

The Evolution of War and its Cognitive Foundations

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Abstract

Coalitional aggression evolved because it allowed participants in such coalitions to promote their fitness by gaining access to disputed reproduction enhancing resources that would otherwise be denied to them. Far fewer species manifest coalitional aggression than would be expected on the basis of the actual distribution of social conditions that would favor its evolution. The exploitation of such opportunities depends on the solution by individuals of highly complex and specialized information processing problems of cooperation and social exchange, and the difficulty of evolving cognitive mechanisms capable of solving such complex computational tasks may account for the phylogenetic rarity of such multi-individual coalitions. We propose that humans and a few other cognitively pre-adapted species have evolved specialized cognitive programs, that govern coalitional behavior, and constitute a distinctive coalitional psychology. An adaptive task analysis of what such algorithms need to accomplish, in the decisions regulating coalition formation, participation, cost and benefit allocation, allows the preliminary mapping of this coalitional psychology. Scrutinization of the adaptive features of coalitional aggression reveals some surprising characteristics, including that, under certain conditions, mortality rates do not negatively impact the fitness of males in the coalition, suggesting why warfare is so favored an activity, despite its risks to participating individuals' welfare.

Introduction

Despite the fact that many evolutionarily-oriented researchers, including Darwin, (e.g. Darwin 1871; Alexander and Tinkle 1968; Alexander 1971; 1979; Tooby and DeVore 1987; Wrangham 1987), have argued that war may have played a significant role in human evolution, detailed analyses of the dynamics of selection on coalitional aggression have unfortunately remained few (Wrangham 1985). Alexander and Tinkle (1968), followed by Durham (1976), provided the first extended attempts to synthesize modern evolutionary thinking with the phenomenon of war in humans. Both papers represented efforts to break with traditional approaches to war that have predominated in the social sciences: that war is the result of cultural and social processes, divorced from any individual or biological "function", or expression of individual psychology. Despite these efforts, warfare and its attendant behaviors have not yet been fully assimilated into Neo-Darwinian evolutionary theory. The gap between group-level behavior and individual adaptation is broad, and difficult to close. More recently, Daly and Wilson (1982; 1988) and Chagnon (1988), in careful and illuminating work, have begun to close the gap by carefully building upward from individual behavior, with portrayals of group-level phenomena built up out of analyses of individual violence-related choices and actions. These studies have also reintroduced a welcome and much needed empiricism into the discussion of these questions.

However, many aspects of how aggression functions adaptively within the context of contending coalitions remain unexplored, and even puzzling. For example, even the basic question of how coalitional aggression can be made fully consistent with the individual or genic level selectional thinking of modern evolutionary biology remains unresolved (see, e.g. Boyd and Richerson 1985). Moreover, war is dangerous and costly, and even where it is not mutually injurious or lethal to the participants, it is difficult to see why any sane organism, selected to survive and genetically propagate, should seek so actively to create conditions of such remarkable personal cost and danger. Yet studies of chimpanzees (Wrangham 1987; Goodall 1986; Nishida, T., Hiraiwa-Hasegawa, M. Hasegawa, T. & Takahata, Y. 1985), as well as of humans (Chagnon 1983, 1988; Otterbein 1970; Fried, Harris, & Murphy 1968; Durham 1976), indicate that with regularity, at least one coalition voluntarily chooses to initiate coalitional aggression, and even a cursory examination of human history reveals case after case where warfare is sought, prized, and glorified by at least some part of the local social group.

An evolutionary perspective leads one to expect that any behavior repeatedly manifested by a species is likely to have a significant adaptive basis, and it seems likely that most proponents of an evolutionary perspective would judge that the adaptive significance of coalitional aggression was similar to the adaptive significance of individual aggression: victors participating in larger and more successful coalitions gain differential access to scarce resources denied to members of the losing coalition, for themselves or for their kin. However, although analysis should certainly start from such a perspective, it cannot end there. War is not simply individual aggression writ large. Groups are not individuals, and the injection of the issue of multiple individuals into an analysis of the dynamics of selection acting on coalitional aggression reveals both unaddressed problems and significant adaptive differences from the case of individual aggression.

