

Abstract

Self-sacrifice can be modeled as a costly social signal carried to the ultimate extreme. Such signaling may be evolutionarily stable if social status is, in part, inherited.

Self-sacrifice remains an evolutionary puzzle in a species like ours in which individuals live in large groups composed of unrelated or loosely related individuals. Whitehouse considers various evolutionary accounts to explain voluntary self-sacrifice: kin selection, multilevel selection, and – through various references – gene-culture co-evolution. All of these accounts pose difficulties, many of them being mentioned by the author. He does not, however, mention an important alternative, social signaling, or mentions it only in passing when discussing costly rituals.

Social signaling (Dessalles 2014; Gintis et al. 2001) is a special case of the theory of costly signaling introduced by Zahavi (1975) and Grafen (1990). By definition, the purpose of social signals is to attract friends. Costly social signals are evolutionarily stable if they are correlated with some definite qualities that increase the fitness of friends (Dessalles 2014). For example, if having friends that are courageous or generous increases one's fitness, then courageous or generous individuals are socially in demand. As a consequence, displaying costly signals correlated with courage or generosity becomes a valid strategy to attract friends.

Social signaling provides robust explanations for a variety of pro-social behaviors, such as competitive helping and overt food sharing (Bliege Bird & Smith 2005). More generally, altruistic acts toward non-kin can be favored by natural selection if they are used to advertise some quality that may be valuable to the signaler's actual or potential friends. The real targets of an altruistic act are its witnesses, who are not necessarily the recipients.

Competition for signaling can lead to extreme costs. This is consistent only if costs (e.g., death probability in risk-seeking behavior to prove one's bravery) are compensated by even greater potential benefits. Social signaling offers such high-benefit situations. The best signalers get high social status, as the emerging result of the will of many to become their friends. Achieving higher social status is known to provide a variety of material and reproductive advantages.

The underlying motivation of men to undertake the somatically risky behaviors associated with warfare is not some form of group altruism; rather, it is a form of enlightened self-interest in which the benefits are measured in terms of personal status, which on average has

led to reproductive advantage in the environments of our evolutionary past. (Patton 1996, p. 7)

Social signaling offers an elegant explanation of extreme bravery (and, correlatively, of cowardice avoidance), as far as it is advantageous to be friends with such a person (rather than with a coward). Similarly, being acquainted with someone who is committed to the group is expected to be desirable in situations of intergroup conflict. The explanation does not hold for self-sacrifice, however, because performers do not survive to enjoy the advantages of having earned high status. An additional hypothesis is needed. The missing element may be that social network and social status are highly heritable in our species. The high status of an individual "raises the status of every member of his family above ordinary families" (Service 1971, p. 140). Such an advantage may be sufficient to make martyrdom an evolutionarily stable strategy as long as it remains a low-frequency behavior (the fewer the heroes, the higher is their status). Martyr candidates do not need to consider, or even be aware of, the positive material consequences for their family (Ginges & Atran 2009), as long as they are sensitive to the future glory of their name.

One aspect of this account is left unexplained. Why would it be profitable to become acquainted with a hero's brother or daughter? Having courageous friends makes sense for protective reasons, but courage is not supposed to be heritable. Why do heroes' family members become socially desirable? One answer is that social status spreads through the social network: Being close to high-status individuals automatically increases one's own status. This would be true for the heroes' kin, for their friends, and for their kin's friends.

Another hypothesis may provide a further reason why heroic acts are especially likely to benefit heroes' families. Honoring heroes and heroes' families appears to be a second-order social signal, that is, a signal about a signal. Those who pay tribute through conspicuous ceremonies to heroic acts and heroes' names signal that they are patriots themselves. The first-hand signal, performing heroic acts, and the second-hand signal, paying tribute to heroes, reinforce each other. On the one hand, self-sacrifice becomes an evolutionarily profitable strategy if many individuals find a social interest in honoring the hero's memory and name, because it benefits the hero's kin. On the other hand, the crowd needs to honor heroes' names to signal their own commitment to the group. This mutual reinforcement system is expected to emerge in situations such as intergroup conflict, in which it is crucial that one's friends be committed to the group and cannot be suspected of any sympathy for the opposite camp.

Analyzing costly behavior, such as heroic acts and even self-sacrifice as social signals, sheds an entirely new light on their biological motivation, which should not be confused with their displayed motivation (increased collective benefit). Both extreme heroic acts and their conspicuous celebration become parts of the same logic, which is to advertise one's commit-

ment to the group in situations of intergroup conflict.

