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Anticipation, Adaptation, and the Concept of Culture in Anthropology

A synthesis for a "preparadigmatic" science is suggested by the philosophy of A. N. Whitehead.

John W. Bennett

Anthropology, a field of study dealing with both physical and behavioral aspects of the human species, is not an integral discipline like biology, but a congeries of topics held together by descriptive interests (*1, 2*). Since most of these topics concern prehistoric or living humans outside the confines of European civilization, a scholarly discipline formed around them. Although anthropologists have repeatedly claimed that their field is the only one to seek a unified science of humanity, this objective has been slow to mature. The failure has been attributed to various characteristics of anthropology that stem from the diversity of its subject matter (*3*).

This diversity and the lack of a clear theoretical aim were matters of concern to anthropologists from the beginnings of the academic field in the 1880's. After the decline of evolutionary theory, American anthropologists in the early 20th century seized on the descriptive humanistic notion of "culture" and converted it into a "scientific" discovery—a new order of reality. Although the concept immediately spread through the social and behavioral sciences, only cultural anthropology continued to use it as a central explanatory concept. In the early 1950's, Kroeber and Kluckhohn (*4*) acknowledged the descriptive or "substantive" basis of the concept but insisted that it retained an "explanatory dimension." Even so, they found it necessary to qualify the explanatory function—"anthropologists do not claim that culture does provide a complete explanation of human behavior, merely that there is a cultural element in most human behavior." While Kroeber and Kluckhohn were attempting to retain a degree of explanatory power for the concept, other anthropologists were looking elsewhere—into ecology, in Steward's case (*5*)—for explanations of human affairs.

One consequence of having a descriptive core concept for a field that aims at generalizing or explanatory (scientific) status (*6*) is the difficulty of distinguishing cultural anthropology from history or literature. At the other extreme, the increasing tendency to adopt sociological concepts like "social exchange" makes it impossible to distinguish cultural anthropology from sociology or economics.

I believe this situation constitutes a major intellectual crisis that is compounded by the gradual disappearance of the focal subject matter of ethnology—the isolated tribal society. As such societies are transformed into self-conscious nations, ethnic groups, or classes, the pull toward social science becomes even stronger. This generates countervailing experiments that use semantical and phenomenological approaches in order to avoid social scientism but that also can be distinguished from art, and leads to the diversification of subject matter to the point where there now exist separate "anthropologies" for economics, politics, society, education, symbolism, ecology, and so on.

If the task is to find a theoretical approach that will avoid both mechanistic social science and evocative humanism and, at the same time, provide for a degree of synthesis of the many subdivisions of the discipline, then a likely possibility is found in the concept of adaptation. This concept appears to introduce a new level of generalization. Instead of the abstractions from behavior, like culture, or the reductive formulas of psychology or genetics, it focuses on human actors who try to realize objectives, satisfy needs, or find peace while coping with present conditions. In their coping, humans create the social future in the sense of generating new problems or perpetuating old ones and may even modify the biological constitution of the population in the process (as in the case of the sickle cell gene) (*7*). By analyzing the factors that guide the choices of strategies, one gains knowledge of the possibility and direction of change and the relation of human behavior to the milieus.

Anticipation: The Basis of Adaptation

On the basis of a careful study of A. N. Whitehead, Burgers (*8*) proposes that the classic problem of teleology has not really been solved, despite the fact that it was discarded by modern science in favor of material and linear causality. The difficulty with linear causality is that it cannot determine causes of events that occur, in part, because of precedents built into the structure of the phenomena. For example, the formation of a crystal is caused by the molecular anticipation of crystallization, which is triggered by an assortment of external factors. But how can one predict exactly when a crystal will form if it is not possible, except in laboratory situations where human will and purpose intervene, to specify when these triggering factors will appear or become effective? More cogently, how

Dr. Bennett is a professor of anthropology and has served two terms as chairman of the Department of Anthropology at Washington University, St. Louis, Missouri 63130.

can one speak of material causation of human actions when the unpredictable and creative powers of the human mind are at work in nearly every situation?

Anticipation in the human realm may appear in the form of purpose, needs, desire, foresight, will, or simply consciousness of continued existence. The process of anticipation is recognized in anthropological theory when we speak of cognition and symbolism as conferring a "time-binding" capacity on human behavior, but instead of being used as the core of anthropological intellectual effort, the concept has been presented as a psychological fact which lies behind culture. The traditional view sees culture as a material process or entity caused by the time-binding capacity of humans but, paradoxically, culture is also viewed as a cause of human behavior. Furthermore, if anticipation is characteristic of all life and even the nonliving realm, then the idea that culture—the human version—is exclusive to the human species is at least partly false or, at best, ambiguous (a position now apparent in the work of animal behaviorists and ethologists) (*9*).

However, if the cognitive form of anticipation is an especially important characteristic of humans, then much human behavior is devoted to reordering phenomena to avoid a random or entropic state. This proposition counterbalances the recurrent tendency (as in functionalism) to make stability or, at least, homeostasis the normative basis of theory in human phenomena, or to apply concepts appropriate mainly to nonhuman realms to the much more dynamic human realm. The persistent developmental or exponential tendency in human behavior, visible whenever the time span observed is long enough, should be evidence that the regularity and return to preexisting states characteristic of homeostatic movement are temporary phenomena that are useful in analyzing limited sequences but not for understanding the basis of species behavior (*10*).