We propose that the distinctive and frequently surprising features of war stem from an underemphasized dimension: cooperation. Although a fight is an aggressive conflict between two individuals, and involves no cooperation, a war is an aggressive conflict between two *coalitions* of individuals, and would not be possible unless each coalition

were able to coalesce, function, and sustain itself as a group of cooperating individuals. We suggest that a detailed analysis of the evolutionary dynamics of cooperation in the context of coalitional aggression may explain:

- 1) adaptive obstacles in the evolution of coalitional aggression,
- 2) why war is so rare among animal species, and
- 3) why, nevertheless, it is so easy to generate conditions in which human males find initiating warfare so psychologically appealing.

*The evolution and natural history
of cooperation and coalitional aggression*

Recent theoretical and empirical advances in evolutionary biology and game theory (Axelrod 1984; Axelrod & Hamilton 1981; Trivers 1971; Maynard Smith 1982) have shown that, if cooperation (independent of kin selection) is to evolve and function stably, it must function in a particular and structured fashion:

- 1) Social or ecological conditions must create frequent and recurrent situations where there are enhanced payoffs to cooperation.
- 2) Cooperators must be able to identify when other participants are not reciprocally cooperating, and who these cheaters or defectors are.
- 3) Cooperators must be able to exclude cheaters (defectors) from taking the benefits of cooperation without having paid the costs, or failing that, they must be able to exclude cheaters from future cooperative interactions they could exploit.

These principles describe the narrow envelope of preconditions that allow cooperation to evolve among social organisms. Instances of such cooperation, while not common, occur with regularity among various animal species, including social primates.

Moreover, not only is there cooperation in such things as predator vigilance and foraging, but there is sometimes cooperation in aggressive competition as well (Packer 1977; Packer & Pusey 1982). *However, it is a major puzzle why animals do not cooperate in aggressive conflicts far more often than they do.* There frequently appear to be situations that would favor their doing so, but in which such cooperation is absent. Presumably, anywhere two or more males who are excluded from reproduction could physically cooperate to break another male's reproductive monopoly, selection would favor the formation of aggressive coalitions. For example, among elephant seals (Le Boeuf 1974) or Hanuman langurs (Hrdy 1977), single males are often able to defend and monopolize groups of females against large numbers of male competitors. It is not clear why excluded males who cannot singly best the resident male do not form aggressive coalitions, and through cooperation gain access to reproductive opportunities otherwise denied to them. This set of conditions seems widespread, and yet far fewer species manifest coalitional aggression than would be expected on the basis of the actual distribution of social conditions that would favor its evolution. (The special selection pressures on social insects requires that they be separately analyzed.)

When one restricts the focus to vertebrate species where *multi-individual* coalitions

of males aggressively compete, reports are rarer still, and only two species are known to exhibit warfare, defined in this fashion, as involving coalitions with more than four individuals: common chimpanzees (Nishida, T., Hiraiwa-Hasegawa, M. Hasegawa, T. & Takahata, Y. 1985; Goodall 1986), and humans. Recent findings suggest that pygmy chimpanzees (Kano, T. and Mulavwa, M. 1984) and dolphins (Wrangham, pers. comm.) may also belong in this group.

Cooperation depends on sophisticated cognition

The "observation" that many expected coalitions do not exist parallels Sherlock Holmes' observation of "the dog that did not bark": the absence of the phenomenon indicates an important and neglected aspect to the problem. The phylogenetic distribution of these species suggests an answer to why coalitional aggression is so rare: humans, common chimpanzees, pygmy chimpanzees, and dolphins are arguably the most cognitively sophisticated social animals known. With certain exceptions stemming from ecologically enforced anti-cheating causal webs (e.g., a cleaner fish you have eaten cannot subsequently clean you of ectoparasites), cooperation depends on the ability to detect, identify, and exclude cheaters. The exploitation of such opportunities depends on the solution by individuals of highly complex and specialized information processing problems of cooperation and social exchange (Cosmides 1985).

Moreover, cognitive mechanisms regulating reciprocation and social exchange cannot simply be either culturally "learned" or be the product of "general intelligence", but must be adaptively designed information processing systems (termed "Darwinian algorithms" [Cosmides 1985]) specialized for these functions (Cosmides 1985; Cosmides and Tooby 1987; Cosmides and Tooby 1988). Following the method adopted by Chomsky to show that operant conditioning could not explain language acquisition (Chomsky, 1957), it can be shown that so-called "general purpose" cognitive mechanisms cannot account for many kinds of cognitive performance, and a human being equipped solely with generalized cognitive abilities could not survive, and would not be produced by evolutionary processes in the first place (Cosmides 1985; Cosmides and Tooby 1987).

