Human Relations, Volume 34, Number 8, 1981, pp. 677–703

Toward the Anthropological Study of Cognitive Performance[1]

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This paper examines the logical and empirical basis for cognitive analysis in anthropology. A review of the assumptions that cognitive anthropology makes about the nature of human cognition and behavior is followed by a critical discussion focusing on four problems: (1) the psychological reality of analyses, (2) the competence versus performance dichotomy, (3) the sharedness of cognitive systems, and (4) explanatory perspective in cognitive anthropology. This discussion concludes that as presently constituted, cognitive anthropology does not take us toward the goal of producing an adequate account of cognitive performance. Evolutionary structuralism, which appears to be a viable approach toward this goal is outlined, its major points are discussed, and its implications for continued research are elaborated.

[1]Preparation of this paper was supported in part by National Institute of Mental Health grant # MH-15589-03. A shorter version of this paper was presented to the symposium "The Future of Structuralism" at the 1981 Intercongress of the International Union of Anthropological and Ethnological Sciences, Amsterdam, The Netherlands, under the title, "Structuralism and the Anthropological Study of Human Cognition." My participation in the Intercongress was made possible by a travel grant from the American Council of Learned Societies, that is here gratefully acknowledged. Earlier versions of this paper were presented in talks given at the University of Illinois, Chicago Circle; Georgia State Univesity; and the University of Houston. For helpful discussion of this material I thank Michael Agar, Bruce Arlinghaus, Gary B. Coombs, Larry Fisher, Charles D. Laughlin, Jr., H. Stephen Straight, and Oswald Werner.
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0018-7267/81/0800-0677$03.00/0

> So den duh guy begins to ast me all kinds of nutty questions: how big was Brooklyn an' could I find my way aroun' in it, an' how long would it take a guy to know duh place.
>
> "Listen!" I says. "You get dat idea outa yoeh head right now," I says. "You ain't neveh gonna get to know Brooklyn," I says. "Not in a hunderd yeahs. I been livin' heah all my life," I says, "an' I don't even know all deh is to know about it, so how do you expect to know duh town," I says, "when you don't even live heah?"
>
> "Yes, " he says, "but I got a map to help me find my way about."
>
> "Map or no map," I says, "yuh ain't gonna get to know Brooklyn wit no map," I says.
>
> —Thomas Wolfe, "Only the Dead Know Brooklyn,"
> *From Death To Morning.*

INTRODUCTION

This paper examines the logical and empirical basis of cognitive analysis in anthropology. It argues that much of cognitive anthropology is, for both logical and empirical reasons, in need of revision. The approach is to characterize cognitive anthropology and thus to make its aims explicit. This is followed by a critical discussion of four issues that prove central to cognitive anthropological understanding. Finally, an alternative approach to the study of human cognition, evolutionary structuralism, is described.

COGNITIVE ANTHROPOLOGY: A BRIEF CHARACTERIZATION

Perhaps the best way to go about characterizing cognitive anthropology is to look at what cognitive anthropologists say about what they do. Conklin (1964) (see also Hammel, 1965) specifies that

> an adequate ethnography is . . . considered to include the culturally significant arrangement of productive statements about the relations obtaining among logically defined categories and contexts . . . within a given social matrix. (p. 93)

Tyler (1969) adds that cognitive anthropology

> focuses on *discovering* how different peoples organize and use their culture. This is not so much a search for some generalized unit of behavioral analysis as it is an attempt to understand the *organizing principles underlying behavior.* It is assumed that each people has a unique system of perceiving and organizing phenomena—things, events, behavior and emotions (original emphasis). (p. 3)

Similarly, Frake (1962, pp. 28-30) argues that the task of the ethnographer is not to get words for things but to find things that go with words. Because not even the most concrete physical objects can be identified apart from a culturally defined conceptual system, ethnographers should strive to define objects according to the conceptual system of their informants. Their task is not one of linguistic recording, it is one of identifying the things in their informants' cognized environments: What does *their world* look like?