A few anthropologists (*11*) use the model of a game as an analogy for the coping behavior of humans in instrumental (technical, economic, political) situations. The specialized and limited game analogy might perhaps be generalized to include the major pattern of human existence or even of all life. That is, in adapting, the organism plays a game with the environment, endeavoring to learn, manipulate, or change the rules in order to realize goals, satisfy needs, or maintain a degree of freedom of choice and action. This process presupposes what Whitehead (*12*) calls anticipation—the future is structured by what the organism does in the present, which in turn has been conditioned by what happened in the past. Thus, regardless of what the actual outcome may be or precisely how much "freedom" the organism may have or acquire, there is an attempt to move through time and space as if freedom or autonomy were attainable and, by so doing, to constantly restructure the conditioning factors. This is one definition of the evolutionary process; the possibility that human thought and action can be fitted into a general evolutionary scheme has existed since Irving Hallowell's classic paper of 1960 (*13*). It is now generally assumed that "mind" was a factor in the evolution of the hominids.

For Whitehead, the universe was a problem of constant evolution, not empirical existence, since, while each event grew out of prior events, it was also shaped by present circumstances. Whitehead also believed that the emergence of one event out of another induced conceptualization; that is, a change in phenomena necessarily creates awareness or understanding of the old and the new. This, in turn, creates a sense of the future. Whitehead believed this process extended beyond human intelligence into the whole universe, that is, the evolution of material substance has similar characteristics insofar as future events are constrained or made probable by built-in mechanisms which have emerged as a consequence of prior events and processes. Simple or linear causation is not ruled out as a concept of explanation, but it is redefined as a descriptive or short-term version of a temporal process featuring complex systemic reciprocities. An analogy in anthropology is the distinction made by Sahlins and Service (*14*) between specific and general evolution in culture—the specific historical sequences of change or evolution often can be understood fairly adequately by simple causation, but the long-term movements and the frequent unpredictable shifts of direction and focus can be grasped only by an understanding of the systemic character of general evolution. An example is the exponential curve of energy utilization by all humans, which is superimposed over many specific curves with flat or cyclical shapes (*2*, chaps. 3 and 4).

The phenomenological element in Whitehead's position is found in the implication that, in living organisms and, perhaps, humans in particular, the factor of mind, intention, will, purpose, or whatever must be considered as distinct, for purposes of analysis, from strictly material elements of a process. That is, one cannot explain mind, or "minding," as White (*15*) would have called it, by atoms, even though atoms are involved in the process. More exactly, for a particular problem involving anticipatory functioning, human behavior has to be considered as an independent phenomenon. White (*16*) and Kroeber (*17*) called this phenomenon "culture," but my position is that this terminological habit has obscured the underlying issue. Culture is a linguistic convention used to describe the empirical consequences of minding; therefore, minding is what we should be concerned with. And a more descriptive label for it is adaptation.

The perceptive reader might object that, since I have suggested that the anticipatory function of reality is most easily visible in complex, reciprocal events in long time sequences where linear causal explanations do not work, it is contradictory to apply the theory to individual human action. First, simple causation frequently does work at the individual level and in society over short periods. Second, there will be an interplay between anticipation and causation. For example, we can say about the study of human social kinship that its persisting structure (a mental thing) is created by role expectations that are conditioned by past precedents. However, the behavior of an individual in kinship contexts is only somewhat explainable by this anticipatory function, since he can choose to follow the structure or not. If the topic shifts from the kinship system to the coping behavior of individuals, we find that the styles of both conforming and nonconforming behavior also create patterned or anticipated structures within, or outside of, the kinship structure. Third, long and short time are relative concepts; the emergence of "patterned deviations" may be perceived as taking place over a long time from the standpoint of the lifetime of an individual. From the standpoint of the kinship system, which may not change over many generations, it may be a minor squiggle on a long-term curve. Thus the use of an anticipatory-adaptational frame clarifies the relativity of time and levels of generality.

The Concept of Adaptation

In biology, the term adaptation has two meanings. The first has to do with genetic evolution, which concerns feedbacks into the gene pool from interactions with the environment and which leads to the persistence or development of traits favorable to survival of the population. The second concept pertains to

behavior during the life span of an organism which enables it to cope with environmental conditions. This behavior operates by cognitive and perceptual processes, although adaptations selected through the genetic-evolutionary process may provide the basis for the capacity. However, since in most organisms adaptive selection is sufficiently general to provide excess capacity or plasticity—"generalization"—the organism maintains a degree of adaptive autonomy or freedom to cope.

The basic meaning of adaptation in the sciences of human behavior (*18*) is derived from the second of the two biological concepts, that is, coping mechanisms utilized by organisms during their lives. However, among humans this behavior is subject to interpretation by values, thus introducing a judgmental dimension in addition to the survival or need-satisfying function. This requires a series of elaborations of the concept; of these, the most fundamental is that what may be adaptive (reducing tension, satisfying needs) for the individual may be maladaptive for the group (threatening survival and integrity). Warfare is, of course, the obvious example; the individual may gain satisfaction and social honor from participation but the activity can be judged as destructive for society. Thus the influence of value judgments must be weighed in analyses of coping adaptation in humans—failure to do so leads to misleading and incomplete analysis. This multidimensional process of behavioral adaptation shapes the rhetoric of politics and social change and reform, and is also fundamental in what we consider to be normal and abnormal behavior.