Moreover, recent empirical studies confirm that humans do indeed have Darwinian algorithms specialized for reasoning about social exchange (Cosmides 1985; Cosmides in press). Hunter-gatherer studies (Lee & DeVore 1968), paleontological evidence (Isaacs 1978), and behavioral ecological considerations (Tooby & DeVore 1987) all indicate that dyadic cooperation and reciprocity have been persistent features of hominid sociality for several million years. Through a series of experiments manipulating the materials subjects were asked to reason about, the existence of specialized Darwinian algorithms for reasoning about dyadic cooperation was verified, and their major outlines explored (Cosmides 1985; Cosmides, in press; see also Cosmides and Tooby 1988).

When the coalition includes more than two individuals, the cognitive problem becomes far more demanding. The tracking of the performance and the levels of participation of multiple individuals over time and through ambiguous situations on limited information, (not to mention orchestrating one's behavior so that it meshes simultaneously with that of several others), requires extremely sophisticated cognitive mechanisms. As will be discussed below, preliminary analysis indicates that cognitive programs designed to regulate adaptive behavior in coalitions must have additional specialized design features different from those required for engaging in dyadic social exchange (Tooby 1986; Tooby and Cosmides, in prep.).

It may be that the distribution of war in the animal kingdom is limited by the same

factor that limits the emergence of the multi-individual cooperation on which war depends: the cognitive prerequisites necessary to exclude cheaters from benefiting from joint action as much as, or more than, genuine cooperators. We suggest that, for example, elephant seals and langurs, despite the reproductive payoffs implicit in their ecological situations, did not have the cognitive preadaptations necessary for the emergence even of enduring dyadic coalitions, which, for example, baboons are capable of orchestrating (Packer 1977). It seems plausible that such cognitive or "evolutionary psychological" factors may help to explain the disappointing discrepancies between theory and observation in socioecology (Tooby 1986; Tooby and DeVore 1987).

Chimpanzees and humans appear to have the cognitive mechanisms it takes to observe, assess, and to regulate the appropriate pattern of response towards several different males structured into a coalition (see, e.g., de Waal 1982; Cosmides 1985). We propose that humans and a few other cognitively pre-adapted species have evolved specialized "Darwinian algorithms", cognitive programs, that govern coalitional behavior, and constitute a distinctive coalitional psychology (Tooby and Cosmides, in prep). Our belief is that innumerable instances of coalitional conflict in the Pleistocene among hunter-gatherer bands (living more densely than do modern relict populations of hunter-gatherers [see Alexander 1979]) selected for psychological mechanisms regulating thought, emotion, and behavior within and between coalitions, independently from any cultural process. We have inherited these psychological mechanisms, which are now functioning (or more commonly malfunctioning) in vastly changed contexts. The exploration of the selective pressures and consequent cognitive mechanisms that would have operated under conditions of primitive war allows the mapping of the psychological characteristics modern humans bring to situations of modern conflict. There are traces of Pleistocene "design" determining how humans think about, and how they feel about coalitions, intergroup competition, and war.

*The evolution of specialized cognitive mechanisms
to regulate coalition participation*

Cooperation in aggressive coalitions, if it is not to be selected out by evolutionary processes, must meet certain requirements, and this prerequisite structure can only be imposed by the psychological mechanisms of the participants. These psychological mechanisms are the direct product of evolution, and constitute the systematic foundation that generates the manifest behavior of coalition formation, maintenance, and war. For these reasons, to understand the cooperative basis of war, one must understand not only the evolutionary game theoretic structure of multi-individual cooperation, as it would have applied to tens of thousands of generations of our ancestors, but also the cognitive mechanisms that incarnated the solutions to these game-theoretic preconditions and hence made these aggressive coalitions function adaptively in the distant past. Examining the problem at both of these levels simultaneously is necessary for the coherent exploration of the cooperative side of war.

Evolutionary considerations indicate that for recurrent, evolutionarily important situations, the psyche will evolve specialized information processing procedures, Darwinian algorithms, which can handle these situations with special efficiency. These programs, or algorithms, should organize information into adaptively meaningful units, focus attention on adaptively important environmental circumstances, call up special inference networks, and so on, allowing the animal to solve such recurrent problems using procedural knowledge built up over thousands of generations.