Perhaps the first general point that should be made about cognitive anthropology is that it focuses on intragroup phenomena. Moreover, these phenomena are culture-specific, unique instances of more general principles of behavior. Cognitive anthropology attempts to understand how members of a culture construct and use a mental model of reality. It aims to produce an analysis which allows the anthropologist to view the world through the informants' eyes—to "get into the informants' mind." Importantly, a cognitive anthropological analysis is not conceived simply as an instrumental explanation of a series of behavioral regularities. Rather, the analysis "gets at" the informants' principles of organization instead of the anthropologist's model of those principles.

Another way to approach the characterization of cognitive anthropology is to look at the sorts of things it takes as the proper objects of study. The above quote from Tyler indicates that what cognitive anthropologists seek to identify, and to explicate, is structure. Often this search focuses on semantic structures, although the nonlinguistic analogs of those structures are sometimes considered. Tyler (1969, p. 25) argues that the approach is concerned with the interrelation of facts within a single (rather abstract) domain, not with the relation between different levels of organization.

Cognitive anthropology's main concern is with structure; used in a sense which meets requirements set out by Piaget (1970, pp. 3-16) in his recent explication of structuralist thought. Thus, it is because structure exists apart from the theoretician that it can be discovered. The structures investigated by cognitive anthropologists are also assumed to form wholes, to have rules governing their composition (i.e., rules of transformation), and to be self-regulating (i.e., they are self-maintaining and complete).

Not only do cognitive anthropologists seek to discover structure, in many cases they attempt to formalize their discoveries. This formalization proceeds on several levels, but the necessity of formalizing analyses is central to cognitive anthropology. As Tyler (1969) says

> If you will attempt to complete the statement of semantic features for the taxonomy of furniture, you will see that the discovery of these features is difficult in your native langauge. It is even more difficult in a strange language. As a consequence, new fieldwork techniques and methods have had to be devised. Most important among these are techniques of *controlled eliciting* and methods of *formal analysis* (original emphasis). (p. 12)

While controlled eliciting is a technique for gathering data about structures, formal analysis is a method of stating the results of controlled elicitation. Formal analysis places "its emphasis on internal consistency, completeness and form" (Tyler, 1969, p. 13). Lounsbury (1964) describes the procedure as follows:

> [w]e may consider a "formal account" of a collection of empirical data has been given when there have been specified (1) a set of primitive elements, and (2) a set of rules for operating on these, such that by the application of the latter to the former, the elements of a "model" are generated. . . . A formal account is thus an apparatus for predicting back the data at hand, thereby making them "understandable," i.e., showing them to be lawful and expectable consequences of an underlying principle that may be presumed to be at work at their source. (p. 212)

A formal analysis, then, is said to be complete when it describes the relations among all of the elements comprising the domain under investigation.

Since cognitive anthropologists seek to discover structure and then, with varying degrees of rigor, attempt to formalize those structures, cognitive anthropology may be characterized as a form of structuralism which focuses on intragroup mental phenomena.

Implicit in this structuralist approach is the view that human cognition and behavior is rule-following (or, at least rule-oriented) in the sense that behavior can be generated by the application of a set of structure-defining and structure-manipulating rules or principles. Indeed, early on in his discussion of cognitive anthropology, Tyler (1969, p 3) calls attention to the fact that cognitive anthropology is concerned with the rules or principles that people utilize in organizing and using their culture.

A subsidiary proposition of this assumption is that the study of social behavior is the study of symbolic-cognitive systems. Moreover, it suggests that what is of interest is not only how this symbolic-cognitive system is used but the structure of the system itself. This investigation often boils down to the formal semantic analysis of a lexical domain, though the behavioral-cognitive domain being studied need not be linguistic. Although the study of nonlinguistic behavioral domains appears to give rise to additional empirical problems, such as how to identify the usually vaguer and less well-bounded behavioral analogs of lexical domains (but cf. Quine, 1960, 1969), the theoretical assumptions remain *in principle* unchanged in symbolic-cognitive analysis of any type of behavior.

