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A Proposed Neurophysiological Basis for War

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Having examined concepts relating to the causes of human warfare advanced by scientists of different disciplines—Monod, Scott, Alland, Montagu, Ardrey, Morris, Lorenz—we have proposed a different explanation, in neurophysiological terms. According to our thesis, the adoption of an upright stance by Australopithecine hominids favored both freeing of the forelimbs and a change in emphasis from osmic to visual sensory input to the brain. Selection pressures, defined as operating at four different levels on a biosystem, then led to appearance of a higher level logic in the brain, beyond that of counting and recognizing two basic geometric fields, the first the world of "self" and the second a world of "other objects." The new logic was an abstracting field logic involving the triangular relation of self, other, and a third entity, the idea of tool as intermediate. The capacity for abstraction inherent in the concept of "tool" raises the internal "communication temperature" of the brain, thus, favoring the genesis of both higher level abstract thought and a neural coordination center, finally realized formally as centers for speech. The high-speed, parallel-processing, visually-oriented brain that resulted was still connected to the older brain elements originally devoted largely to processing autonomic system data, food, emotive response, sex, and smell. The highly interconnected new brain (neocortex) and older brain (limbic system) constituted a communication system that was unstable at high communication "temperatures." The unstable neuroelectric fields generated new modes of behavior and still higher levels of abstract thought. One of the new modes of behavior to emerge was human group warfare.

INTRODUCTION

Man's social institutions are plagued both by random, individual violence and by larger-scale, mass violence or war. Questions concerning the innate aggressiveness of human beings cannot be clearly framed without considering the distinction between these two types of behavior. The distinction is nevertheless not often made. We shall attempt to sharpen the dichotomy in the paper and call attention to a novel view of warfare loosely based upon neurophysiological concepts.

Aggressive behavior or human warfare are topics that have attracted much attention. Marx, Darwin, and Freud all considered such behavior, and the recent literature on the topic is rich and variegated (Carthy *et al.*, 1964; Lorenz, 1966; Fried *et al.*, 1968; Montagu, 1968, 1969; Scott, 1969; and Alland, 1972). Particularly illuminating in our judgment, are the views of Scott, Alland, and Monod, which are summarized below.

Scott's (1969) view is that group fighting, part of agonistic behavior, is exhibited by very few species. It has been observed among only two phyla—Arthropoda and Vertebrata. In the great majority of cases in which it forms a prominent part of social organization, agonistic behavior is confined to fighting between individuals. Much of agonistic behavior is ritualistic. In most species in which dominant–subordinate behavior exists, threat and avoidance substitute for actual fighting. But these patterns, Scott points out, are definitely not the basis for human warfare. He examines various primate species, as models for human precultural social life and finds no general evolutionary tendency toward group warfare, other than in human beings. Scott believes that a major motivational system for humans is allelomimetic (acting like the rest of the group), as well as agonistic. He finally opts for the thesis that a major cause of destructive fighting, when it occurs between groups, is social disorganization. In human beings, at the age of late male adolescence, there is a period almost a decade long following the youth's taking leave of the primary family and prior to his establishing a new one. This period is marked by expressions of individual violence. Although this period of disorganization of social participation does not directly lead to warfare, the violent tendencies of a generation of young men can be organized by providing some kind of external threat.

Alland reacts to notions of behavioral determinism, such as those popularized by Ardrey, Lorenz, and Morris, by offering a *reductio ad absurdum* of their reductionist theories; viz, if human nature is to blame for warfare and violence, there can be no human responsibility, and all calls for social action are useless. He then takes up specific challenges to and refutations of the view that competition, aggression, and territoriality are human "instincts." He concludes that man is a social animal with potential for both aggressive and cooperative behavior. Which behavior emerges depends largely on the nature of society. It seems clear that evolved human behavior is not tightly bound to the genetic code. Instead, it emerges epigenetically in response to a surrounding social milieu. Society is one of the major determinants of human behavior, and it provides the norms.