An adaptive task analysis of what such Darwinian algorithms need to accomplish, in the decisions regulating coalition formation, participation, cost and benefit allocation,

allows the preliminary mapping of this coalitional psychology. Scrutinization of the adaptive features of coalitional aggression reveals some surprising characteristics, including that, under certain conditions, mortality rates do not negatively impact the fitness of males in the coalition, suggesting why warfare is so favored an activity, despite its risks to participating individuals' welfare.

Cooperation and the risk contract of war

Not only is the problem of multi-individual cooperation difficult for the animal to solve, it is also more difficult for the evolutionary biologist to solve. Although considerable progress has been made in modeling and conceptualizing two-individual cooperative interactions, the theory of multi-individual cooperation in the context of aggression remains largely undeveloped, not least because it has not been much addressed (Axelrod 1984). Therefore, one important step that needs to be taken is the augmentation and adaptation of the evolutionary theory of cooperation to the somewhat differing case of multi-individual coalitions, especially in the context of competition between two competing coalitions. The differences between dyadic cooperation and coalitional cooperation have significant implications for the study of war. Once the analysis of the features of multi-individual cooperation is done, then a more precise model can be made of exactly what cognitive programs must be present to regulate socially interdependent behavior among members of an aggressive coalition.

Certain features, however, are readily grasped. Cooperation in aggressive coalitions, if it is not to be selected out by evolutionary processes, must meet certain requirements, and this prerequisite structure can only be imposed by the psychological mechanisms of the participants. This psychologically imposed structure can be termed *the risk contract of war*, and its general features can be formally explored (Tooby 1986). Obvious features parallel two-person cooperation: cheaters or non-participants must be identified and excluded (or punished). More generally, the coalition is not stable unless the participants are rewarded or punished in proportion to the risks they have run, and in proportion to how important their contribution was to success. The elements that must be integrated into a model of coalitional aggression (and into psychological mechanisms regulating participation) include:

- o the risk and/or to each participant,
- o the relative value of the actions of each participant to achieving the common goal,
- o the probability of achieving success given a certain set of performances by the members of the coalition,
- o the aggregate value of achieving the common goal, and
- o how the aggregate benefits of victory are allocated to each participant.

Each coalition member has impact on the coalition 1) by regulating the level of his own direct participation in the joint action, and 2) by the actions he undertakes to enforce the risk contract on the other coalition members. These two dimensions of *regulating direct participation* and *enforcement* have important and sometimes surprising properties, which deserve independent exploration.

For example, the optimum level of direct participation is extremely sensitive to the probability of success, and the relationship between these variables may help explain why

males will engage so readily in warfare when they are confident of success. It can be shown that given 1) certainty of victory, 2) the assurance of a random distribution of risk of death among participants, 3) the assurance of a relatively "fair" allocation of the benefits of victory, and 4) efficiency in the utilization of reproductive resources on a zero-sum basis, *selection will favor participation in the coalitional aggression regardless of the existence or even the level of mortality (within broad limits).*

Within a polygynous system with certain formal properties (e.g. access to females being the limiting resource for male reproduction (Trivers 1972); male labor being comparatively unimportant to female reproduction, etc.), the deaths of some members of a coalition will not decrease the *average* reproduction of the members of the coalition, because the reproductive resources and opportunities within the coalition, or gained as the result of victory, will simply be reallocated among the survivors. So long as the members of the coalition do not lose reproductive resources, the level of deaths among the males will not influence the average success of the coalition members. Each individual who dies loses, but each survivor gains to the same extent, and provided the participants do not know *in advance* who will live and who will die, but rather that the risk is distributed randomly, and provided they are assured of success (as in, for example, a much larger group attacking a much smaller one), the collective decision of the coalition to go to war will benefit its members (in the currency of fitness). Natural selection weighs decisions on the basis of their *average* consequences to individuals, summed over evolutionary time; consequently, these factors explain why males can so easily be induced to go to war, despite its lethal effects on many of them. To put it starkly, if 1) males do not invest, and 2) if the model evolutionary world were divided into two only coalitions with no possible aggressive threats from elsewhere, then theoretically it would not matter if all but one of the winning coalition of males were killed, provided all of the losing coalition's males were killed. It would not even matter if such a "war" gained the winners no extra females.

