Culture

The Evolution of Dysfunction

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Article abstract

Cultural ecological theory has typically assumed that evolutionary processes lead inevitably to the emergence of positive functions and useful adaptations (Vayda, Harris, Durham, Barkow, Adams). But biologists are aware that dysfunctions, as well as positive functions, may result from evolution. In both biology and anthropology, dialectical models are better able to incorporate dysfunctional evolutionary trends. In this paper, a "thought experiment" illustrating dysfunctional evolutionary processes is provided. The strengths, and weaknesses, of using biological ideas as "creative analogies" for cultural processes are discussed. We need to pay more attention to the evolution of dysfunctions and to the emergence of contradictions in cultural systems.

The Evolution of Dysfunction

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Cultural ecological theory has typically assumed that evolutionary processes lead inevitably to the emergence of positive functions and useful adaptations (Vayda, Harris, Durham, Barkow, Adams). But biologists are aware that dysfunctions, as well as positive functions, may result from evolution. In both biology and anthropology, dialectical models are better able to incorporate dysfunctional evolutionary trends. In this paper, a "thought experiment" illustrating dysfunctional evolutionary processes is provided. The strengths, and weaknesses, of using biological ideas as "creative analogies" for cultural processes are discussed. We need to pay more attention to the evolution of dysfunctions and to the emergence of contradictions in cultural systems.

D'après la théorie écologique, il est automatiquement sous-entendu que le processus d'évolution conduit inévitablement à l'émergence de fonctions positives (Vayda, Harris, Durham, Barkow, Adams). Mais les biologistes savent fort bien que l'évolution ne crée pas seulement des fonctions positives — elle crée aussi des contradictions, des dysfonctionnements. En anthropologie comme en biologie, les modèles dialectiques se prêtent le mieux à l'intégration des tendances évolutionnistes dysfonctionnelles. Un exemple théorique est donné à l'appui de ce qui précède. Suit une discussion sur les avantages et les désavantages d'établir des parallèles souples entre les processus biologiques et les processus culturels. En conclusion, il est nécessaire d'étudier de plus près l'évolution des contradictions et des dysfonctionnements dans les systèmes culturels.

Introduction

A fundamental assumption of contemporary ecological anthropology, as it is derived from Julian Steward, is the assumption of "positive function". This is true both for ecological approaches which are primarily synchronic (e.g., Vayda and Rappaport, 1968), and for those which attempt to add a diachronic element to the ecological schema (e.g., Harris, 1968, 1977, 1979). In both cases the ecological outlook is based upon functionalist assumptions and is innocent of any idea of contradiction, dialectic, or the evolution of dysfunction. The intellectual history of the functionalist outlook in ecological anthropology leads back to Julian Steward:

[Steward], like most American anthropologists, was a functionalist... The general methodology in the newer ecologies has been functionalist, but the referrent of function is either to the biosphere seen as a system or to the population as an aggregate of human organisms... The deepest difference between Steward's work and that represented by the Marxian tradition... lies in the total absence of dialectical process in Steward's view of history. (Murphy, 1977: 19, 36)

The assumption of positive function is nearly universal in ecological anthropology and related theoretical outlooks. Thus, Vayda (1968: x) remarks, "The functional analyst looks for order, coherence,

equilibrium, and the like rather than for their opposites... we may assume that evolutionary selection is working continually to produce pattern and order and to reduce disorder." Harris (1975: 153) argues, "Viable systems may be regarded as consisting largely of positive-functioned traits, since the contrary assumption would lead us to expect the systems' failure." Durham (1976: 106) insists, "We must be suspicious of explanation in *any* terms proposing that cultural behaviors are dysfunctional for their individual practitioners." Barkow (1978: 13) goes still further, concluding that, "Human social institutions are and can only be patterned expressions of biologically-based learning preferences, predispositions, and motivations, characteristics which are there because they once, at least, maximized individual inclusive fitness." Adams (1981) quotes Lotka (1922: 148) with approval, and claims that this principle holds for cultural evolution:

In every instance considered, natural selection will so operate as to increase the total mass of the organic system, to increase the rate of circulation of matter through the system, and to increase the total energy flux through the system, so long as there is present an unutilized residue of matter and available energy.

