Predator—Prey Models and Contact Considerations

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Abstract Employing ethological models derived from terrestrial predators and prey, I attempt to evaluate the likelihood that an intelligent alien will be beneficent, neutral or hostile. To this end I review what is known about selective pressures for intelligence generally, and for predators and prey particularly. I also review some of the conditions that would promote or inhibit the development of intelligence. After discussing the contributions to intelligence of tool use and spatial behavior, I—in agreement with the majority of evolutionary biologists, psychologists and anthropologists—settle on social behavior as the most potent contributor to the development of higher intelligence. Predators, although well equipped with fierce dispositions, 'weaponry' and 'armor,' can establish well organized and highly supportive in-groups, such as wolves do. It seems likely that any intelligence that evolves in a social unit will be affected by minimal requirements involved in-group cooperation and cohesion. The result will likely be constraints on agonistic behavior and an ability to engage in cooperative endeavors … within the group. Toward outsiders, the behavior of such organisms may well be far more exploitative. Our own history suggests as much. I conclude with an expression of strong support for the efforts of SETI and others to obtain information about intelligent others. The potential benefits to be gained from this are simply too great to gainsay. However, despite the unlikelihood of actual physical contact, I conclude with a caution about divulging too much information about ourselves.

Keywords Aliens · Intelligence · Extraterrestrial intelligence · Agonistic behavior · Predation · Evolution · Social behavior · Altruism · Aggression

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1 Introduction

Within the scientific community, as well as in the popular press and among science fiction writers, there has long been a concern with extraterrestrials and the possibility of communication with them. This concern has led to projects such as the Search for Extraterrestrial Intelligence (SETI) (Morrison, Billingham, and Wolfe 1977) that continues to be a focus of attention for many scientists even though Congress terminated funding in 1993 (Holohan and Garg 2005; Tarter 2007).

Twenty years ago, Harrison (1993) published an intriguing paper concerning extraterrestrial intelligence in one of psychology's major journals. At the same time, scientists have theorized and speculated about the nature of extraterrestrial intelligence and the problems involved in communication between sapient species (Sagan 1973). The consensus has been that the universe is very likely to host other intelligent beings, that some of these will be more technologically advanced than we are today, and that some will be trying to locate other intelligences.

In the science fiction community, images of extraterrestrials have been variegated in form, in intelligence and in intentions. They range from the beneficent aliens of Julian May (1987a; b), who wish only to elevate the lot of humanity and facilitate our participation in an intergalactic "milieu," to the malevolent extraterrestrials of Greg Bear (1987), who travel about the universe locating intelligent life forms and destroying them because they may be potential future competitors. Generally, however, images of aliens in the popular press and among scientists are positive. It is widely believed that if a sapient species can achieve the degree of civilization necessary to support interstellar communication, it is unlikely to be hostile.

In this chapter, I wish to examine this assumption. As an anthropologist, I am aware that there are some markedly different paths to the evolution of intelligence. These differences can provide us with models that can suggest some of the variety we may anticipate among extraterrestrials. I am concerned about the possibility that a technologically-oriented intelligence may as likely be developed by a predatory species as by a non-predatory one. I am particularly concerned with the kinds of stimuli that promote the development of intelligence, and with what sorts of ethical notions might be associated with these varying modes of evolving intelligence. This exercise in modeling should have consequences for how we approach the possibility of extraterrestrial communication.

2 The Case for Intelligence

Among the range of definitions for intelligence, one that is widely accepted is the ability to learn new response patterns (Jerison 1973). Generally, intelligence confers upon an organism greater adaptability and flexibility in dealing with environmental challenges. However, many complex adaptations to the environment do not require the classical concept of intelligence. Scientists have long known that insects are capable of complex adaptations to their environments in a fashion that relies on genetic programming rather than on learning (Wilson 1980). Indeed, Schull (1990) has argued that even the adaptive characteristics of plant and animal species exhibit information processing and that it would be fruitful to view such species as intelligent. Overwhelmingly, however, the scientific community believes that a greater capacity for learning is a superior adaptation to suggested alternatives.

In the evolution of intelligence on earth there has been a consistent trend from relatively closed instinctive patterns toward "open" learning (Hinde 1974; Sluckin 1965). Jastrow (1981) has noted the evolution of intelligence from lower organisms to humanity and to computers. He and others believe that, if one has competing species, the evolution of intelligence is inevitable because of the advantages it confers upon the possessor (Itzkoff 1983; Sagan 1977). However, questions about the rate at which intelligence is developed and the nature of the species that are most likely to possess it are more complex.

