth of the peaceful savage*. Oxford: Oxford University Press.
- Knight, C., Power, C., & Watts, I. (1995). The human symbolic revolution: A Darwinian account. *Cambridge Archaeological Journal*, 5, 75–114.
- Low, B. S. (1979). Sexual selection and human ornamentation. In N. A. Chagnon & W. Irons (Eds.), *Evolutionary biology and human social behavior* (pp. 462–487). Boston: Duxbury Press.
- Ludvico, L. R., & Kurland, J. A. (1995). Symbolic or not-so-symbolic wounds: The behavioral ecology of human scarification. *Ethology and Sociobiology*, 16, 155–172.
- MacNeill, A. (2004). The capacity for religious experience is an evolutionary adaptation to warfare. *Evolution and Cognition*, 10, 43–60.
- Maynard Smith, J., & Harper, D. (2003). *Animal signals*. Oxford: Oxford University Press.
- McCauley, R., & Lawson, E. T. (2002). *Bringing ritual to mind: Psychological foundations of cultural forms*. Cambridge: Cambridge University Press.
- Olson, M. (1965). *The logic of collective action: Public goods and the theory of groups*. Cambridge: Harvard University Press.
- Otterbein, K. (1968). Internal war: A cross-cultural study. *American Anthropologist*, 70, 277–289.
- Otterbein, K. (1994). *Feuding and warfare: Selected works of Keith F. Otterbein*. New York: Gordon and Breach.
- Paige, K. E., & Paige, J. M. (1981). *The politics of reproductive ritual*. Berkeley: University of California Press.
- Pinker, S. (1997). *How the mind works*. New York: W.W. Norton and Company.
- Poggie, J. (1995). Food resource periodicity and cooperation values: A cross-cultural consideration. *Cross-Cultural Research*, 29, 276–296.
- Rappaport, R. (1999). *Ritual and religion in the making of humanity*. Cambridge: Cambridge University Press.
- Ruffle, B., & Sosis, R. (2007). Does it pay to pray? Costly ritual and cooperation. *The BE Journal of Economic Analysis and Policy*, 7, 1–35.
- Schlegel, A., & Barry, H. (1980). The evolutionary significance of adolescent initiation ceremonies. *American Ethnologist*, 7, 696–715.
- Singh, D., & Bronstad, P. M. (1997). The anatomical locations of human body scarification and tattooing as a function of pathogen prevalence. *Evolution and Human Behavior*, 18, 403–416.
- Smith, E., Bliege Bird, R., & Bird, D. (2003). The benefits of costly signaling: Meriam turtle hunters. *Behavioral Ecology*, 14, 116–126.
- Sosis, R. (2000a). Religion and intra-group cooperation: Preliminary results of a comparative analysis of utopian communities. *Cross-Cultural Research*, 34, 70–87.
- Sosis, R. (2000b). The emergence and stability of cooperative fishing on Ifaluk Atoll. In L. Cronk, N. Chagnon, & W. Irons (Eds.), *Human behavior and adaptation: An anthropological perspective* (pp. 237–272). Chicago: Aldine de Gruyter.
- Sosis, R. (2003). Why aren't we all Hutterites? Costly signaling theory and religious behavior. *Human Nature*, 14, 91–127.
- Sosis, R. (2004). The adaptive value of religious ritual. *American Scientist*, 92, 166–172.
- Sosis, R. (2005). Does religion promote trust? The role of signaling, reputation, and punishment. *Interdisciplinary Journal of Research on Religion*, 1, 1–30.
- Sosis, R. (2006). Religious behaviors, badges, and bans: Signaling theory and the evolution of religion. In P. McNamara (Ed.), *Where God and man meet: Evolution, genes, and the religious brain* (pp. 61–86). Westport, CT: Praeger Publishers.

- Sosis, R., & Alcorta, C. (2003). Signaling, solidarity, and the sacred: The evolution of religious behavior. *Evolutionary Anthropology*, 12, 264–274.
- Sosis, R., & Alcorta, C. (in press). Militants and martyrs: Evolutionary perspectives on religion and terrorism. In R. Sagarin & T. Taylor (Eds.), *Natural security: A Darwinian approach to a dangerous world*. University of California Press.
- Sosis, R., & Bressler, E. (2003). Cooperation and commune longevity: A test of the costly signaling theory of religion. *Cross-Cultural Research*, 37, 211–239.
- Sosis, R., & Ruffle, B. (2003). Religious ritual and cooperation: Testing for a relationship on Israeli religious and secular kibbutzim. *Current Anthropology*, 44, 713–722.
- Sosis, R., & Ruffle, B. (2004). Ideology, religion, and the evolution of cooperation: Field experiments on Israeli kibbutzim. *Research in Economic Anthropology*, 23, 89–117.
- Strassmann, B. (1996). Menstrual hut visits by Dogon women: A hormonal test distinguishes deceit from honest signaling. *Behavioral Ecology*, 7, 304–315.
- Thorpe, I. (2003). Anthropology, archaeology, and the origin of warfare. *World Archaeology*, 35, 145–165.
- Whitehouse, H. (2000). *Arguments and icons*. Oxford: Oxford University Press.
- Whiting, J., Kluckholm, R., & Anthony, A. (1958). The function of male initiation ceremonies at puberty. In E. Maccoby, T. Newcomb, & E. Hartley (Eds.), *Readings in social psychology* (pp. 359–370). New York: Holt, Rinehart, and Winston.
- Wrangham, R., & Peterson, D. (1996). *Demonic males: Apes and the origins of human violence*. New York: Houghton Mifflin Co.
- Young, F. (1965). *Initiation ceremonies*. New York: Bobbs-Merrill.
- Zahavi, A. (1975). Mate selection: A selection for a handicap. *Journal of Theoretical Biology*, 53, 205–214.