This zero-sum nature of within coalition reproductive reallocation cushions successful coalitions from most of the negative fitness consequences that would seem to necessarily follow from the decision to initiate warfare. Because evolved psychological mechanisms will be shaped by the average result of a decision, the finding that average fitness is enhanced by the decision to embark on a successful war provides a powerful explanation for the existence of strong pro-war emotions (given the necessary conditions). Coalitions of males, when they assess the relevant variables indicating that they are larger or more formidable than any local competing coalitions, should appear to manifest an eagerness and satisfaction in initiating warfare and an obliviousness or insensitivity to the risk they run as individuals, in terms of their individual somatic welfare.

This approach also predicts the striking asymmetry that exists between males and females in coalitional aggression: females are rarely limited by access to males, so that the net reproduction of a coalition of females would drop in direct proportion to the number of females killed. In a curious fashion, males may be so ready to engage in coalitional aggression because it is reproductively "safer" for them to do so. Females have more to lose, and less to gain, and such differences in consequences should be reflected in psychological sex differences in attitudes towards coalition formation and coalition-based aggression.

However, it is important to bear in mind that this willingness to participate is directly dependent on the probability of success, and on the fact that the coalition members do not know which of them is going to suffer the costs of death or disability. In mirror image to the case of success, if failure is guaranteed, any risk or participation is a direct loss to the male. Moreover, (leaving aside kin selection), an important aspect of the risk contract is that risk be randomly distributed, so that if males find

themselves in situations where death is certain for them if they continue, there is no inducement that is sufficient to make continued participation worthwhile to them, in the currency of fitness. Many important aspects of warfare are derived from this: if one side can create circumstances where death seems certain to some part of the opposing coalition, panic and rout -- an expected psychological adaptation to this circumstance -- should result.

More globally, perception and belief in success play a crucial role in encouraging coalitions to initiate war. Exploring the psychological mechanisms for assessment of the probability of success, and what cues -- reliable in the Pleistocene -- are used in making such determinations, will prove important to understanding the behavior even in modern contexts. Mob and crowd behavior, civilian and military morale, eagerness or reluctance to go to war, and group panic can all be at least partly illuminated by this kind of analysis, and its accompanying empirical investigations. A social psychology that evolved in the Pleistocene to assess and predict on the basis of the behavior of dozens or, rarely, hundreds of individuals, might well derive "supernormal" confidence in a crowd of hundreds or thousands: in the Pleistocene, having so many on your side would have nearly always guaranteed invincibility. There is no evolutionary precedent for imagining or assessing the existence of thousands or millions of opponents, who cannot be directly perceived, and it seems likely that one of the mechanisms regulating the perception of the probability of success is direct observation of relative numbers. Public demonstrations by populations crowding the streets can create panic even among militarily well-entrenched rulers.

Approximations of the prerequisite conditions, while not always present, should have been frequently approached in the Pleistocene. In primate groups and hunter-gatherer bands, female reproductive capacity does not appear to "go unused" due to the mortality of males associated with those females, but rather is reallocated among the living local males. Secondly, while male labor and male investment appears likely to have been a factor in human evolution, the level of production of male hunter-gatherers appears to be similar enough to their level of consumption (Lee and DeVore 1968) that reasonable variation in ecological circumstances would have often made their contributions relatively unnecessary. In short, war is not simply a response to resource scarcity: when times are good, and male productivity irrelevant, war may be very advantageous.

The requirement that "victory be assured" or at least very likely is not as stringent as it may seem, either. While modern history is full of surprises, primitive war between small coalitions may be more predictably related to relative size. Barring very large differentials in individual aggressive formidability, assembling a significantly larger coalition will virtually guarantee victory. Such a consistent relationship between size and probability of victory leads to the "balance of power" races discussed by Alexander (1979) as being a prime mover in social evolution. Being a member of an identifiably small coalition -- a "minority" -- is a dangerous proposition: the persecution and expropriation of local "minorities" is a relatively safe fitness-enhancing activity. Correspondingly, the most significant costs of mortality to males may be the risk that a high incidence of mortality in your coalition (e.g. a Pyrrhic victory) may weaken the local coalition so that it becomes smaller and weaker than neighboring coalitions, and itself subject to victimization.