To develop a new view of the relationships between man's innate characteristics, his social behavior, and the emergence of warfare, we begin with the ideas expressed recently by Monod (1971). He believes that the achievement of an upright posture, by Australopithecus not only freed the forelimbs, but created selection pressure for mental processes of internal simulation. Subjective simulation, much as would be involved in fashioning weapons for a hunt planned for the future, became elaborated as the dominant conscious (self-aware) function of the brain. This new and superior function, to be effective, required an enhanced mode of communication among members of social groups, and selection for development of speech followed closely. Upon the perfection of speech, cultures could then be elaborated. We shall explore this scenario in more detail. To do so, we must first translate the concept of "selection pressure," as we understand its meaning in modern biology.

SELECTION PRESSURE

Mutations are spontaneous alterations, caused by physical or chemical events that occur as accidents, that lead to enduring structural changes in the macromolecules responsible for (otherwise) invariant reproduction in living systems. A mutated form then faces four possible levels of selection processes that determine its survival in a population gene pool. First, the mutation must be consistent with the continued operation of the system within which it occurs. The first selection is, thus, intraorganismal for compatability. Second, the mutated organism must be capable of behavior tolerated by other members of its species. The second level of selection is, therefore, intraspecific, or, in the area of human beings, includes cultural influences on reproductive activity. Third, a mutated form, accepted initially into the gene pool of its species, must survive any interspecific competition that may be occurring. Finally, the gene pool, now altered by the forms reproducing themselves successfully, must meet and and survive any random changes in the geophysical or chemical environments of its ecological niche. The cumulative effect of all four levels of selection are, perhaps too casually, often lumped in the term "selection pressure," and we shall adopt this usage.

SELECTION PRESSURE FOR VISUAL INFORMATION PROCESSING AND ITS CONSEQUENCES

We are concerned here with the brain of an upright primate, whose behavior is no longer tightly tied to the paleomammalian brain (in MacLean's nomenclature (1970)), built upon structures devoted largely to processing autonomic responses to sensory inputs. This new mammalian brain emphasizes visual information processing instead. It was probably developed in parallel with the emphasis on odor in the paleomammalian brain. The neomammalian brain favored distant vision. The emergence of an upstanding hominid overwhelmingly favored vision as a dominant modality. Modern man is predominately visual in most of his conscious activities.

What did selection pressure on the "visual" brain of these upstanding hominids lead to? In our view, the extension of the sight sensorium permitted the development of abstract thought. It raised the logic level of the brain beyond that of a geometric field logic (Bloch *et al.,* 1971). The "visual" brain must cope with and interpret among different complex geometric relationships. That capability, in one line of animal development, led to tool-making activity. Tool-making activity has been traced back 2½ million years by Leakey and colleagues.

The appearance of tools creates a cultural, intraspecific selection pressure on developing comprehension of complex entities beyond subject–self and object–other, and extending to a third concept – that of an artifact that can relate the self to an object, and yet is neither self nor other, but is an intermediary. This abstraction of "tool" confers sufficient advantage that we can conceive of a greater selection pressure on the brain to develop further abstractional capability, broad enough to encompass not only this triangular relation, but also any "polygonal" relation in which any vertex, representing various sensory input modalities to action modalities, can be joined or correlated or translated into an identification with any other vertex. A coordination center that supports internal language capability ultimately emerged. The speech areas of Wernicke and Broca, asymmetrically placed, represent some of the products of these trends and selection pressures. These neural structures support internal simulation, abstraction and both internal and external communication.

The evolutionary processes that led to the emergence of abstract thought, in summary, are these:

(1) Adoption of an upright posture. Advantages were distance vision, and freeing forelimbs for nonlocomotor skills.
(2) Dominance of visual inputs (remote sensing and integration) over the previously dominant osmic inputs (local sensing and integration) to the brain. A logic level higher than a geometric field logic follows.
(3) High visual information rates, higher level logic and emergence of a coordination center raise the internal "communication temperature" of the brain (as described below); articulate speech and abstract thought become elaborated.