Evolutionary theorists and developmental biologists have long been aware that the development of intelligence involves a series of interactions between organisms and their environment (Laughlin and Brady 1978; Laughlin and D'Aquili 1974; Manosevetz et al. 1969; Mazur and Robertson 1972; Tunnell 1973). The environment must contain conditions for which intelligence is an adaptive trait. While "brains" should develop more complexity and flexibility, it is not necessary to anticipate that they become larger (Miller 2007). Beings with greater intelligence then reproduce in increasing numbers, filling their eco-niches and driving out less intelligent competitors. It is important to note, however, that the entities disadvantaged in this scenario are the ones that either compete directly with intelligent others or are directly exploited by them.

Complex environments select for intelligence by creating conditions where more intelligent competitors have an advantage in exploiting limited resources (Evans and Schmidt 1990; Robinson 1990). Animals that proceed by instinct have a limited set of behavioral repertoires with which to respond to changing conditions. They are limited not only by their physiology, but by their ability to perceive the existence of new demands and new resource possibilities. Their coping equipment is genetically based and suited to the environment in which the organism evolved. Should that environment change, the organism may prove unable to adapt to the new circumstances and be seriously disadvantaged in its competition with other species (Daly and Wilson 1978; Dawkins 1976; Smith 1984).

Generally, increasing intelligence gives an organism a better opportunity to model the environment, both natural and behavioral, so that food getting, mating and general survival strategies can be maximized. Intelligence is selected for because it benefits the possessor, not because it is helpful to others.

2.1 Costs and Advantages of Intelligence

An increase in intelligence has meant a corresponding rise in brain size. As Jerison (1973, 8) has noted, "The mass of neural tissue controlling a particular function is appropriate to the amount of information processing involved in performing the function." This has been true in organic evolution and in the evolution of artificial intelligence as well (Gardner 1985; Goldstein and Papert 1977; Jastrow 1981; Llinas 1990; Nelson and Bower 1990; Schank and Childers 1984). It seems likely that, however information is processed, it would also be true for extraterrestrials.

Intelligence is not without certain physical costs. Particularly in the case of higher mammals, intelligence has been found to be expensive in terms of the body's resources. Brain tissue requires large supplies of glucose and oxygen (Milton 1988), but these are justified by the advantages that intelligence confers. Indeed, the costs of intelligence are evidence of its importance and success as an environmental adaptation.

There are also social consequences that accompany the development of significant intelligence. An increasing reliance on a learned repertoire implies an increased period of dependency on the part of the young. The need for learning plus the problems of rearing learning-based offspring involve a very high cost from an evolutionary perspective. Such organisms have few offspring and this means that, unlike lower organisms that reproduce in greater numbers, the survival of each offspring is important. This longer maturation period and the need for security create a trend toward social living, because the infant and its mother need the support of others (Laughlin and D'Aquili 1974). This model is true not only for humans but also apes, cetaceans, elephants, and most other mammals with appreciable intelligence. Further, as we shall see, the exigencies of social life can prove to be as strong a stimulus for the evolution of increased intelligence as any other factor. This creates a positive feedback loop in which intelligence promotes social living, which, once established, makes increased intelligence highly adaptive.

Even among lower animals, greater intelligence means more flexibility in dealing with environmental conditions. For predators, this implies a greater ability to locate and consume prey, while, for prey, greater intelligence increases the likelihood of avoiding such a fate (Byrne and Whiten 1988).

As intelligence increases, other emergent properties appear which reflect the expanded complexity of the system, and which confer still greater advantages on the possessor. At some point, increasing intelligence should lead to self-awareness (Itzkoff 1985; Jastrow 1981; Laughlin and D'Aquili 1974). An organism equipped with self-awareness can model not only the external environment, but also include itself as an element of attention. It has a self-concept separable from the environment and capable of conscious examination and reflection (Tunnell 1973). Concurrent with such a development is an increase in the organism's ability to construct an internal environment that can not only represent the external world, but also make possible the construction of symbols which are, by definition, arbitrarily related to their referents (Gazzaniga 1992; Laughlin and D'Aquili 1974; Laughlin et al. 1990).