*Quis custodiet ipsos custodes? Guarding the guardians,
and the problem of enforcement.*

The second dimension of coalitional aggression involves the enforcement of the risk

contract. It is not sufficient for members simply to regulate the level of their own direct participation: for coalitions to stably evolve and function, the risk contract must be enforced by some or all of its members on any cheaters, defectors, or non-participants. Are others running their share of the risk and contributing their share to the joint effort? If not, at least some members of the coalition must exclude them from sharing in the benefits, or otherwise eliminate benefits that can be gained by "parasitizing" the system. In situations where numbers are a key to success, exclusion as a punishment has direct costs to the coalition. Instead, enforced inclusion, coupled with punishment or retaliation for non-participation, is an alternative strategy that would be favored in conditions of intense coalitional competition. Active recruitment, and enforcement of coalitional participation are repeated features of human social life: even under complex modern political situations, the persecution of pacifists and those who avoid conscription is widespread, and there are indications that much mob activity seems motivated by fear of non-participation as well as attraction to the coalitional goal.

Exploration of the specific adaptive design criteria for the psychological mechanisms involved in enforcement is beyond the scope of this paper. However, it bears pointing out that the problem of coalitional enforcement is itself a problem in cooperation: rewarding positive contributions or punishing defection itself requires effort, cost, and risk. The problem of multi-individual cooperation is recursive. Are others running their share of the risk and contributing their share to the joint effort of enforcing equal participation? Who bears the costs of enforcing the reciprocal distribution of the duties of enforcement? If some individuals are bearing the costs of enforcing coalitional participation, and others are garnering equal benefits without paying the costs, then enforcers will be selected against. The structure of the problem is similar to models of hypothetical group-selected reproductive restraint, in which the benefits of reproductive restraint are distributed throughout the group or local population, while the costs are born by the individual practicing restraint. While group selected reproductive restraint proved to be mythical, large coalitions are very much a part of human social life. Does this imply group selection? This problem with coalition maintenance is so severe, that Boyd and Richerson (1985) consider it a fundamental objection to the idea that coalitional behavior (involving more than a very small number of individuals) can evolve by natural selection at all. They prefer attributing such coalitional behavior to cultural processes or dual inheritance processes.

However, we feel that evolutionary processes creating specialized cognitive adaptations in the context of coalitional aggression can be straightforwardly explained using standard genic selection, without recourse to either group selection or gene-culture coevolution theories. However, given the major outlines are determined by the structure of "individual selection" (i.e. genic selection) operating in complex social groups, it is easy to see how cultural processes and/or group selection may magnify and/or slightly modify the process (see, for example, Durham 1976; Alexander 1979). Although a full analysis of the selective dynamics relevant to the problem of enforcement must be dealt with elsewhere (Tooby and Cosmides, in prep.), there are several families of possible solutions to the question of how enforcement can evolve (Tooby 1986), of which the most straightforward are:

- 1) In the real world of Pleistocene hunter-gatherer bands, or even modern horizontal societies, the benefits of coalitional action are not inherently a "public good", shared equally, but vary depending on life history variables, kinship factors, and many other social variables. Some individuals will have far more of stake in successful coalitional action than will others, and their "cost of enforcement" will be offset by greater individual benefit. For example, individuals with many kin in the coalition will benefit far more from successful coalitional behavior, and should be disproportionately involved in enforcement. This is not simply a theoretical possibility: Chagnon's striking work

(Chagnon 1988) describes just this phenomenon: "the leader of the largest descent group is invariably the headman of the village", and "the leaders are the very individuals who decide whether killings are revenged" through coalitional action against members of the offending village. Similarly, more formidable individuals can enforce with less cost and personal risk than less formidable individuals.

2) The effect of incentive asymmetries towards solving the enforcement problem can be strongly magnified by the unique properties of contingent threat: unchallenged, it low cost and reusable. Certain individuals in the group will have a greater than average interest in certain coalitional behavior, and will have an incentive to enforce that behavior. If that enforcement is in the form of a threat, it need not be costly to the threatener provided no one "takes him up on it". If the threatener has a stronger interest in the coalitional action than threatened individuals have in avoiding cooperation, then it will not make sense to resist, and the enforcer costs himself nothing in making the threat. A person with one bullet in his gun can order around many unarmed people, and a strong asymmetric incentive parallels a one-bullet gun. Such an enforcer can do this indefinitely, never having to "fire the gun", provided that he does not order others to do things which are too objectionable. Again, Chagnon's work is illuminating: in his studies, no one attempts to coerce local village members into attacking other villages where they have close kin (Chagnon 1988). The cost of enforcement is prohibitive in such cases. One expects to see separate psychologies of offense and defense: differences between when the coalition is attacking, and when it is defending itself. For one thing, successful defense is more of a "public good", and insufficient participation in defense, as expected, does appear to be considered more reprehensible than insufficient enthusiasm for initiating a war.