Closely related to this assumption is another about the nature of human cognition and behavior. This is that human cognition and behavior is hierarchically organized on the basis of a set of distinctive features. This assumption can most easily be seen in the analytic tools that cognitive anthropology employs. By way of example, Frake (1962) points out that one analytical tool available to cognitive anthropology is the taxonomy. The development of a taxonomy involves the explication of contrast on two levels: contrasts within and among domains of symbolic organization of varying scope. An associated attribute of a taxonomy is inclusion: versus branching, i.e., the lower levels are included in the higher ones while elements at the same level are coordinated with each other. Intralevel contrast develops the breadth of the domain under study while the interlevel contrasts increase the depth and detail of the domain being examined.

It might be objected here that these are simply residual results of the form of analysis employed. Here I would point out that methodological techniques have an intimate relationship with the theoretical programs which utilize them. Method is implied by theory, these cannot be logically incompatible. Hence a willingness to analyze behavior and cognition into hierarchically ordered levels is an indication of the analyst's implicit theoretical commitment to certain assumptions about these phenomena.

The final set of assumptions in cognitive anthropology to be considered here also stem from the central use of formal analysis. These are that (a) analyses can and should be presented with a maximum amount of specificity and clarity; (b) the analysis should be exhaustive in the sense of specifying all the cognitively relevant relationships between all elements in a symbolic domain; and (c) a formal account should reduce redundancy by handling predictable relationships between elements by common rules and by omitting strictly idiosyncratic cognitive content within elements. The first assumption is straightforward. Precision is a desideratum sine qua non of scientific explanation (see Hempel, 1965; Nagel, 1961; Salmon, 1971). And the second assumption poses no special problems. It is surely desirable for an account of some phenomenon to be as complete as possible, though the criteria for "cognitive relevance" remain to be specified. The third assumption, that the analysis should be as elegant as possible, is problematic. It suggests that the more parsimonious the account the better. In the following section of this essay, I will argue that this maxim is not a priori desirable in the study of human cognition and behavior (see also Rubinstein & Laughlin, 1977; Rubinstein and Tax, 1981; Count, n.d.; Rubinstein, Laughlin, & McManus, n.d.).

In sum, cognitive anthropology makes three sets of assumptions about the nature of human cognition and behavior. At the center of the first set is the notion that human behavior is rule-following. This raises a number of questions about the nature of these rules, their ontological status, the relation of these rules to individual actors in a culture, and the like. The second set focuses on the notion that human cognition and behavior should be seen as hierarchically ordered. This suggests questions about the uniqueness of an individual's rule system, the combinability of rule systems, the verification of such hierarchical ordering, and the relationship of behavior to the rules. Finally, the third set of assumptions incorporates the view that the simpler the formulation of these rules the better. This raises the questions, are the rules utilized by informants always the simplest, or is it possible for a messier, less elegant set of rules to provide a more adequate explanation of the behavior being studied?

In the next section these and other related questions are discussed. The outcome of this discussion is a demonstration that cognitive anthropology is fundamentally incapable of arriving at a theory of cognitive performance.

COGNITIVE ANTHROPOLOGY: A CRITICAL EVALUATION

A discussion of the problems inherent in cognitive anthropology can be organized around four main issues: psychological reality; the sharedness of cognitive systems; the competence: performance dichotomy; and the choice of explanatory perspective in anthropological analysis.[3] Each of these will be treated briefly below.

On Psychological Reality

To advance the claim that a particular anthropological analysis has psychological reality for the informants is to assert that the analysis explicates the cognitive processes that were, and are, utilized by the informants to arrive at certain behaviors. Differently phrased, the claim is that the ethnographer has discovered the significant stimuli in the informants' environment, as well as the principles of organization that the informants use to model these stimuli. The importance of this is that the ethnographer is claiming to have, in some sense, "gotten inside of the informants' mind" and managed to puzzle out of the complex of mental activity the particular set of cognitive activities that went into the informants' production of particular behaviors.

Cognitive anthropological analyses claim, albeit often only implicitly, to present the calculus used by informants, *rather than any equivalent calculus.* Since there are always alternative calculi that are equally effective (see Hunter, 1977, p. 39; Wallace, 1970, pp. 87-88) how can we tell that we have identified *the* calculus used by the informants?