Since adaptation, with regard to human behavior, is the positive half of a paired concept (the negative half is maladaptation), the neglect of the value dimension leads to neglect of the anticipatory aspect of behavior. While the element of freedom contributes a flow of novel or creative responses, the majority of coping mechanisms is based on precedents. Likewise, the values used to assess the consequences of adaptation are almost always derived from mind-sets established before the particular adaptive event. The difference between human and nonhuman adaptive behavior seems to lie in the greater frequency of both the creative and the precedental forms among humans, whose adaptive behavior is characterized not merely by symbol generation (that is, culture), but also by memory storage (learning), and preservation of outmoded (perceptually maladaptive) solutions which generate conflict. Similar patterns are apparently found in all organisms and, analogically, nonliving things, but the precise loci and magnitudes of the functions obviously vary from realm to realm. However, since there is continuity between the living and nonliving, to call culture a "superorganic" (*17*) is to exaggerate the differences between humans and all other phenomena.

The statement, "culture is man's way of adapting to the environment," is characteristic of the recent effort to shift to an adaptational frame while preserving culture as a central referent. Presumably the intention of such a definition is to exclude nonhumans, who adapt mainly by programmed mechanisms built into the genes (*19*). Such a proposition has to be qualified in light of the recent work by animal experimentalists and field observers who have observed, in various species, plasticity and innovativeness that transcend programming and clearly belong in the cultural domain. However, if we define culture as, for example, "the distinctive human cognitive interplay between constraint and freedom of action," the proposition is not false. At least, it is a typical heuristic statement which can be neither entirely supported nor entirely refuted.

More serious objections to the idea of culture as an adaptive mechanism stem from the levels of generalization implicit in the statement. If culture is a descriptive concept, an epiphenomenal construction, or a generalization of a complex natural process, then it cannot be a method of adapting. If Whitehead's doctrine of the basic continuity of anticipation and freedom is correct, then the human differs from the nonhuman only in degree and in emphasis on particular features. Cognition is present in humans and not in crystals, but cognition, in varying and lesser degrees, is present in mammals.

The term "preadaptation" is used in evolutionary biology to refer to an opportune coincidence between an existing trait and some new environmental factor. There is a question as to whether this properly refers to the anticipatory function. If we understand preadaptation in its most general sense, then it can be included. However, when we are concerned with human coping behavior, anticipation becomes coterminous, in large part, with foresight, or cognitive understandings of future contingencies. These certainly exist in humans but are not by any means universally operative. That they are not has been a perennial problem in human thought, as evidenced by attempts to forecast the future. Such forecasting or planning represents an attempt to subject the anticipatory function to a degree of conscious control. The frequent failure of planning, persistence of old precedents, or emergence of unanticipated consequences testifies to the incompleteness of cognitive anticipation. Thus the human species has both directional movement (teleology) and uncontrolled drift, or stagnation, although hominid evolution has featured a reduction of the latter. Obviously, interplay between directional movement and randomness is required in order to retain the freedom, or flexibility, component of adaptation.

The principal problem of the concept of adaptation in a broadened science of human ecology concerns the relation between adaptation in a biological sense and adaptation defined as a social and behavioral process. In the biological sciences, adaptation tends to refer to entropy functions; the behavior of organisms results in steady states or homeostatic rhythms. However, in social behavior, the organism may do just the opposite—disturb or overturn existing conditions in order to satisfy needs. In general, the biological conceptions of adaptation have had a strong element of mechanistic teleology—as, for example, in research which seeks to demonstrate that predator and prey interaction tends to stabilize species populations, or in the investigations of trophic cycling of nutrition in a relatively closed environment like a pond. There is nothing wrong with these interpretations, since they seek to define the structure of anticipatory phenomena in a domain devoid of cognition (*20*). However, in the human case, teleology tends to become equivalent to conscious causation or history, that is, it assumes a cognitive role and anticipation becomes a conscious focus of policy. This means that projection of mechanistic teleological assumptions on the human social organ is a dubious enterprise at best, although there is no doubt that directional movements out of awareness of the human actors do occur in society and in relations between man and nature. Such directional movements must be treated as empirical possibilities, not as natural laws. Anthropology has periodically, for example, in both past and present cultural evolutionary theory, fallen into a mechanistic teleological mood, which makes it extremely difficult to handle short-term adaptive behavioral sequences and outcomes. The result is the tendency for cultural anthropology to oscillate between particularistic, microsocial depiction and grand evolutionary generalization.

However, the union of biological and social adaptational phenomena may be defined on a different level, that is, in terms of tension reduction in the organism. In Alland's definitions (*21*), tension reduction is equivalent to what he calls "internal adaptation," or the resolution of various processes within the individual in the course of behavior. Alland contrasts this concept to "external adaptation" or, presumably, what I call coping. There is no doubt that tension reduction figures in human coping behavior. Perhaps neurosis may be defined broadly as a state of perpetual conflict between functional coping styles and inner needs for satisfaction. If so, then neurosis is nothing more than hypertypical human behavior. This observation may provide an opportunity to orient culture and personality studies in anthropology toward adaptation, bringing them into conjunction with other subdivisions of anthropology.