The capacity for symbolism represents an enormous evolutionary advantage for any intelligent species. Prior to its appearance, communications are limited by environmental stimuli in what is termed a “closed” system (Hockett 1973). In such circumstances, an organism emits a signal that is automatically called forth by an external stimulus. There is no displacement in time or space, and such calls are generally mutually exclusive. The information-carrying capacity of the system is thus limited to the number of calls hard-wired into the organism. With symbolism, organisms gain the ability to displace their messages and to combine them in ever more complex and novel assemblages. Further, they can assign meanings in complex ways influenced, but not dictated, by biology. This opens up the realm of culture, a learned set of patterns for behavior that are far more malleable than the biological substrate that made them possible.

While symbolism involves greatly increased freedom from the constraints of the organism’s biological limitations, this freedom is not absolute. For humans, the structure of our brain imposes limits both on the amount of information we can process at any given time (Greenspan 2004; Miller 1951; 1956), and on the kinds of information we can process (Ardila and Ostrosky-Solis 1989; Jerison 1990; Lenneberg 1967; Thompson and Green 1982). There is reason to believe that similar limitations and perceptual dispositions would attend any evolving sentience (Gazzaniga 1992; Sauer and MacNair 1983; Stokoe 1989; Wasserman 1989). Given such an expectation, it seems likely that sentients who have evolved from a predator background would differ markedly from sentients whose gustatory preference run to plants.

3 Predator Intelligence Models

There are a variety of relations that obtain between predator and prey. Some predators, such as the anteater, specialize in a single prey; others, like the wolf, ingest a wide range of prey, but most probably fall in the mid-range (Evans and Schmidt 1990). All predators need strategies to locate, obtain and consume prey, but the nature of these strategies can range from the genetically programmed activities of spiders, to the complex hunting practices of the !Kung bushmen of the Kalahari Desert (Lee 1979; 1984; Marshall 1976). In the latter case, intelligence not only makes it more likely that prey will be obtained, but also promotes an optimal distribution of calories and even saving to meet future needs.

In assessing whether or not predators are as likely as others to develop high intelligence, the answer is unequivocal—they are not less, but more likely than others to evolve a high intelligence. This somewhat surprising conclusion results from an examination of ethological research, as well as contemplation of the models purporting to describe factors that promote intelligence.

Recall that intelligence is selected for when it enables an organism to exploit resources that would otherwise elude it. This argument holds for both predators and prey, but, for reasons I will discuss below, its selective pressure is greater for predators. Recall also, that complex environments select for intelligence by creating conditions where more intelligent competitors have an advantage in exploiting limited resources (Evans and Schmidt 1990; Robinson 1990). Predators have a more difficult set of problems to solve and these involve environmental conditions that are more complex for the predator than for its prey. Said another way, predators are more environmentally challenged than prey and this increases the selective advantage of increased intelligence.

Prey need to locate resources which, in the case of herbivores, are nicely stationary. Further, they need to survive the depredations of predators, *but* it is not necessary that all individuals need to endure to insure the perpetuation of the prey species. Indeed, many prey adapt to the competition with predators by becoming more fecund rather than more elusive.

In contrast, predators must actively solve their problems, including locating prey. As Malthus would suggest, there are always more prey than predators, but such prey may prove difficult to find. To survive, predators must prove more capable than their prey. The complexity of a predator's environment includes not only those elements also encountered by prey, but also the behavior of the prey itself. It might be argued that the prey could benefit from being able to better model the behavior of predators but, given their higher birth rate and the costs of intelligence, the selective advantage of intelligence is actually less for prey than for predators.

An intelligent predator is likely to view other entities in an extremely utilitarian, probably gustatory, fashion. There would likely be constraints on exploitative behaviors, since no intelligent predator would wish to extirpate a source of calories, but there is no reason to anticipate much in the way of altruism between sapient species. Indeed, should extraterrestrial visitors prove to be evolved from a consistent predator base, it seems likely that their interest in us would, at least from our perspective, be quite malevolent.

One can argue that the assumption of uniform hostility on the part of extraterrestrials descended from predator stock is too simplistic since it does not incorporate the meliorating influence of adaptation to social life over a prolonged period of evolution. My image of predators also obfuscates the possible role of culture in reducing an "us–them" view of the universe. In fairness, then, we should examine a wider range of possibilities in which intelligence can be promoted by a variety of circumstances in addition to predation.