The view of history as the emergence of positive functions is a very old line of thought in the Western tradition, of course, and the beneficial effects of selection have their parallel in the salubrious operation of Adam Smith's invisible hand (Gould, 1980a). Social Darwinism and the adaptationist or modern synthetic approach to biological evolution are so very similar to classical economic ideas, in fact, that one would expect that anthropologists would be the first to suspect ethnocentric bias. Instead, at least since the time of Steward, the idea that natural selection is continually at work in cultural systems to produce positive functions has dominated anthropological theory in the United States. As von Bertalanffy (1969: 66) has put it:

Society and science have been so steeped in the idea of mechanism, utilitarianism and the economic conception of free competition, that instead of God, Selection was enthroned as ultimate reality.

A very different approach to historical theory is provided by dialectical models. Dialectical models allow for the analysis of functions within a synchronic framework, but they also specify that historical development is *not* the simple appearance of ever more useful traits. The evolution of dysfunctions and contradictions becomes a key concept from the dialectical approach, for it is the evolution of dysfunction which often leads to system collapse or to drastic change. Dialectical analysis in social history is most

often associated with the Marxist position. Unfortunately, as was the case with Steward, more recent ecological theorists seem innocent of any influence from the dialectical tradition.

Although ecological theorists are usually not familiar with the Marxist literature, they are almost always open to theoretical arguments which employ a biological analogy. Of course, great care must be taken, for culture cannot be reduced to biology. Cultures are *symbolically*-based evolving systems; biological systems are *genetically*-based evolving systems. However, if we carefully avoid any reductionist line of thought, it may still be possible to generate some interesting hypotheses through a method of "creative analogy" (Diener, Nonini, and Robkin, 1980; Diener, 1980).

Dialectical models in biology, which assume the importance of nonadaptive components or dysfunctions generated through historical process have long been important in Europe and are growing in influence in the United States. Pattee (1972: 39) emphasizes that natural selection may result in stagnation, and hence evolutionary theory requires additional concepts which focus upon the transcendence of existing contradictions through macroevolutionary change. Weizenbaum (1976: 119) notes that "hacking" (microchange) can lead to instability in complex systems of all types, demanding macrochange if further advances are to be obtained. Felsenstein (1978) insists that selection models which appeal to positive functions cannot account for macroevolution. Gould and Eldredge (1977), Stanley (1975, 1978, 1979), Carson (1975), Lewontin and Levins (1978), and many others have recently proposed alternative approaches to biological evolution which require that historical process and the development of structural contradictions and dysfunctions be accorded a critical role. As Gould (1980b: 39-44) notes:

This history of evolutionary thought has been dominated by two major traditions... In one, the adaptationist program that has prevailed under the "modern synthetic" theory of evolution, constraints are imposed primarily by working solutions... In the second tradition, long popular in Europe... constraints of architecture prevent... designs of perfectly adequate function... the adaptationist program views all parts as existing "for" some function and as best designed to perform it... From the alternative position selection on one part of a structure may impose a set of correlated and nonadaptive modifications on other parts of an integrated body plan. Many features, even fundamental ones, may be nonadaptive...

In the recent past, anthropologists have approached such seemingly dysfunctional cultural phenomena as massive pig feasting and widespread

warfare in New Guinea (Rappaport, 1968), extreme aggression in Amazonia (Durham, 1976), ecologically destructive animal husbandry practices in India and the Near East (Harris, 1974, 1977), and even wholesale homicide in Mesoamerica (Harner, 1977), by asking, "What is the *hidden* function?" It is my contention that no assumption of hidden function is warranted; it is entirely possible that extant traits are the *dysfunctional* outcome of evolutionary process.

In a number of recent publications, my colleagues and I have marshalled evidence to indicate that specific cases are often better understood from a dialectical perspective which includes a concept of evolved dysfunction, than from a positive-function point of view (e.g., Diener, 1974; Diener, Nonini, and Robkin, 1978; Diener and Robkin, 1978; Diener, 1978; Diener and Avery, 1979; Diener, Moore and Mutaw, 1980; Diener, In Press a, b). However, even when the adaptationist program is rejected in a particular study, the propensity to think in terms of positive functions remains difficult to replace so long as no alternative theoretical outlook is available. As Gould (1980b: 41) notes:

Given the inventiveness of the human mind and a preference for adaptive stories, the failure of one specific proposal merely calls forth a substitute in the same mold. And the failure of all proposals usually elicits the response that there is as yet not enough known about the functional morphology or behavior of a specified organism to say why this particular structure is right for it.