Adaptive and maladaptive behavior in humans is based on the capacity for "self-objectification" and the "normative orientation" (*13*). Humans, with their impressive symbolic capacity (that is, capacity to become relatively free of arbitrary or one-to-one determining stimuli), also have the capacity to perceive the self in relation to the environment, which is of course the basis of human ecology. The self-objectification capacity is also quantitative. Tribal societies apparently possess this capacity to a lesser degree, that is, they perceive the self (humans) as largely in synthesis with the environment whereas industrial societies appear to develop the most pronounced sense of self detached from the environment. This is, of course, a facet of the more general subject and object conceptualization that is strongly developed in these want-dominated societies.

If we consider adaptation in terms of human relationships with the physical environment, the significant behavioral process is probably the ability to create an image of the physical world which is only partially congruent with empirical reality. The degree of congruence is variable; there exist no known generalized psychological controls over this symbolizing capacity, which varies only by individuals or, within particular groups, by experiential vectors controlled by degree of exposure to alternatives. However, it is this variance in experience and exposure which also lies at the root of the ethnological concept of discrete cultures. Since the human capacity for symbolic constructions of milieus is theoretically indefinite, different cultures are simply products of time and spatial position that affect experiences. A particular culture is a time-slice description of experiential constructs, subject to change as experience and environment change—granting some lags in individuals and in particular segments of the symbolic constructions.

The principal consequence of the disharmony between empirical nature and symbolic views of nature is, of course, the projection of human rhythms and purposes onto the physical universe. These human intentionalities can be defined as natural at a high level of generality, and theory must take this into account even though attempts to deal with it border on philosophy and religion. (For example, are human actions, destructive or problematic for nature in the short run, part of some larger design which contains cyclical patterning or homeostatic controls?)

In any case, the short-term consequences of human intentionality and anticipatory behavior have a more massive potential impact on the physical environment than the behavior of any other species. It is this impact which is currently conceived as problematic, since there appears to be no reliable means of control. The utilization of resources for the satisfaction of human purposes is subject to conceptions that are generated within the social organ and that have no reliable controlling relation to rational considerations such as sustained resource yield. Thus the distinctive characteristic of anticipatory behavior in the economic sphere is that it generates a form of adaptive behavior in which anticipation is keyed to satisfaction of wants or consummation rather than to future consequence (or, according to Whitehead, the freedom component tends to dominate over prudent anticipation). This has been an overall evolutionary tendency in the human species; particular societies over limited spans of time may demonstrate the opposite characteristics, but the general vector has been toward increasing use of resources to satisfy wants and desires. Hardin's "tragedy of the commons" (*22*) is the tendency, not the exceptional case.

One philosophical argument for eventual control falls back on the concept of ultimate naturalness. This can be expressed as slow-working, self-correcting feedback or as faith in the human ability to cognitively appraise the dangers and call a halt. These doctrines tend to neglect the way human intentions are bound by the communication systems called institutions or by vested interests and prestige reciprocities. Planning is expected to mitigate the pressures, but recently most planning appears to be compromise with vested interests, which ameliorates conditions or assuages conscience but does not affect fundamental direction.

Adaptation and Cultural Anthropology

In cultural anthropology, the first statement of the behavioral background of resource utilization or energy generation in the human species was presented by Barnett (*23*), who was concerned with innovation as the basis of culture change. With the use of Gestalt psychology, he defined innovation as the ability to synthesize components of perceptual and experiential fields in order to create new combinations or images of reality. The process as defined is not unique to humans, so its basic properties cannot account for the superior human capacities. Instead, one must rely on the quantitative differences between humans and other species to account for this superiority. For adaptational theory, the key is the cognitive capacity to visualize changes in contemporary phenomena, that is, to conceive of new things and thereby establish new anticipations. When existing phenomena need to be altered in order to achieve these anticipated ends, we can speak of coping. This appears, for all practical purposes, to be identical to innovation. I believe that the adaptational rhetoric is superior to the cultural since it focuses attention on the human actor and his behavior rather than on abstractions from his behavior. Generalization is achieved when we speak of group styles or modes of coping, that is, social adaptation. These are not really equivalent to culture as classically defined, since we remain at the level of behavior and human purposes.

Implicit in the above is the proposition that the important phenomena for an adaptational anthropology are dynamic human purposes, needs, and wants. Most of the past ethnological work on tribal cultures assumes or describes static patterns of purpose and want. Hence, ethnological theory, or cultural anthropology generally, has been poorly equipped to handle situations with rapidly changing purpose and want factors. Anthropology has generally neglected the fact that tribal societies represent sidelines but not the main thrust in behavioral evolution. If cultural anthropology is to convert to a study of contemporary society, it must make this shift to a theory with factors of reality as the central component.

The first anthropological attempt to

conceptualize coping behavior, and to contrast it to the cultural level of description, is Firth's distinction (*24*) between structure and organization. He defined structure as the relatively slow-to-change anticipations that are called values, norms, or expectations of the behavior of others. Organization refers to the more quickly changing behaviors designed to attain immediate ends or to cope with shifting temporal circumstances. The basic distinction is thus temporal, not substantive, and Firth's essays can be read as an attempt to keep an explanatory role for culture while giving recognition to the need and purposive dimension of behavior which is of paramount importance in the everyday movement of human existence.