THE COMMUNICATION TEMPERATURE OF THE BRAIN

The adoption of abstract, internal simulation introduces the advantages of combined parallel and serial processing. As long as sensory input–motor output relations are established by linear, rather unbranched chains of neurons, the behavior is stimulus bound and fairly stereotyped. (It is clear, as Pavlov has shown, that parallel chains can develop as conditioned reflexes. These are precursors to man's capability, and indicate that the developmental line has many moderate steps rather than requiring one giant step in man's brain. Nevertheless, the conditioned reflexes are fairly stimulus bound.) The high degree of connectivity and branching present in the larger brains, permit parallel processing to replace or to extend the more nearly serial processing of information that is characteristic of simpler neural systems. Although parallel processing involves more synapses, it is nevertheless a faster style of internal communication than is serial processing. If additional synapses are placed in a serial chain, the accumulation of synaptic delays slows communication. In contrast, parallel processing, by permitting the decomposition of a problem and the simultaneous treatment of its parts, not only compensates for the slowing effect of added synapses, but tremendously increases the information processing rate of the brain. If the total information rate is thought of, at first metaphorically, as characterized by a "temperature," then the parallel-processor will have a much higher communication temperature than will a structurally simpler brain. Abstract thought is an expression of the fires of the brain.

While fire and temperature are metaphors, they are not meant to be taken lightly. In an active ensemble of entities, temperature is the summation of kinetic energy of the atomistic particles. If the atomistic action, e.g. nerve impulses, is high but not derived from an inertial character, "temperature" would be an appropriate measure of activity, but the metrics, the weights, would not be particle mass. Brian Goodwin has used the concept at the cellular level; here it is being used at the neural level.

COMMUNICATION TEMPERATURE AND INSTABILITY

The rich arborization of neuronal pathways, the emergence of coordination centers, the speed of parallel processing and the enormous combinational possibilities for motor actions when internal abstraction patterns act as new sensory inputs, ungated by the overload protectors, pour information on almost all direct sensory pathways from receptors. All these new properties of the "visual" brain of the emerging upright hominid, so raised the communication temperature of the brain, that internal fluxes of ideation, racing through myriad circuits interconnecting great components within the brain, finally produced a new electrohydrodynamic instability. Out of these unstable fluxes, the "turbulence" of thought, new forms emerged, as they do in hydrodynamic systems exposed to high velocity fields (Iberall, 1972). Deeper abstractions came into being—goals, values, friends, enemies, and, most portentous of all, fellow man as an abstracted object.

Before exploring the consequences of this new abstraction, we would like to suggest a crude neurophysiological interpretation of the instability underlying it. In the scheme that follows we have perhaps exaggerated the anatomical aspects of MacLean's concept of the "triune brain." The neocortex, and essentially the limbic system, are not sharply defined anatomically. Their boundaries can be disputed. The high degree of interconnectivity, and the different emphasis on processing is not disputed, however.

According to our hypothesis, information entering through lower nervous system levels, e.g. from sensory channels, reaches the limbic system, where data are processed according to each mode of on-going activity, such as feeding, fighting, etc. The information also passes to the cortex, which, with its coordination center, spreads and diffuses and channels information into a multichanneled response. The limbic system and lower centers are, thus, repeatedly confronted with progressively elaborated inputs. Reverberations continue as long as any suitable source of input information—whether external or internal—is present. Response does not have to be "appropriate" to the originating channel. The system, thus, becomes linearly unstable. It is only stabilized, as in hydrodynamic turbulent fields, by finding a complex constellation of channels by which the internal circulating signals can be maintained near an energy minimum.

We must note, from a neurophysiological panel discussion at the 1972 American Society for Cybernetics Meeting (presentations by Harnad and Goldstein), that what we have referred to here as up—down (neocortex–limbic system) instability, may very well also involve left–right (hemispheric) instability. The point of our paper is to suggest, not pinpoint absolutely, neural mechanisms.

Our internal instability model—partly biochemical, partly bioelectric, partly mechanistic, involving specific brain structures and their interacting flux streams—in which the resolving nonlinear limit cycle stability emerges from cross-correlation operators, may provide a general model for the emergence of all behavioral modalities.