3) Such effects can be still further magnified if the individuals or core group with the strongest incentive to enforce coalitional behavior directs his or their efforts not only at enforcement, but at involving other coalition members in the process of enforcement. The threat is made or pressure is exerted on selected individuals in order to induce them to go out and actively enforce coalitional norms. *By this process, those who direct the enforcement of coalitional behavior may effectively divorce their own self-interested management or regulation of enforcement from the actual costs of the enforcement: sergeants work harder than generals.* As modern political life shows, such "geometric" structures of coercion can be indefinitely extended, from generals and party chairmen on down to individuals in charge of neighborhood block surveillance. Getting someone else to do the dirty work seems quite widespread: a classmate doing fieldwork in Afghanistan was "induced" by the members of the group he was studying to go to evict, single-handedly, heavily armed trespassers and their livestock from a nearby pasture (Barfield, pers. comm.).

These and other potential solutions to the problem of enforcement, when combined with plausible assumptions about Pleistocene conditions, (at the group sizes and demographic factors likely to be involved), indicate that strong selection would have existed for the growth of an adaptively designed coalitional psychology, in a manner not requiring recourse to either group selection, cultural processes, or gene-culture coevolution.

*The importance of exploring the evolutionary dynamics
and cognitive foundations of coalitional aggression*

The political complexity of post-Neolithic state systems cannot be directly reduced to models based on interband conflict in the distant past, and in the modern world wars may occur that few if anyone wants, fueled by political systems based on coercion of the

unwilling. However, to understand these more complex manifestations, it is nevertheless necessary to explore the evolutionary and psychological basis of coalitional aggression which underlies the human history of warfare, and which still interpenetrates modern group, political, religious, and mob phenomena.

Although humans now nearly universally live in state systems, our minds were formed during tens or hundreds of thousands of generations in small, horizontally organized hunter-gatherer bands. The special psychological mechanisms to deal with coalitional aggression that evolved then are with us now, and influence modern human behavior in a wide variety of contexts. Phenomena that might be partially illuminated by the approach we have outlined include the appearance and distribution of pro-war attitudes, attitudes towards dissidents, draft evaders, and pacifists, the formation of attitudes among elite male organizations and coalitions, gang behavior, attitudes towards "cowardice", exclusivity and bandwagon effects with winning coalitions, mob behavior, psychological sex differences in male-female sociality, military and civilian morale preceding and during wartime, the political consequences of mass public demonstrations, the effects of real or falsely depicted external threats on public attitudes, the militarization of society as a means of stifling dissidents, and the distinctive ethos of warrior groups.

BIBLIOGRAPHY

- Alexander, R.D. 1971. The search for an evolutionary philosophy of Man. *Proceedings of the Royal Society of Victoria*. 84(1): 99-120.
- Alexander, R.D. and Tinkle, D.W. 1968. A comparative book review of *On Aggression* by Konrad Lorenz and *The Territorial Imperative* by Robert Ardery. *Bioscience*. 18: 245-248.
- Alexander, R.D. 1979. *Darwinism and Human Affairs*. Seattle: University of Washington Press.
- Axelrod, R. 1984. *The evolution of cooperation*. New York: Basic Books.
- Axelrod, R. & Hamilton, W.D. 1981. The evolution of cooperation. *Science*, 1981, 211, 1390-1396.
- Boyd, R. and Richerson, P.J. 1985. *Culture and the evolutionary process*. Chicago: University of Chicago Press.
- Chagnon, N. 1983. *Yanomamo. The fierce people*. (3rd edition). New York: Holt, Rinehart and Winston.
- Chagnon, N. 1988. Life histories, blood revenge, and warfare in a tribal population, *Science*. 239: 985-992.
- Chomsky, N. 1957. *Syntactic Structures*. The Hague: Mouton.
- Cosmides, L. 1985. *Deduction or Darwinian algorithms?: An explanation of the "elusive" content effect on the Wason selection task*. Doctoral dissertation, Harvard University.
- Cosmides, L. 1989. The logic of social exchange: Has natural selection shaped how humans reason? Studies with the Wason Selection Task. *Cognition*. 31: 187-276.