Firth's distinction helped to liberate cultural anthropology from its preoccupation with reified, fixed systems and began the transition to an adaptational framework. Any consideration of everyday reality alters the generalizing, timeless mode of classic ethnological description; it requires the anthropologist to become concerned with purpose and accomplishment, that is, to deal with instrumental activities as significant in their own right. Ethnology's frame of reference has shifted since the introduction of Firthian concepts—from essentially archeological description of self-contained tribal societies to studies of human behavior in tribal contexts under varying degrees and conditions of involvement with larger systems.

I conclude from the emphasis of published reports that the trend in recent years is toward a three-way classification of the data of cultural anthropology. This classification, which can handle both tribal and nontribal materials, is as follows (*25*).

1) *Thought*. Description of ideas, values, goals, and purposes as articulated by the members of the group under study. These need not, of course, be unique to that group. The collection of thought patterns should be made without prejudice as to their permanence or changeability, since the depth or rootedness of particular mental constructs cannot be known in advance. Societies differ in the extent to which mental concepts actually define the ends of living and the degree of adaptive flexibility. To an increasing extent in the contemporary world, people learn differing and often compartmentalized systems.

2) *Interhuman activity*. In the social dimension, the relations between people are expressed by structural diagrams and reciprocities of behavior. Mental constructs from 1 may or may not define the parameters of these interhuman relationships, since, to an increasing extent, situational coping (see 3 below) tends to set styles of response. However, every society retains a corpus of relationships that may be described by such terms as consensus, conflict, affiliation, individualism, or role playing.

3) *Adaptive behavior*. Obviously the distinction between this category of data and the others is purely analytical, because both thought patterns and interhuman relationships are involved in adaptation. However, in the adaptational mode, the emphasis shifts toward strategic coping, that is, the attempt to realize individual and social objectives through the mobilization of social and material resources. This category of behavior has become dominant in the contemporary world with its interdependence and growing constraints on free action.

The empirical question for the cultural anthropologist concerns the extent to which these three categories of data are integrated in any concrete social situation. When congruence can be demonstrated—for example, when the observed social behavior and thought articulations are mutually consistent, and coping is handled mostly by precedent—one might well speak of the existence of a culture. This usage of the term is reminiscent of Redfield's distinction (*26*) between culture and civilization which implies that, in the latter, inconsistency between the sectors of experience is typical and thus requires rational action for resolution or suppression of the resultant conflict—a process largely unknown in the "folk society." The distinction is, of course, relative and idealized, since all human societies display inconsistency.

However, a conception of culture as the precedents that people use to construct patterns of coping is more appropriate for an adaptational approach. Precedents may be derived from either the thought or the interhuman activity data categories, and therefore can be called by a variety of names: norms, values, role expectations, prestige, and the like. However, precedents, made available by advanced communication and memory functions in the human species, do not determine coping behavior at all times. The degree to which precedents are operative, and their quantity, is an empirical, not a theoretical, question. Since few human actions occur without precedents, either manifest or latent, these precedental factors (culture) become part of the milieu to which humans respond. To simplify the argument somewhat, the adaptive nexus of human action can be defined as the relation of present goals to past precedents—a nexus in which causation is absorbed into the context of reciprocal functioning as a temporal process. This does not, of course, eliminate simple cause and effect sequences that are a result of factors which compel the sudden redirection of action along new lines, for example, a natural catastrophe. However, in these cases, the adaptive nexus soon comes into operation.

In an adaptational approach, it is also essential to distinguish the microsocial and macrosocial levels of behavior and function, since in human societies (and to a real but unknown extent in nonhuman societies) these characteristically differ in their consequences. The microsocial description concerns behavior of individuals in defined group situations and pertains mainly to their instrumental actions, that is, satisfaction of purpose and want. This mode also has both manifest and latent meaning that depend on the particular precedental components and their quantity. The macrosocial level pertains to the consequences of these individual actions for other and larger groups and society in general. Here judgments must be based on both neutral and scientific assessments and on values and purposes believed to be representative of a general trend. It cannot be assumed (contrary, incidentally, to traditional democratic values) that microsocial actions are always consistent with macrosocial aims and standards. In the tribal society, such consistency was probably of a high order; in modern pluralistic societies of all levels of development, the expectations are less probable. The satisfaction of individual needs characteristically may violate (that is, be maladaptive for) social well-being.

The details of the anthropological synthesis suggested by the use of adaptation as a paradigm is a topic for a separate paper, but a summary can be provided. Among the topical fields of cultural anthropology, political, economic, ecological, and social-transactional studies appear to constitute a core which is increasingly concerned with human coping with real events (*27*). I shall call this instrumental anthropology. If this constitutes one wing of cultural anthropology, then the other consists of interpretive anthropology, including the study of symbolism, meaning, and the combination of symbolism and semantics known as structuralism, according to the designation given it by its founder, Claude Levi-Strauss. Methods of research in this wing may also feature especially intimate interaction with human subjects. In general, this interpretive wing of anthropology exploits the descriptive mode of the

culture concept—Geertz's term, "thick description," is apt. The instrumental wing moves toward science, that is, generalizations and explanations of human behavior, by the use of a variety of models. An adaptational approach would appear to be more securely based in the instrumental wing, but since values, symbols, and precedents are part of the adaptive nexus, they cannot be ignored. Psychocultural anthropology for the moment stands between these wings (*28*). The current feasible limits of synthesis in cultural anthropology are thus suggested—for instrumental anthropology, culture is the qualitative and quantitative precedents for decision, or opportunities for and constraints on free choice; for interpretive anthropology, culture is the qualitative corpus of symbolism characteristic of the era. Although the two wings are mutually dependent, the multidimensionality of human behavior appears to require differing conceptual foundations; culture is, at best, a heuristic device.