My colleagues and I have attempted to contribute to the construction of a dialectical theory for cultural anthropology (Diener, Nonini, and Robkin, 1980; Diener, 1980a, b). In this paper,[1] I wish to build upon this theoretical effort by offering a "thought experiment" to show how it is possible for behaviors which are ecologically dysfunctional to evolve and replace more advantageous behaviors.

The evolution of dysfunction: a theoretical example

Assume an organism in a geographically limited range, e.g., an island. The organism relies upon a mobile insect prey as its only food resource and, to enable us to disregard hunting skill in our analysis, assume that the prey is randomly distributed and that all prey encountered by the predator are successfully captured. This makes a random walk as successful as any other hunting strategy.

The predator in our example spends most of its time hunting for prey, and this activity dominates its time and energy budget. The ability to survive and reproduce is thus heavily dependent upon success in the hunt, which itself is dependent upon both finding prey and utilizing them efficiently.

Predators hunt individually, and prey are always encountered singly. Some prey encounters involve two predators who chance upon the same prey victim at the same time; when this happens, the prey is equally and peacefully divided. We assume that this cooperative feeding is genetically controlled.

The genetic control of social behavior is typically complex. However, for the purposes of this example, we will simplify the situation by assuming that cooperative feeding is controlled by a single "cooperative" gene. Yet our argument is not dependent upon this simplifying assumption for its validity; if it is granted that feeding behavior is at least under some degree of genetic control, and that selection favors efficient individual feeding, then a much more complex discussion would yield the same results as will be presented here. But for clarity of exposition, we may assume a single "cooperative" gene governing feeding behavior in this "thought experiment".

Given the situation described, the size of the predator population will primarily be a function of the metabolic costs of maintenance, reproduction, and hunting activity, balanced against the metabolic income gained from success in the hunt. Predators will expand until they become numerous, at which time many prey encounters will be joint encounters by two predators, and the sharing of prey will decrease the overall metabolic income of individual predators. When the decrease in metabolic income reaches a point at which no surplus exists to allow further population growth, the predator population will stabilize and the proportion of prey encounters which are joint encounters will become a constant (population "stability" could take the form of "outbreak-crash" oscillations, etc., but ignore this complexity). The population as we first "observe" it is in this kind of equilibrium.

Now, introduce a point mutation at the locus which controls cooperative feeding behavior, and assume that the mutation makes available a new "competitive" allele. Previously benign behavior in the cooperative organism is replaced by aggressive behavior in the competitive organism. When a competitive organism happens into a joint prey encounter, it attacks the other member of its species, inflicting a serious wound to cooperative predators so encountered. The competitive predator then captures all the prey for itself in such encounters.

At first appearance, competitive predators would only encounter the more numerous cooperative predators in joint prey encounter situations, and, of course, cooperative predators would encounter both the competitive form and other cooperative predators as well. However, as the proportion of competitive

TABLE 1
Outcomes for joint prey encounters for hypothetical competitive and cooperative predators

		ANIMAL TWO	
		COMPETITIVE PREDATOR	COOPERATIVE PREDATOR
	COMPETITIVE PREDATOR	Both animals slightly injured, prey escapes.	Cooperative animal seriously injured, competitive animal captures prey.
ANIMAL ONE			
	COOPERATIVE PREDATOR	Cooperative animal seriously injured, competitive animal captures prey.	Prey equally divided.

predators grows in the population, they also begin to encounter one another in joint prey encounters. When two competitive predators come across the same prey at the same time, they attack one another, each suffering a minor wound while the prey escapes. The appearance of competitive predators due to a point mutation thus makes possible several types of joint prey encounters, each with its respective outcomes (Table 1).

The above, simplified example of intra-specific conflict is susceptible to game theoretical treatment. More complex game theoretical treatments of the evolution of animal conflict are available (Maynard Smith, 1974; Maynard Smith and Price, 1973). The situation is that of the Prisoner's Dilemma, a classic example showing how the search for individual advantage can lead to the evolution of dysfunctional behavior in terms of the interests of all the players involved in the game (Rapaport, 1967).

Game theoretical analysis requires that we supply a numerical Payoff for each of the outcomes of joint prey encounters presented in Table 1. A single numerical Payoff is assumed to reflect the food obtained as well as the cost of any injury sustained. We will assume that when two cooperative predators meet and share a prey, they each benefit to the value of + 1. When a competitive predator meets a cooperative predator, injuring the cooperative predator and capturing all of the prey for itself, then the competitive predator benefits to the value of + 2, while the cooperative predator suffers a serious injury of the value − 2. As competitive predators become more common, they will begin to encounter one another in

joint prey encounter situations. Here, the prey will escape while each competitive predator sustains a minor injury of − 1.