We are now confronted by dual competing processes. On the one hand, in local neural nets, the nervous system is self-energizing; on the other hand, it is laterally inhibiting, i.e., self-quenching. Selection pressure on the extremely active visual cortex puts a premium on the development of a higher "Q" response (less inhibition), but the "high Q" property in turn generates a pressure toward genesis of a coordination center. The emergent compromise that took place in hominids was an increasing "Q" achieved by increased suffusion (diffusion) of information into lateral channels, balanced by some degree of lateral inhibition. What resulted was a marginally stable system without too much reinforcement or too much damping.

CONSEQUENCE OF THE MARGINAL STABILITY OF THE HOMINID BRAIN

The more primitive epimeletic (care-giving) and et-epimeletic (care-soliciting) behavior (Scott, 1962) that is clearly programmed in domestic animals, and in primates, can be caught up in the turbulent, unstable turmoil of messages from the limbic system, processed by the new cortex with its complex coordination center. Signals related to feeding, sex, or other actions can all become intermixed. Nonsexual uses of sex emerge and novel behavioral patterns appear. Among these is warfare. Killing man becomes an abstraction, and ultimately a tolerable abstraction.

In the abstractions of language which themselves are not direct programs for conduct, diffuse neuroelectrical patterns that increase the range of possibilities for specific actions, warfare now becomes possible. As Scott suggests, warfare can be most easily introduced when images of social disorganization arrange themselves in the mind.

Warfare emerges from the cooperative instability of heated up ideational abstractions in a disturbed social period, coupled with allelomimetic (cooperative) social behavior brought to a focus by a communally-perceived threat. When rising "temperature" takes place in individual brains, people and circumstances fan the reverberating fires into a socially cooperative mode or mood of social antagonism of one group against another. As the individual becomes more unstable at higher communication temperatures, the tendency toward increased social cooperativeness becomes the new stability regimen.

Why then isn't the individual more of a killer? The internal coordination center that led to speech did not convey much of a selective advantage to man as an individual. As an individual, man resembles other primates. He can do fairly well as an individual competitor in his niche, but not exceptionally well. He becomes exceptional only when organized into society. Then there is a tremendous feedback amplication of his individual activities, coordinated by his coordination center. Thus, the instability that expresses itself in killing by the individual generally occurs only under extreme personal duress and is very rare. It is most commonly directed at close family (i.e., at a familiar person). If we talk about killing one's mother or father or sister or brother or friend or an innocent or a child, we immediately evoke a feeling of horror. These thoughts and themes furnished the foundations for Greek tragedy 2500 years ago. The artistic achievement thus represented is another of man's great abstractions of language. It is no wonder that all of these themes of drama emerged almost simultaneously.

SUMMARY

To summarize our proposed neurophysiological basis for warfare, we have the following themes:

(1) The communication temperature of a parallel-processing brain capable of abstract thought is very high.

(2) The high communication temperature is associated with some damping

processes, but, nevertheless, only marginally stable states result involving potentially unstable fluxes of information among brain levels.

(3) Instabilities inevitably appear, and these cause the neuro-muscular system to adopt complex behavior and/or more elaborate abstraction formations to permit a new stability.

(4) The new behavior and abstract thoughts permit warfare, if perceptions or conceptions of social instability are present, in the form of detected or imagined threats.

(5) Warlike behavior appears as a population phenomenon involving cooperative behavior in the face of perceived threats, The group behavior ultimately discharges the energies and diminishes the temperature of the system, and social stability is regained at a lower level of group cooperativeness and cohesion (Richardson, 1948).

(6) The long term behavior of the social system is, thus, that of limit cycle oscillations between war and peace, with a period related to the maturation time of the human male. Although generation boundaries are slurred, they appear to be sharpened in social structures by entrainment of clusters of young and old around their prominant leaders or pace-setters. Then, during each generation, as Freud implies, the old discharge their hostility on the young. Warfare takes place—the innocent young against the young and innocent—led by the old, until the intensity of social disorganization subsides.