Summary: Adaptation and Policy Science

The central issue in human affairs is dual. It includes the search for autonomy in the midst of constraint and the countervailing search for control in the face of license. Humans, like all organisms and, in a metaphorical sense, all physical phenomena, seek satisfaction of anticipations; while this search is governed in part by built-in controls and possibilities, there is a large domain of freedom and novelty. Humans have greater freedom (will) than other species and phenomena, but at the same time it is apparent that this capacity can be abused, and survival or peace of mind threatened by disregard of prudent restraint. As Boas observed in a neglected essay (*29*), humans exist in a milieu of their own making which is always a mixture of freedom and conformity. I believe that this should be the central issue in the concept of culture if the concept is to be salvaged.

My proposal for this salvage (or replacement) operation is to focus on adaptation as the central topic of cultural and perhaps of all anthropology. Adaptation is a word for the human capacity for coping with milieu in order to establish protocols of both freedom and constraint. It is a researchable field since anthropology already has developed many of the necessary concepts and operations, however disguised these may be by the abstract language of patterns, values, and the like.

A cultural anthropology conceived in terms of social adaptation will almost automatically become a science oriented toward policy (*30*). Its findings will pertain to the basic question of what humans need and want, how they go about acquiring these, and what consequences for society and the environment will result. While the program outlined here can apply to tribal and peasant society, it is perhaps more cogently represented in the study of modern life, wherever this may be found—in the industrial societies or in the new, former tribal nations. Within the discipline, the approach, at the least, prefigures a synthesis between the subdivisions now labeled social, economic, political, and ecological anthropology, and possibly psychological anthropology as well. In addition, the importance of valuational phenomena for the study of adaptational processes means that anthropological studies of symbolism, art, religion, and values may eventually become part of a joint effort. Whether he considers himself humanist or scientist, the anthropologist will acknowledge that man lives by both bread and dollars, art and the spade, belief and pragmatic accommodation. It is the union of these modes which constitutes the distinctive human version of Whitehead's anticipation, and his homogeneous, but also varied, universe.