If the ethnographer takes his or her task to be the discovery of significant stimuli, and the explication of the principles used by the informants to organize those stimuli, then the ethnographer is obliged to claim psychological reality for the analysis presented. Hence, it is fair to ask for a

[3]Some of the material in this section is drawn from Rubinstein (1974). It must be emphasized that this discussion focuses on ethnoscience qua the study of human cognitive process. Much of what I say here is not intended as a treatment of ethnoscience qua lexicographic exercise.

demonstration of that psychological reality. Broadly phrased, the question is, can the psychological reality of the analysis be put to empirical test?

Four characteristic ways of "resolving" the problem of psychological reality emerge from the literature: (1) the question is dismissed as unimportant; (2) an appeal is made to the simplicity or formal elegance of the analysis; (3) introspective confirmation is sought from the actors themselves; and (4) the abstraction of internal states from their external manifestations is used as supporting evidence.

The first method of resolving the question of psychological reality is to set it aside by saying that it is trivial and unimportant. To do this is, as I have suggested above, to miss the point of cognitive analysis which is the production of psychologically real analyses. Thus, this response vitiates all cognitive claims.

The second approach is to suggest that the most parsimonious analysis is the psychologically real one. The dictum here is that, all else being equal, the briefer or the more general the analysis the better. This is an unsatisfactory answer for two reasons. First the consistent application of the principle of parsimony would require that with the development of an analysis that is more parsimonious than an analysis earlier accepted, we replace the earlier calculus with the newly derived one. This would create serious problems, for if the first psychologically real calculus is removed in favor of the second, we in effect deny the reality of the first. Here it would be possible to hedge a bit and suggest the modification of the criterion of psychological reality as follows: all else being equal, the more parsimonious an analysis the closer it is to being psychologically real. But this is a considerably different claim from that which says the ethnographer can discover the psychologically real calculus. In fact, this move forces the ethnographer to relinquish any claim for the cognitive status of the analysis. Thus, for practical reasons, parsimony cannot be used as a necessary condition for determining psychological reality.

Second, empirical evidence suggests that cognitive systems and strategies are not always the most streamlined and direct (e.g., Saltz, 1971, pp. 253-341; Bruner, Goodnow, & Austin, 1956; Neisser, 1967). Indeed it appears that cognitive systems and strategies quite often turn out to be suprisingly clumsy and indirect. The dictum of parsimony will not suffice as a general rule for resolving the problem of psychological reality.[4]

[4]There are several general problems involved in the application of the principle of parsimony to scientific theories. How, for example, is the criterion establishing the degree of parsimony to be formulated? Quine (1964) has persuasively argued that the application of the principle of parsimony may confound, rather than aid, the development of sound scientific theory.

The third solution typically involves recourse to the informants' introspective confirmation of the ethnographer's analysis. This approach relies on the informants' ability to describe their internal states to the ethnographer. In effect this method of resolution involves the presentation of the analysis to the informant with the question: What do you think, is this the way you went about it? (This, of course, is a caricature of the approach. However, the problems facing this formulation remain intact even in the more sophisticated versions of this approach.) The objection to this approach can be concisely stated: how is it possible for the ethnographer to know that the introspection is accurate?

Even if we suppose that every informant has the ability to give accurate introspections, the problem stands. For how is the ethnographer to know that informants are in fact conveying their true introspections to the ethnographer? Certainly had Turnbull (1967, 1972) attempted to confirm his analysis of the Ik via introspective techniques, he would have met with little success. On the other end of the spectrum informants might "feed the ethnographer what he/she wants to hear," with equally spurious effects (Chagnon, 1977).

This discussion has an analog in experimental psychology where it is labeled "experimenter bias" or the "Rosenthal effect." That literature notes that it is quite possible that the information which the informant gives to the ethnographer will be biased due to any one of a number of variables in the interaction situation (Rosenthal, 1963).