4 Evolutionary Sources of Intelligence

4.1 Tool Use

Since the middle of this century, one of the classic arguments in anthropology concerning a probable stimulus for intelligence focused on early tool use (Oakley

1959). Tool use and, especially, tool manufacture place a premium on eye-hand coordination, the ability to visualize a future result, and other capacities associated with intelligence (Washburn 1960; Wynn 1988). To the extent that tool use and tool making represent an adaptive advantage in a competitive environment, the qualities on which they depend will be selected for. It is argued that our *australopithecine* forbears, who first used tools, and *Homo habilis,* who first constructed tools, set in motion a positive feedback loop, an ineluctable chain of events that culminated in *Homo sapiens sapiens*. The selection for better eye-hand coordination and greater intelligence resulted in organisms that could construct more effective tools. These tools conferred an even greater adaptive advantage which, in turn, increased the selective pressure for better eye-hand coordination, greater intelligence, and so forth.

Although it is now regarded as unlikely that this model best accounts for the evolution of human intellectual capacities (Wynn 1988), it does seem probable that constructing tools helped to further human intelligence. It also seems possible that the development of a tool tradition would have a similar influence on extraterrestrial life forms.

Interestingly, while the role of tool reliance is relevant to the development of intelligence, it seems to tell us nothing about the ethical implications of that intelligence. Tools can be used for a variety of purposes, both malignant and benign. The purpose for which tools are used will depend on considerations that are essentially independent of tool manufacture. Tool use means greater efficiency, but it does not suggest toward what end.

4.2 Spatial Behavior

Most evolutionary scenarios for our hominid past include a prolonged period of foraging. Except for carnivores, it seems likely that a lengthy interval of gathering would characterize many organisms as they evolved toward higher intelligence. Several anthropologists have argued that the demands of foraging behavior make increased intelligence highly adaptive. Foraging puts a premium on memory and on the ability to locate and exploit ephemeral resources. Further, foraging through a defined domain rewards the ability to estimate the location and reoccurrence of seasonal resources. One authority on primate foraging behaviors has argued that primates with larger brains also have larger ranges and more varied diets, suggesting a causal relationship (Milton 1988).

Whatever the role of foraging in selecting for intelligence, it seems likely that it would be only one factor among many. Some authorities have suggested that the evolution of the nervous system was partly due to the memory requirements described above and partly due to a more general need for problem solving skills. It is thought that there were selective pressures calling for the mind to make ever-finer discriminations (Iran-Nejad et al. 1992).

The ability to develop accurate cognitive maps of an organism's territory would confer a variety of advantages ranging from more reliable resource exploitation to fewer encounters with dangerous competitors. However, again, this adaptation would seem to provide little indication of the ethical implications of an intelligence derived from such stimuli. To encounter matters of ethical moment we must, almost by definition, look to the social realm where organisms interact with one another.

4.3 Social Behavior

In my opinion, the best argument for the importance of the social environment in creating pressure for increased intelligence was advanced by Alison Jolly (1985), a noted primatologist. Jolly's study of lemurs revealed that there were significant, complex, social problems that needed to be solved for an organism to mate, cooperate with others, and maintain a viable group status. She argued that the need to adapt to complex social circumstances selected for intelligence in both males and females. Further, the slow maturation of young lemurs created a situation in which learned social skills had an early impact on dominance relations and, later, on mating opportunities. This reproductive concern is not limited to males, because it has been shown that dominant females tend to have more opportunities for mating and a greater likelihood of raising dominant males.

Several studies have supported Jolly's contribution and elaborated some of the mechanisms involved (Lewin 1988; Paoli and Borgognini 2006; Stanford 1998). Cheney, working with vervets, found that their adaptive social behaviors and social learning were significantly more complex than behaviors related to other tasks such as foraging (Cheney and Seyfarth 1988). There is currently general agreement that demands of social participation are perhaps the most powerful stimuli for the development of higher intelligence. Authorities assert that socially-skilled organisms have significant advantages over others, including a better ability to foresee the behavior of competitors (Smith 1984, 69), and greater skill in constructing and maintaining profitable alliances (Harcourt 1988).

Portions of this scenario seem foreordained by the nature of intelligence itself. As we noted earlier, greater intelligence means a prolonged period of dependency, a greater need for a learned behavioral repertoire, and a general trend for social living to support the first two. The complexities of social life, the differential access to resources, and mating opportunities that accompany high levels of social skill all place considerable selective pressure on increased intelligence and, to some extent sociability. Ethological studies indicate that any organism whose behavior puts the group at risk suffers exclusion, injury and/or a loss of mating opportunities.