References

Bliege Bird, R. & Smith, E. A. (2005) Signaling theory, strategic interaction, and symbolic capital. *Current Anthropology* **46**(2):221–48. CrossRef (<http://dx.doi.org/10.1086/427115>) | Google Scholar (https://scholar.google.com/scholar_lookup?title=Signaling+theory+strategic+interaction+and+symbolic+capital&publication+year=2005&author=Bliege+Bird+R.&author=Smith+E.+A.&journal=Current+Anthropology&volume=46&doi=10.1086/427115)

Dessalles, J.-L. (2014) Optimal investment in social signals. *Evolution* **68**(6):1640–50. Available at: http://www.dessalles.fr/papers/Dessalles_13011901.pdf (http://www.dessalles.fr/papers/Dessalles_13011901.pdf). CrossRef (<http://dx.doi.org/10.1111/evo.12378>) | Google Scholar (https://scholar.google.com/scholar_lookup?title=Optimal+investment+in+social+signals&publication+year=2014&author=Dessalles+J.-L.&journal=Evolution&volume=68&doi=10.1111/evo.12378) | PubMed (<https://www.ncbi.nlm.nih.gov/pubmed/24495174>)

Ginges, J. & Atran, S. (2009) What motivates participation in violent political action. *Annals of the New York Academy of Sciences* **1167**(1):115–23. Available at: https://halshs.archives-ouvertes.fr/docs/00/50/51/90/PDF/Ginges_Atran2009b.pdf (https://halshs.archives-ouvertes.fr/docs/00/50/51/90/PDF/Ginges_Atran2009b.pdf). CrossRef (<http://dx.doi.org/10.1111/j.1749-6632.2009.04543.x>) | Google Scholar (https://scholar.google.com/scholar_lookup?title=What+motivates+participation+in+violent+political+action&publication+year=2009&author=Ginges+J.&author=Atran+S.&journal=Annals+of+the+New+York+Academy+of+Sciences&volume=1167&doi=10.1111/j.1749-6632.2009.04543.x) | PubMed (<https://www.ncbi.nlm.nih.gov/pubmed/19580558>)

Gintis, H., Smith, E. A. & Bowles, S. (2001) Costly signaling and cooperation. *Journal of Theoretical Biology* **213**:103–19. Available at: <http://faculty.washington.edu/easmith/JTB2001.pdf> (<https://faculty.washington.edu/easmith/JTB2001.pdf>). CrossRef (<http://dx.doi.org/10.1006/jtbi.2001.2406>) | Google Scholar (https://scholar.google.com/scholar_lookup?title=Costly+signaling+and+cooperation&publication+year=2001&author=Gintis+H.&author=Smith+E.+A.&author=Bowles+S.&journal=Journal+of+Theoretical+Biology&volume=213&doi=10.1006/jtbi.2001.2406) | PubMed (<https://www.ncbi.nlm.nih.gov/pubmed/11708857>)

Grafen, A. (1990) Biological signals as handicaps. *Journal of Theoretical Biology* **144**:517–46. Available at: <http://users.ox.ac.uk/~grafen/cv/hcapsig.pdf> (<http://users.ox.ac.uk/~grafen/cv/hcapsig.pdf>). CrossRef ([http://dx.doi.org/10.1016/S0022-5193\(05\)80088-8](http://dx.doi.org/10.1016/S0022-5193(05)80088-8)) |

Google Scholar ([https://scholar.google.com/scholar_lookup?title=Biological+signals+as+handicaps&publication+year=1990&author=Grafen+A.&journal=Journal+of+Theoretical+Biology&volume=144&doi=10.1016/S0022-5193\(05\)80088-8](https://scholar.google.com/scholar_lookup?title=Biological+signals+as+handicaps&publication+year=1990&author=Grafen+A.&journal=Journal+of+Theoretical+Biology&volume=144&doi=10.1016/S0022-5193(05)80088-8))
| PubMed (<https://www.ncbi.nlm.nih.gov/pubmed/2402153>)

Patton, J. Q. (1996) Thoughtful warriors: Status, warriorship, and alliance in the Ecuadorian Amazon. Doctoral dissertation, University of California, Santa Barbara.
Google Scholar ([https://scholar.google.com/scholar?q=Patton+J.+Q.+ \(1996\)+Thoughtful+warriors:+Status+warriorship+and+alliance+in+the+Ecuadorian+Amazon.+Doct](https://scholar.google.com/scholar?q=Patton+J.+Q.+ (1996)+Thoughtful+warriors:+Status+warriorship+and+alliance+in+the+Ecuadorian+Amazon.+Doct))

Service, E. R. (1971/1962) *Primitive social organization: An evolutionary perspective*. Random House.
Google Scholar (https://scholar.google.com/scholar_lookup?title=Primitive+social+organization:+An+evolutionary+perspective&publication+year=1971&author=Service+E.+R.)

Zahavi, A. (1975) Mate selection - A selection for a handicap. *Journal of Theoretical Biology* **53**:205–14. CrossRef ([http://dx.doi.org/10.1016/0022-5193\(75\)90111-3](http://dx.doi.org/10.1016/0022-5193(75)90111-3)) |
Google Scholar ([https://scholar.google.com/scholar_lookup?title=Mate+selection+-+A+selection+for+a+handicap&publication+year=1975&author=Zahavi+A.&journal=Journal+of+Theoretical+Biology&volume=53&doi=10.1016/0022-5193\(75\)90111-3](https://scholar.google.com/scholar_lookup?title=Mate+selection+-+A+selection+for+a+handicap&publication+year=1975&author=Zahavi+A.&journal=Journal+of+Theoretical+Biology&volume=53&doi=10.1016/0022-5193(75)90111-3))
| PubMed (<https://www.ncbi.nlm.nih.gov/pubmed/1195756>)