It is clear that introspection does not offer a solution to the problem of psychological reality. I should emphasize here that the weight of my assertion that introspection is not a solution to this problem is not intended to advance the stronger claim that introspective accounts from informants have no place in ethnography. In fact, I think that introspective accounts from informants have a large role to play in the study of cognition and behavior (Rubinstein, 1976, pp. 120-124; and cf. Fisher & Werner, 1979).

The fourth and final approach to the question of psychological reality rests on the abstraction of internal behavior states from their external manifestations. This approach may be characterized as follows: the ethnographer collects the data, constructs the cognitive analysis, and then checks the adequacy of the analysis by returning to the data. The failing of this approach rests on the distinction between exploratory and confirmatory inquiry (Giere, 1976).[5] The period of exploratory inquiry finds the ethnographer developing working hypotheses and analyses. In

[5]Note the similarities between this distinction and Reichenbach's (1938) distinction between the context of discovery and the context of justification. In the context of discovery no logical rules or conventions need be followed, while in the context of justification it is essential that logical rules and conventions be scrupulously adhered to.

this phase of inquiry it is legitimate for the ethnographer to seek recourse to the same corpus of data that he/she used to derive the working hypotheses and analyses when he/she seeks to evaluate the utility of these concepts. The period of exploratory inquiry would thus yield testable hypotheses and the beginnings of a theoretical structure. The period of confirmatory inquiry, however, focuses on the testing of well-developed theoretical structures via hypotheses derived from them. The confirmatory period yields statements about the nature of the phenomena being investigated. In the confirmatory period it is not legitimate to return to the same corpus of data because this creates a statistical bias tending toward the confirmation of the hypotheses under test. If the original corpus of data is used to evaluate the analysis then the evaluation is post hoc. Cognitive anthropologists often return to check the adequacy of their analyses on the same body of data from which the analyses were derived [recall, Lounsbury's assertion that formal analysis is "an apparatus for predicting back the data at hand" (1964, p. 212)]. Hence, the post hoc fallacy is implicit in their analyses.[6]

This appears not to raise any problems for the cognitive anthropologist who would return to the field to collect a new sample of his/her informants' behavior against which to test the analysis. However, this approach is confounded by the nature of cognitive systems, for as Piaget (1971a, 1971b) and others (d'Aquili, Laughlin, & McManus, 1979; Neisser, 1967; and Saltz, 1971) have pointed out, cognitive systems are dynamic and they continually model reality for the individual. The shape of an individual's cognitive system is uniquely influenced by his/her experience. Thus between time T_1 and time T_2 an informant's cognitive system will necessarily undergo change, unless the informant is in vacuo. The best that can be said is that our present models and research techniques are inadequate for testing the psychological reality of anthropological analyses.

On the Sharedness of Cognitive Systems

A major assumption of cognitive anthropology is that the members of a single society utilize a single monolithic cognitive system.[7] Thus, the explication of the cognitive system(s) of a limited number of informants is seen as sufficient for the explication of the cultural "cognitive system." As currently formulated this position is untenable on two levels. First it

[6]See Huff (1954) and Salmon (1973) for fuller discussions of this type of logical fallacy.
[7]Although interest in intracultural variation has increased in recent years, treatments of the issues thus posed have heavily emphasized problems in lexicographic rather than cognitive analysis (e.g., Werner & Fenton, 1973).

can be demonstrated that a mutually shared cognitive system is *not* a *logically necessary* condition for the existence of sociocultural systems. Second, the weight of empirical evidence about the nature of cognitive systems suggests that they are highly idiosyncratic constructions (models) of the environment. To combine these systems without some form of facilitating mechanism, e.g., ritual (see d'Aquili et al., 1979) is to damage at least some of the systems that are "forced" into the general mold.