- Cosmides, L. & Tooby, J. 1987. From evolution to behavior: Evolutionary psychology as the missing link. In J. Dupre (Ed.), *The latest on the best: Essays on evolution and optimality*. Cambridge, MA: The MIT Press.
- Cosmides, L. & Tooby, J. 1988. Evolutionary psychology and the generation of culture, Part II. Case study: A computational theory of social exchange. *Ethology & Sociobiology*.
- Daly, M. & Wilson, M. 1982. Homicide and kinship. *American Anthropologist*, 84, 372-378.
- Daly, M. & Wilson, M. 1988 *Homicide*. Hawthorne, New York: Aldine de Gruyter.
- Darwin, C. 1871. *The Descent of Man and Selection in relation to sex*. Two vols. New York: Appleton.
- de Waal, F. 1982. *Chimpanzee politics: Power and sex among apes*. New York: Harper & Row.
- Durham, W. 1976. Resource competition and human aggression, part I: a review of primitive war. *Quarterly Review of Biology*, 51, 385-415.
- Fried, M., Harris, M., & Murphy, R. 1968. *War: The anthropology of armed conflict and aggression*. New York: Doubleday.
- Goodall, J. 1986. *The Chimpanzees of Gombe*. Cambridge: Harvard University Press.
- Hrdy, S.B. 1977. *The langurs of Abu: Female and male strategies of reproduction*. Cambridge, Massachusetts: Harvard University Press.
- Isaac, G.L. 1978. The food-sharing behavior of protohuman hominids. *Scientific American*, 238, 90-108.
- Kano, T. and Mulavwa, M. 1984. Feeding ecology of the pygmy chimpanzee (*Pan paniscus*) of Wamba. In R.L. Susman (Ed.) *The Pygmy Chimpanzee: Evolutionary Biology and Behavior*. pp. 223-234. New York: Plenum.
- Le Boeuf, B.J. 1974. Male-male competition and reproductive success in elephant seals. *American Zoologist*, 14, 163-176.
- Lee, R.D. & DeVore, I. 1968. *Man the hunter*. Chicago: Aldine.
- Marr, D. & Nishihara, H.K. 1978. Visual information processing: Artificial intelligence and the sensorium of sight. *Technology Review*, October, 28-49.
- Maynard Smith, J. 1982. *Evolution and the theory of games*. Cambridge, U.K.: Cambridge University Press.
- Nishida, T., Hiraiwa-Hasegawa, M. Hasegawa, T. & Takahata, Y. 1985. Group extinction and female transfer in wild chimpanzees in the Mahale National park. Tanzania. *Z. Tierpsychol.* 67: 284-301.
- Otterbein, K. 1970. *The evolution of war*. New Haven: HRAF Press.
- Owens, J., Bower, G.H., & Black, J.B. 1979. The "soup opera" effect in story recall. *Memory & Cognition*, 7, 185-191.

- Packer, C. 1977. Reciprocal altruism in *Papio anubis*. *Nature*, 265, 441-443.
- Packer, C. & Pusey, A.E. 1982. Cooperation and competition within coalitions of male lions: kin selection or game theory? *Nature*, 296, 740-742.
- Symons, D. 1987. If we're all Darwinians, what's the fuss about? In C. Crawford, M. Smith, and D. Krebs. (Eds.), *Sociobiology and psychology*. Hillsdale, N.J.: Erlbaum.
- Tooby, J. 1985. The emergence of evolutionary psychology. In D. Pines (ed.), *Emerging syntheses in science*. New Mexico: Santa Fe Institute.
- Tooby, J. and Cosmides, L. The cognitive foundations of war. In preparation.
- Tooby, J. & Cosmides, L. 1988. Evolutionary psychology and the generation of culture, Part I. Theoretical considerations. *Ethology & Sociobiology*.
- Tooby, J. & DeVore, I. 1987. The reconstruction of hominid behavioral evolution through strategic modeling. In W.G. Kinzey (ed.), *The evolution of human behavior: primate models*. New York: SUNY Press.
- Trivers, R.L. 1971. The evolution of reciprocal altruism. *Quarterly Review of Biology*, 46, 35-57.
- Trivers, R.L. 1972. Parental investment and sexual selection. In B. Campbell (ed.), *Sexual selection and the descent of man 1871-1971*. Chicago: Aldine.
- Wrangham, P.W. 1985. War in evolutionary perspective. In D. Pines (ed.), *Emerging syntheses in science*. New Mexico: Rio Grande Institute.
- Wrangham, P.W. 1987. The significance of African apes for reconstructing human social evolution. In W.G. Kinzey (ed.), *The evolution of human behavior: primate models*. New York: SUNY Press.