References and Notes

1. This article is a condensation and, I believe, a sharpening of chapter 8 of my book (*2*). A related version is J. W. Bennett, in *Proceedings, Eighth International Congress of Anthropological and Ethnological Sciences* (Science Council of Japan, Tokyo, 1968), vol. 3, p. 237.
2. J. W. Bennett, *The Ecological Transition: Cultural Anthropology and Human Adaptation* (Pergamon, New York, 1976).
3. There is an issue in the philosophy of science that I shall refrain from joining. I refer to the distinction by Thomas Kuhn [*The Structure of Scientific Revolutions* (Univ. of Chicago Press, Chicago, 1962)], later modified by him, between scientific fields with a central theory or paradigm, and those without—an argument adopted by George Stocking, who called anthropology a "preparadigmatic" science [G. Stocking, *Race, Culture, and Evolution: Essays in the History of Anthropology* (Free Press, New York, 1968)]. As implied in the text, various reasons can be adduced for the diversity or disunity of anthropology: the inherent variety of subject matter; the multidimensionality or multipotentiality of human phenomena; and the close, empirical contact with the subject matter which characterizes anthropological method. I thank G. E. Montgomery for clarification of this issue.
4. A. L. Kroeber and C. Kluckhohn, *Pap. Peabody Mus. Archaeol. Ethnol. Harv. Univ.* **47**, (No. 1) (1952).
5. J. Steward, in *Theory of Culture Change*, J. Steward, Ed. (Univ. of Illinois Press, Urbana, 1955), p. 30.
6. There is a persisting controversy over the scientific as opposed to humanistic identities of cultural anthropology. For a review of the issues, see Robert Redfield [in *Anthropology Today*, A. L. Kroeber, Ed. (Univ. of Chicago Press, Chicago, 1953), p. 728]. Clifford Geertz, in a more recent collection of essays on culture, appears to abandon scientific postures and accept the humanistic; he considers cultural anthropology's objective to be the preparation of "thick description" [C. Geertz, *The Interpretation of Cultures* (Basic Books, New York, 1973), chap. 1]. A similar methodological concept, "depictive integration," was popularized by A. L. Kroeber and others. Both of the above authors refer to a detailed description of human contexts that is similar to historical writing. I hesitate to choose sides; although I wish to introduce more generalizing capacity into cultural anthropology, my choice of a Whiteheadian source for the approach provides a link to phenomenological and humanistic orientations. I believe there is no fundamental difference between science and humanistic study; there are merely various methodological continua that vary by subject matter.
7. I refer here to the interrelation of tribal agricultural methods, population and migration, and malarial disease on the one hand, and the build-up of the sickle cell gene in West African populations on the other. This is a clear case of how human activities influence human biology, and the reverse. While a great deal of information on sickle celling has appeared in recent years, the classic statement remains Frank Livingstone's article [*Am. Anthropol.* **60**, 533 (1958)].
8. J. M. Burgers, *Science* **189**, 194 (1975).
9. H. Kummer, *Primate Societies: Group Techniques of Ecological Adaptation* (Aldine, Chicago, 1971), chap. 1.
10. In my opinion, the most cogent discussion of potential applications of general systems theory to human society is that of Walter Buckley [*Sociology and Modern Systems Theory* (Prentice-Hall, Englewood Cliffs, N.J., 1967)]. The most intensive attempt by an anthropologist to apply ecosystem theory (which is quite different from general systems theory) to a human situation is R. Rappaport's study of swine management in a New Guinea tribal group [R. A. Rappaport, *Pigs for the Ancestors: Ritual in the Ecology of a New Guinea People* (Yale Univ. Press, New Haven, Conn., 1967)]. My paper, however, is primarily concerned with adaptation as a concept useful in the analysis of human behavior in historical populations. When adaptation is applied to archeological populations or ethnological populations of a residual character, the concept takes on more generalized and often more biologically oriented meaning. In such studies, the central issue of human purpose and the means devised to fulfill it are present, but are generalized over longer historical periods or larger demographic or geographic units. Paradoxically, the use by archeologists and ethnohistorians of adaptation as a central concept has produced findings of greater significance for resource management and human engineering than has cultural anthropological research. As an example of the combined ethnographic, archeological, and ecological approach to human adaptation (in this case, the Aleut people), see W. S. Laughlin [*Science* **189**, 507 (1975)].
11. W. Davenport, *Jamaican Fishing: A Game Theory Analysis* (Yale Univ. Press, New Haven, Conn., 1960).
12. The basic ideas were presented by A. N. Whitehead [*Process and Reality* (Macmillan, New York, 1929) and other editions], but the most accessible phraseology appears in *Adventures of Ideas* (Macmillan, New York, 1933). ". . . 'to be something' is to be discoverable as a factor in the analysis of some actuality. . . . Any set of actual occasions are united by the mutual immanence of occasions, each in the other. To the extent that they are united they mutually constrain each other . . . one occasion will be in the future of the other. Thus the earlier will be immanent in the later according to the mode of efficient causality, and the later according to the mode of anticipation. . . ." (Mentor, ed., 1955, p. 199). However, "the antecedent environment is not wholly efficacious in determining the initial phase of the occasion which spring from it" (*ibid.*, p. 200). (See also, G. H. Mead, *Philosophy of the Present*, Chicago, Open Court, 1932).
13. A. I. Hallowell, in *The Evolution of Man*, S. Tax, Ed. (Univ. of Chicago Press, Chicago, 1960).
14. M. D. Sahlins and E. R. Service, *Evolution and Culture* (Univ. of Michigan Press, Ann Arbor, 1960).
15. L. A. White, in *The Science of Culture*, L. A. White, Ed. (Grove, New York, 1958).
16. _____, in *The Evolution of Culture*, L. A. White, Ed. (McGraw Hill, New York, 1959).
17. A. L. Kroeber, *Am. Anthropol.* **19**, 163 (1917).
18. For some discussions of the concept of adaptation in anthropology, see (*19, 20*) and the following. M. Harris, *Trans. N.Y. Acad. Sci. Ser. 2*, **23**, 59 (1960); M. D. Sahlins, in *Horizons of Anthropology*, S. Tax, Ed. (Aldine, Chicago, 1964); R. A. Rappaport, *Am. Anthropol.* **73**, 73 (1971).
19. M. F. A. Montagu, Ed., *Culture: Man's Adaptive Dimension* (Oxford Univ. Press, New York, 1968).
20. Although data is accumlating from plant and animal ecology to demonstrate that the stability