We will assume that in the search for prey the predators cannot avoid occasional joint prey encounters, and that they cannot tell if the other predator so encountered is a cooperative or a competitive form until the episode is under way. This enables us to avoid such complications as the evolution of avoidance behavior. The numerical values may be substituted in the matrix of Table 1 (Table 2).

Our original population of 100% cooperative predators was stable, and success in harvesting prey bore heavily upon reproductive success. Hence, an innovation which allows a predator to harvest prey more successfully will lead to the expansion of the innovative form in the population. We need not make specific assumptions regarding the rate of expansion; it is sufficient to note that animals more successful in feeding are also more successful in reproduction. It is at this point that we introduce our competitive mutation which enables aggressive animals to capture all of the prey in joint prey encounters.

In the population of totally cooperative predators, each predator had been gaining a Payoff of + 1 for each joint prey encounter in which it engaged, as well as an unspecified Payoff for each solitary encounter with prey. The competitive mutation does not change solitary prey encounters; they continue exactly as before and can be ignored here. At first appearance, the competitive form comes only upon cooperative predators in joint prey encounters, always wounding this more docile form and capturing all of

TABLE 2
Numerical Outcomes for joint prey encounters for hypothetical competitive and cooperative predators

		ANIMAL TWO	
		COMPETITIVE PREDATOR	COOPERATIVE PREDATOR
	COMPETITIVE PREDATOR	− 1 − 1	− 2 + 2
ANIMAL ONE			
	COOPERATIVE PREDATOR	+ 2 − 2	+ 1 + 1

the prey for itself. Hence, the mutated form immediately increases its Payoff in joint prey encounters from + 1 to + 2, and, since feeding success is closely related to breeding success, the competitive predator begins to spread in the population.

When competitive predators reach the point of comprising 10% of the population, both forms do slightly less well. Cooperative predators will now meet competitive predators in 10% of their joint prey encounters, sustaining an injury of − 2 each time; in the remaining 90% of their joint prey encounters they will continue to gain a Payoff of + 1, for an average Payoff in all joint prey encounters of + 0.7. Competitive predators also encounter cooperative predators in 90% of their joint prey encounters, capturing an entire prey for a reward of + 2. However, they also now encounter other competitive predators in 10% of these instances, suffering a minor injury while the prey escapes, for − 1. The overall Payoff for all joint prey enconters to competitive predators is thus + 1.7 at this point, much better than the mere + 0.7 registered by the cooperative predators. Because these food and injury Payoffs influence breeding success, the competitive predator will continue to expand in the population.

When competitive predators reach a level at which they make up 40% of all predators, the situation has importantly changed. Now, competitive predators meet other competitive predators in nearly half of their joint prey encounters, suffering many minor injuries and losing many prey. Of course, competitive predators continue to encounter cooperative predators in 60% of their joint prey encounters, gaining a Payoff of + 2. But injuries and prey losses are so costly to the competitive predators that, overall, the average Payoff from all joint prey encounters to them is only + 0.8, *a lower Payoff than the average Payoff in joint prey encounters to cooperative predators*

prior to the mutation which made competition possible.

However, cooperative predators do even worse when competitive predators make up 40% of the population. Meeting competitive predators 40% of the time for a Payoff of − 2, while meeting cooperative predators 60% of the time in joint prey encounters for a Payoff of + 1, yields them only an average Payoff of − 0.2 in such encounters. A situation which was formerly beneficial for them has become an overall liability. Because the cooperative predator continues to do less well than the competitive predator at this point, the competitive predator continues to expand in the population.

By the time the competitive predator has increased to become 70% of the population, joint prey encounters are an overall liability to *both* forms of predator. Encountering competitive predators 70% of the time for a Payoff of − 2, while gaining a Payoff of + 1 only 30% of the time, the cooperative predator must pay an average cost of − 1.1 for each joint prey encounter. The competitive predator does better. Meeting another competitive predator in 70% of joint prey encounters, while encountering the docile form only 30% of the time, the competitive predators now pay an overall cost of − 0.1 for each joint prey encounter. Yet, because the competitive predators continue to do better than the cooperative predators (or, more accurately, relatively less badly), they continue to expand in the population. In time, all cooperative predators will be replaced. When all predators are competitive, each joint prey encounter will result in conflict and injury, and all prey so encountered will escape. Differing Payoffs for joint prey encounters to each form of predator, under different population-mix conditions, are presented in Table 3 and Figure 1.