This model would seem to have some utility for conjecturing about the nature of extraterrestrial intelligence and attitudes. It seems likely that any intelligence that evolves in a social unit will be affected by the minimal functional requirements involved in-group cooperation and cohesion. The result will likely be an organism that has serious constraints on agonistic behavior and an ability to engage in cooperative endeavors. This scenario is markedly more hopeful than the one suggested above for intelligent predators, but it would still be wise to consider the probable nature of social behavior, for there are often marked differences between in-group behavior and that directed toward outsiders. All one need do to realize the significance of this distinction is to reflect on human history.

5 Machiavellian Social Behavior

If this material can be used to project extraterrestrial intentions, an examination of group behavior among monkeys, apes and humans reveals some rather disquieting social trends. Indeed, according to recent authorities, the altruism and cooperation that characterize social life appears to have roots in a rather ominous social calculus. Smith has argued that the exigencies of social life provide a powerful stimulus for increased intelligence, the capacity for symbolism and the ability to abstract patterns: "…an animal would have to think of others as having motivations similar to its own, so that it could foresee their future behavior, and it would have to communicate symbolically" (Smith 1984, 69).

However, the question remains as to what end these abilities are directed, and a collection of essays suggests that Machiavellianism is evolutionarily adaptive:

> …in most cases where uses of social expertise are apparent, they are precisely what Machiavelli would have advised! Cooperation is a notable feature of primate society, but its usual function is to out-compete rivals for personal gain. [However,]…it seems likely that the later course of human evolution has been characterized by a much greater emphasis on altruistic uses of intelligence. (Byrne and Whiten 1988, vi)

Unfortunately, the authors also note that the weight of evolutionary evidence supports the idea that our intelligence evolved principally from "a need for social manipulation" (Byrne and Whiten 1988, vi). Basically, it seems that it is in the individual's interest to take advantage of others, as long as doing so does not jeopardize social standing, mating possibilities, and access to resources.

If the nature of in-group dynamics seems a somewhat unpromising suggestion of what extraterrestrial contact might hold, the character of out-group relations is even less encouraging. Nobel laureate Konrad Lorenz (1963) has argued that intergroup relations among many species are characterized by aggression and that this agonistic behavior has a positive function. He suggests that intra-group aggression serves as a spacing mechanism to promote a dispersal of populations throughout the environment, thereby facilitating a more efficient utilization of resources. He notes that such behavior is particularly true for members of the same species and for others that exploit the same resources.

In instances of confrontations between carnivores, Lorenz believes that there are instinctive inhibitions on the use of deadly force. He suggests that these have evolved because carnivores are very well equipped to damage each other. Thus, the result of an aggressive encounter would probably mean the death or maiming of both parties. Instead, intra-carnivore contests, rather than extending to deadly action, are limited to displays of ferocity. However, herbivores and omnivores are less well equipped to seriously injure one another and, as a consequence, are presumed to lack instinctive checks on the display of intra-species aggression. Indeed, since both parties can survive the encounter, intra-species aggression among non-carnivores may help select for increased intelligence, because more intelligent organisms avoid contests they are apt to lose but initiate ones that they are likely to win (Cheney and Seyfarth 1988; Harcourt 1988). This would increase mating opportunities and inclusive fitness.

According to Borgia (1980), who has examined human aggression as a biological adaptation, individuals will participate in aggression when it improves their fitness relative to other behaviors in which they could engage. Thus, an accurate assessment of complex social circumstances where aggression may be directed toward others or toward oneself is a highly adaptive skill, and one that also places an emphasis on and selects for intelligence.

Intra-species behavior ranges from Machiavellian to agonistic according to whether the principles are members of the same or of different groups, among other relevant social variables. However, inter-species behavior displays a far narrow set of behaviors. Simply put, with the exception of some symbiotes, the record of inter-species behavior is clearly one of competition and aggression (Byrne and Whiten 1988; Hinde 1974; Lorenz 1963). It seems that the only consideration that tempers inter-species aggression is self-interest. Thus, some predators limit their kills and increase their territories in order to preserve the availability of prey (Lorenz 1963).

Thus, whether a species derives its intelligence from tool use, territorial exploration, an adaptation to complex social life, or some combination of the three, there seems to be no reason to anticipate the evolution of an intelligence characterized by beneficence. On the contrary, it seems that one of the functions of intelligence is to promote a more efficient exploitation of the environment, an environment that contains other organisms, including members of one's own group.