bias in bioecology has been excessive [C. S. Holling, *Diversity and Stability in Ecological Systems* (report and symposium held 26–28 May 1969 at Brookhaven National Laboratory, Upton, N.Y.)].
21. A. Alland, *Evolution and Human Behavior* (Doubleday, Garden City, N.J., 1973).
22. G. Hardin, *Science* **162**, 1243 (1968).
23. H. G. Barnett, *Innovation: The Basis of Culture Change* (McGraw-Hill, New York, 1953).
→ R. Firth, *J. R. Anthropol. Inst.* **85**, 1 (1955).
25. For a comparable listing, see H. A. Selby, *Biennial Review of Anthropology*, B. Siegel and A. Beals, Eds. (Stanford Univ. Press, Stanford, Calif., 1972)].
26. R. Redfield, *The Primitive World and Its Transformations* (Cornell Univ. Press, Ithaca, N.Y., 1953).
27. A random selection of articles on instrumental cultural anthropology is as follows. F. Barth, *Am. Anthropol.* **69**, 661 (1967); M. D. Sahlins, in *Essays in Economic Anthropology*, J. Helm, Ed. (American Ethnological Society and Univ. of Washington Press, Seattle, 1964), p. → J. W. Bennett, *Southwest. J. Anthropol.* **24**, 276 (1968); R. E. Rhoades and S. I. Thompson, *Am. Ethnol.* **2**, 535 (1975); J. Westermeyer, *Am. Anthropol.* **75**, 123 (1973); R. M. Netting, in *Annual Review of Anthropology*, B. Siegel, Ed. (Annual Reviews, Palo Alto, Calif., 1974), p. 21; T. H. Hay, *Am. Anthropol.* **75**, 708 (1973); G. Britan and B. S. Denich, *Am. Ethnol.* **3**, 55 (1976); L. A. Despres, in *The New Ethnicity: Perspectives from Ethnology*, J. W. Bennett, Ed. (American Ethnological Society and West Publishing, St. Paul, Minn., 1975), p. 127; N. Whitten and D. Whitten, in *Annual Review of Anthropology*, B. Siegel, Ed. (Annual Reviews, Palo Alto, Calif., 1972), p. 247.
28. "Instrumental anthropology," with its concern for rational or purposive behavior, would appear to be concerned with phenomena similar to that contained in Daniel Bell's "techno-economic" domain; and my "interpretive anthropology" appears similar to that in Bell's "culture," or "expressive symbolic" domain of contemporary society. Bell's third domain, "polity," or the field of social control, is echoed in my emphasis on "policy" as a consequence of applying adaptational analysis to social behavior. However, I read Bell's book after completing this article and there has been no effort to bring concepts in line with his thesis [D. Bell, *The Cultural Contradictions of Capitalism* (Basic Books, New York, 1976)].
29. F. Boas, in *Freedom: Its Meaning*, R. N. Anshen, Ed. (Harcourt Brace, New York, 1940).
30. C. S. Belshaw, *The Sorcerer's Apprentice: An Anthropology of Public Policy* (Pergamon, New York, 1976).

Three-Dimensional Structure of a Transfer RNA in Two Crystal Forms

Analysis of three sets of atomic coordinates of yeast phenylalanine tRNA establishes common features.

Joel L. Sussman and Sung-Hou Kim

Transfer RNA (tRNA) plays a central role in decoding the genetic information in messenger RNA (mRNA) during protein biosynthesis. Recently, x-ray crystallographic studies on yeast phenylalanine tRNA ($tRNA^{Phe}$) revealed its intricate tertiary structure. Although the "complete" refinement of the yeast $tRNA^{Phe}$ structure will require a few more years, the three sets of currently published atomic coordinates of this tRNA in two different crystal forms are good enough to compare and draw conclusions about the structural features that are common.

The purpose of this article is, first, to critically analyze the three sets of published atomic coordinates, in order to determine the range of errors and the criteria used in defining structural features, especially hydrogen bonds, for each model; and second, to compare the three models so as to sort out those structural features that are present in all three models at high confidence level. The common structural features so obtained can provide a solid foundation for all studies on the structure-function relationship of tRNA.

There is a general tendency to freely accept x-ray crystallographic results of macromolecules despite the cautious statements investigators make. Such acceptance is usually safe for gross structural features such as backbone folding, secondary structures, and approximate coordination geometry around metal ions, but not for isolated features such as the existence or absence of a single hydrogen bond, small differences in conformational angles, or detail of coordination distances and symmetry. It is also not uncommon that the interpretation of electron density maps changes at successive stages of x-ray crystallographic studies. However, such changes become minor as the refinement proceeds.

These shortcomings can partially be overcome if one can compare several structures of the same molecule determined and refined by different groups, and then accept only those structural features that are common among them as reliable at high confidence level. Such is the case with yeast $tRNA^{Phe}$. For example, one can see in Fig. 1 a few changes in the assignment of tertiary base pairing at two different stages of refinement in each model. Although there may be more changes on further refinement, the gross differences among the three models have now disappeared. There are many minor differences (see below) at the present stage of refinement, but one should not take them as *real* until they are supported by other evidence. It is likely that most of these apparent differences will also disappear on further refinement of the three models.

The backbone structure of yeast $tRNA^{Phe}$ was revealed from an x-ray crystallographic study on the orthorhombic form at a resolution of 4 Å (*1*), and the preliminary tertiary interactions within the structure have been described for both orthorhombic (*2*) and monoclinic (*3*) crystal forms based on 3 Å resolution data and recently reviewed (*4*). Preliminary comparison of the two crystal forms, based on the structure factor amplitudes at 4 Å (*5*) and on the general appearance of the electron density maps at 3 Å resolution (*6*), suggested the similarity of the structures in both crystal forms. In the last few months, three sets of atomic coordinates have been reported for this tRNA, so that it is now possible to make a detailed, objective comparison between the structures; two sets of atomic coordinates for this tRNA in an orthorhombic crystal form have been obtained by two different refinement procedures with the use of the same diffraction data (*7*, *8*), and one for the same tRNA in a monoclinic crystal form by another procedure (*9*). All three procedures are different but related to each other with the common goal that the model obtained should fit the experimental data and known stereochemistry.

For convenience, the structures in the orthorhombic crystal form refined by the Duke group (*7*) and the MIT (Massachusetts Institute of Technology) group (*8*) are called A and B, respectively, and that in the monoclinic form refined by the MRC (Medical Research Council of Great Britain) group (*9*) is called C.

Dr. Sussman is a fellow of the Arthritis Foundation, in the Department of Biochemistry, Duke University School of Medicine, Durham, North Carolina 27710. Dr. Kim is an associate professor in the Department of Biochemistry, Duke University School of Medicine.