TABLE 3
Payoff values of average joint prey encounters for hypothetical competitive and cooperative predators at various proportions of predator population-mix

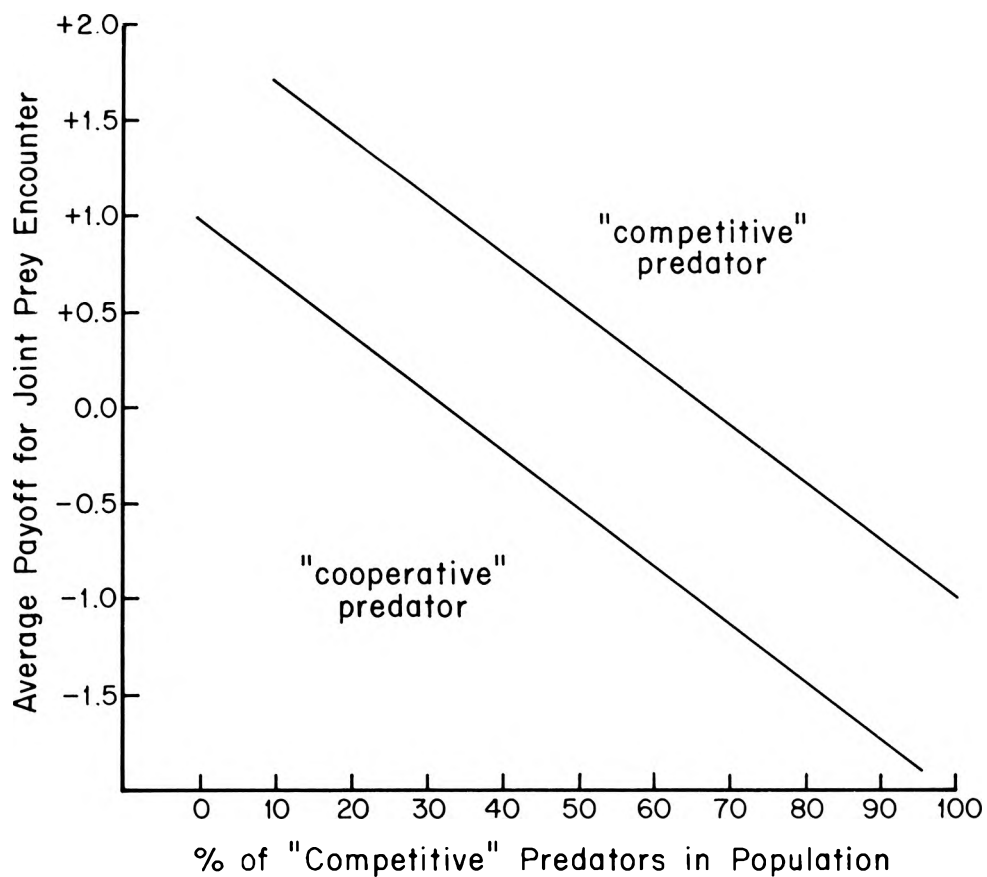| COOPERATIVE PREDATOR		COMPETITIVE PREDATOR	
% of Population	Payoff Value of Average Joint Prey Encounter	% of Population	Payoff Value of Average Joint Prey Encounter
100	+ 1.0	0	+ 2.0 (at appearance)
90	+ 0.7	10	+ 1.7
80	+ 0.4	20	+ 1.4
70	+ 0.1	30	+ 1.1
60	− 0.2	40	+ 0.8
50	− 0.5	50	+ 0.5
40	− 0.8	60	+ 0.2
30	− 1.1	70	− 0.1
20	− 1.4	80	− 0.4
10	− 1.7	90	− 0.7
0	—	100	− 1.0

Figure 1. Payoff values of average joint prey encounters for hypothetical competitive and cooperative predators as a function of predator population-mix.