6 Conclusion

I confess to having begun the research for this chapter in a mood of optimism, anticipating that extraterrestrial intelligences would be at least as likely to display benevolence as malevolence since they would have mastered a complex technology, survived their own evolutionary challenges, and learned sufficient cooperation to make high civilization possible. My research has led to a reevaluation of my original expectations and, to the extent that these models are applicable to future encounters with extraterrestrials, a much more somber conclusion.

Obviously models such as these, which are grounded in the particular nature of terrestrial organisms, especially mammals, cannot presume to anticipate all possibilities. It is possible, though not probable, that an extraterrestrial intelligence would be telepathic, hive oriented or significantly different in a variety of ways (Hanlon and Brown 1989; Wasserman 1989). In such circumstances, models such as those proposed here may have limited, or even no, utility. However, several authorities believe there are good reasons to anticipate a sentience significantly different from our own but sharing sufficient characteristics to enable communication (Raybeck 1992; Sagan 1973; 1977).

I have not argued that a species must be a carnivore to be a predator. Indeed, some omnivores, such as ourselves, are truly formidable predators. Neither have I argued that a species must be exclusively a predator to be influenced by selective pressures appropriate for a predatory evolutionary scenario. However, if predation is a major means of environmental adaptation, then the presumed result is a simplistic world view representing a consistent "us–them" dichotomy in which "us" are fine… but "them" are dinner.

The assessments of non-predator forms of intelligence, while more complex and somewhat more encouraging than the models suggested by a presumed intelligent predator, still imply a rather unpromising set of circumstances. As noted earlier, intra-group behavior among non-predators seems best characterized by Machiavellianism rather than by disinterested altruism. As for inter-group relations, the likelihood of violence seems greatly increased. Still worse is the prognostication for inter-species violence, which would seem to approximate that suggested by the models for predator behavior.

If these scenarios seem too pessimistic, we should recall our own recent history and current state of affairs. As an omnivore with a rather predatory past, our treatment of our own species has not generally been characterized by an enlightened altruism. Slavery, colonialism, religious wars, and inter-ethnic violence have marked our history and continue to mar our present. This is not a necessary state of affairs, as there are societies, such as the Semai, where war and even interpersonal violence are effectively unknown (Dentan 1968; Knauft 1987). However, when humans compete for limited resources, inter-group violence is a common, and often predictable, response (Ferguson and Farragher 1988; Harrison 1973; Montagu 1968). Indeed, competition within groups can, in several social settings, also readily yield agonistic behavior (Chagnon 1983; Meggitt 1977). Thus, it would seem naive to anticipate better behavior from extraterrestrials than we manifest ourselves.

While the speed-of-light limitations on space travel make it unlikely that any extraterrestrial could readily visit us, such things are within the realm of possibility. The best analogy might be with early European exploitation of Southeast Asia. The distance was impressive, communications haphazard, and the risks great. Nonetheless, a small European power, Portugal, managed to enslave populations, devastate property and destroy small states. It also led to Portuguese control of the spice trade, and to Portuguese ascendancy back in Europe (Hall 1955; Harrison 1968; Swearer 1984).

Despite the rather negative conclusions of this study, I would not counsel the abandonment of SETI or any reduction of the current efforts to listen in on intelligent extraterrestrial life forms. On the contrary, I think we would be well advised to be as informed as we can concerning the possibility of other sentients. This is particularly the case as evidence continues to point to the increasing likelihood of extraterrestrial intelligence (Shostak 2009; Tarter 2007). Indeed, in light of the behavioral significance of differing gustatory patterns, I would particularly like to know what they had for dinner. I would feel much more comfortable entering into discussions with a salad-eater than with an entity that derives its nourishment from higher on the food chain. Nonetheless, as I have suggested, it is just these latter entities that we are most apt to encounter. What then?

The potential benefits to be gained from interstellar communication are too great to be ignored or avoided. Certainly the listening should continue but, as I have suggested, the potential danger of attracting the attention of an extraterrestrial sentient is also too great to be ignored. I recommend carefully assessing the location of any future extraterrestrial communicants, and gathering whatever information about them might be possible, prior to contemplating an active exchange of messages. Finally, if we do find reason to send forth a message, I recommend we break with the model established by Pioneers 10 and 11, which included a detailed representation of our solar system and some hints on how to get here. At the minimum, we should try to avoid including a return address.

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