(7) The internal tendencies toward instability and war are worsened by the increasing communication temperature of man's external social milieu brought about by technological advances.

HOW LONG AGO DID MAN ACQUIRE THE POTENTIAL FOR SPEECH AND WARFARE?

No authority has found evidence of group aggression among hominids earlier than 40,000 years ago. It is interesting that a recent article of Leopold and Ardrey (1972) points out that Oakley's work has indicated that there was a sudden spread of hearths 40,000 years ago, at which point in time, man evidently added controlled fires to his cultureal heritage. Culture in a modern sense also came into existence at about that time (Oakley, 1961; Klein, 1969; Iberall, 1972). We propose that speech also came into existence about 40,000 years ago. That is, we suggest that high speed human speech, rich in expressivness, did not exist in any hominid up to and including Neanderthal man and could not have appeared until a time near the end of the Neanderthalers or the beginning of Cro-Magnon man. We have assembled evidence for the theses elsewhere (Iberall, 1972, pp. 223, 227, 228). Our opinion is based on the evidence that right and left handed tools existed in equal numbers before Upper Paleolithic times, and that a predominance of right handed tools has occurred since Neolithic times. Dominant handedness has often been thought to be related to dyssymmetry of speech centers. Added evidence now includes the observation that Neanderthal man had a supralaryngeal pharynx that was inadequate for the production of the phoneme structure of human languages.

The new born human, chimpanzee, and Neanderthal man did not have an accoustically useful pharnyx. "There is practically no supralaryngeal portion of the pharynx present in the direct airway out from the larynx when the soft palate shuts off the nasal cavity in the chimpanzee, Neanderthal, and newborn man. In adult man half of the supralaryngeal vocal tract is formed by the pharyngeal cavity" (Liebermann *et al.*, 1972). While cruder or slower symbolization might have been possible earlier, it would seem that an abstract language structure fully capable of processing information at neural rates (e.g. 5–10 signals per second) was not feasible without modern human phoneme capability and some particular brain capability.

The start up of a modern fixed settlement style of life did not begin until after the passage of 30,000 years after the beginnings of speech, according to our estimate, i.e., until the Mesolithic times, perhaps 11,000–12,000 years ago (Mellaart, 1965). The explosion of urbanization is viewed as having begun perhaps 6,500 years ago. Thus, 30,000 years of cultural selection pressures may have been required to exploit the consequence of language in the form of a formal social structure that could be transmitted as a learned culture.

IMPLICATIONS OF THE NEURAL TEMPERATURE–INSTABILITY THEORY OF WARFARE

The view of behavior discussed in this paper is based upon analogies to physical, especially hydrodynamic, systems and their stability requirements. The implications we draw extend that analogy, perhaps dangerously far. The implications are sufficiently interesting to justify the attempt to sustain the analogy.

At present man has an unstable, or only marginally-stable brain, with novel behavioral modes open to him, including high artistic achievement and warfare. The instabilities that fuel the high levels of abstraction required to support these behavioral modes come from the design of his brain and are purely internal. Now, however, with the technological achievements resulting from his capability for abstract thought threatening him, man is moving into greater social instability. Fast external communication increases the overall rate of information processing. The system is overloaded and adopts as a new mode of stability, a pervasive apathy, or a wish to turn back the clock.

Thus, we see communes, simple and rustic, arising as an alternate to urban life style. But communes are not stable social organizations in a context of an industrial society, and their lifetimes are short.

All the current trends and pressures are in the same direction—toward increased social instability. Under these circumstances, the likelihood of war increases, and the state of war becomes more chronic than its cyclical recurrence would suggest. In any case, we see no simple constructive relief in sight. Existing social programs do not reduce the high communication temperature, while pursuing the abstracted goals of technological societies, which now appear to become the goals of all societies. As a result we will be in for a steady weakening of the social contract and a retreat of civilization from advanced to simpler forms as the more complex forms fail, and no new complex forms stable enough to replace the old are generated by the collapsing system. We cannot see any escape from the course toward chaos without a higher order integration of information flow and its use as a basis for decision making within the social organism.

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