The conclusion to be drawn from our highly simplified example is that, since microevolution in biological systems is driven by relative reproductive advantage at a given point in time, and since reproductive advantage need not be tied to either distant group benefits nor abstract ecological efficiency, it is entirely possible for evolution to lead to a *decrease* in the ecological efficiency of a population. The behavior which evolves in our example is truly dysfunctional, for it involves a constant source of injury and no prey is ever captured in joint prey encounters once the evolutionary stable strategy is reached. Once the competitive predator has fully replaced the cooperative predator, there is no way to return to the formerly more "adaptive" state. For even if a mutation for the cooperative form did appear, the cooperative animal would immediately encounter competitive predators in every joint prey encounter, always suffering serious injury and losing all prey. Hence, cooperation could not spread if reintroduced, even though we know that a commitment to cooperation rather than competition would eliminate all injury and make possible the capture of all prey. That is, *evolutionary* advantage may result for an organism even if it incurs a significant *ecological* disadvantage in the process; it is only necessary that an *even greater injury* be imposed simultaneouly upon a competitor:

> This may at first sight seem odd. Thus, if we were to imagine that the reward for victory, v, is the obtaining of an item of food, and that the cost of the contest is the food equivalent of the energy used in the contest, it might seem that an evolutionary stable population, that is, one employing an "evolutionary stable strategy", or ESS, which cannot be replaced by another strategy through mutation, would use up in fighting all the energy obtained from its food. Clearly no such population could survive. The absurdity arises because of a misinterpretation of the utility of v. The advantage that the winner of such a contest has over the loser is to be measured not by the energy in the food obtained, but by the energy *which the loser must expend* in finding a second similar item of food... The pay-off for winning is measured by the increased reproductive success... There is therefore nothing absurd about the conclusion... However, the ESS is not that which would be favored by group selection. (Smith, 1974: 215, emphasis mine)

Conclusion

Vayda argues that evolution is constantly at work to produce positive functions. Harris suggests that almost all traits are positive-functioned. Durham tells us that we must be wary of any attempt to introduce a concept of dysfunction. But the functional status of any trait is an empirical question; evolution may result in both positive functions and dysfunctions, and we

must reject any approach that finds *everything* functional (Hemple, 1959).

Because evolution often leads to dysfunctions or, in Bremmerman's (1973) colorful language, "evolutionary hangups", selection may result in system stagnation and collapse. In biological systems featuring much dysfunction, macroevolution via speciation may become the only avenue of change, and this is a very different process from natural selection under normal conditions (Stanley, 1979; Diener, 1980, for application to cultural theory). Of course, a system featuring much dysfunction may also simply become extinct, as indeed most biological systems have in the history of life. Only some "collapses" are "upward" (Allen, 1977, 1981).

Adams tells us that "in every instance" evolution by natural selection operates to "increase the total energy flux through the system". But in our example, energy flow *decreased* as a direct result of the evolutionary process. Of course, it would be possible to imagine a pattern of events in which this outcome could be avoided, e.g., by the evolution of avoidance behavior or stylized aggression. But such changes cannot be genetically called up just because they would be useful, and, indeed, such changes often appear linked to speciation events (Ford, n.d.). Further, other forms of dysfunction might also evolve. In short, biological systems are historical products and not perfect creations — and history allows dysfunctions.

Cultural systems are also evolutionary systems, although of a totally distinct class. The biological analogy can never be all of cultural anthropology, and it is often misused, but in this case biological analogy may serve a useful purpose. It it is possible for competition to result in the evolution of dysfunctional traits in the animal world, can we not admit that competition in the human social world also may result in dysfunctional behavior? Need unstinting violence in Amazonia, in ancient Mesoamerica, or in Central America today, be *necessarily* positive functioned? Or do we require theoretical models which demand that we analyze each case and condition and ask what is functional and what dysfunctional?

Biological systems are gene-based; cultural systems are symbol-based. While striking similarities exist between these two realms (Bender, 1976, n.d.), the differences are even more important. Symbolic coding and communication leads to a simultaneity and consciousness not present in genetic systems (Bronowski, 1965; Robinson, 1980). Further, from the very richness of symbolic systems capable of evolution, as the work of Godel and others indicates, comes an impossibility of certainty (Nagel and Newmann, 1956). Human cultural evolution thus involves a struggle for functional ends in the face of possible

dysfunctional outcomes; a struggle that cannot be undertaken with certain knowledge, but which must be engaged through human choices. But before we can work to change the world, we need to admit that some things can simply be *wrong*. Both in biology and in cultural anthropology, the concept of evolved dysfunctions is both necessary and useful.

NOTE

1. An earlier version of this paper appeared in Diener (1979).

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