The first line of criticism was developed by Wallace (1970, pp. 27-34). His argument is worth considering at length. A system, for Wallace, is defined by two attributes. First, it is comprised of a group of elements which are related such that a change in the state of one element produces a nonrandom (i.e., predictable) change in at least one other element in the group. Second, there needs to be at least one sequence which involves all of the elements in the group. He goes on to consider the question: What is the least complex system that an ethnographer might describe? Wallace notes:

> such a system must satisfy the following minimal requirements; first, that two parties *A* and *B*, the initiator and the respondent, respectively, interact; second, that each completion of one sequence of interactions be followed, sooner or later, by a repetition of the same sequence. (1970, p. 27)

Wallace calls the resultant system a primary equivalence structure (ES_1). He goes on to develop a secondary equivalence structure (ES_2), and notes that, "the distinguishing feature [of the ES_2] is that the consummatory act of each party is released by (but not necessarily exclusively conditional upon) the instrumental act of the other" (Wallace 1970, p. 27). He then develps three- and four-person equivalence structures based on this model of interaction. Wallace is careful to note that these equivalence structures would represent the ethnographer's model of the observed social interaction. He considers what combination of maps held by two parties are compatible with the ethnographer's model. He assumes for simplicity that the ethnographer's model is valid, and that the systems are perfect in that there are no exceptions to the regularity expressed in his formulation of equivalence structures by the biconditional. Returning to the distinction between instrumental and consummatory acts, he notes that in a teleological sense *A* does a_1 in order to be able to do a_2; likewise for *B*'s doing b_1 and b_2. And, he says,

> it is therefore true by definition that neither *A* nor *B* will continue to participate in the system unless, first, each perceives that *within the limitis of the system,* his ability to perform his own consummatory act depends on his partner performing his instrumental act; second, that when he performs his own instrumental act, its function is to elicit his partner's instrumental act; third, that he repeatedly performs his own instrumental act. (Wallace 1970, p. 30)

Wallace is thus able to show that there are four "cognitive" maps compatible with the continued existence of a simple system of social interaction, demonstrating that it is not logically necessary for the existence of sociocultural systems that their members share a single cognitive map. Wallace also argues that in some contexts cognitive nonsharing may be essential to the existence of a social system.

Wallace's argument aptly demonstrates the logical case against the claim of "cognitive sharing." What remains is the parallel, though weaker, claim that while it is not logically necessary for members of a sociocultural system to share a cognitive map, such cognitive sharing may well be expected to exist.

The bulk of the empirical evidence concerning cognitive systems provides no justification for this view. For, as noted above, Piaget (1963, 1971b), Neisser (1967), and Saltz (1971) have demonstrated that cognitive systems are dynamic entities; they result from a constructive process. Importantly, the direction that the construction takes is influenced by individual experiences, thus making identity in construction unlikely.

In what sense then, if any, are cognitive systems held in common? Clearly, the answer to this must be that they are shared only in the broadest possible way. To attempt to equate cognitive systems in detail requires that the details of at least some of the systems being combined be damaged. There appears to be no conceptual or empirical support for the claim that such detailed combinations can be made. In addition, there is a growing body of literature within the ethnoscientific tradition which recognizes just this point (e.g., Werner & Fenton, 1973; Sanday, 1968).[8]

The assumption that members of a sociocultural unit share in a single cognitive system is neither logically warranted nor empirically justified.

On the Competence versus Performance Dichotomy

Much of cognitive anthropology has grown by analogy to linguistic theory (Werner & Fenton, 1973; Fisher & Werner, 1979). Because of this cognitive anthropology owes many of its theoretical and methodological concepts to linguistics. Examination of its literature shows that often embedded in the work of cognitive anthropologists are two distinctions borrowed from linguistics: (1) deep structure versus surface structure, (2)

[8]Commenting on several papers in a symposium on visual information processing, Newell (1973, p. 299) notes that ". . . the same human subject can adopt many (radically different) methods for the same basic task, depending on goal, background knowledge, and minor details of payoff structure and task texture—all this—implies that the 'normal' means of science may not suffice [to identify the subject's method]". Earlier in the same paper, he argues that psychology is after the discovery of specific methods that subjects use in doing experimental tasks. And, he notes that, "[earlier] considerations lead directly to the next assertion: SECOND INJUNCTION OF PSYCHOLOGICAL EXPERIMENTATION: never average over methods. To do so conceals rather than reveals: you get garbage, or even worse, spurious regularity" (1973, p. 294).

competence versus performance. Often cognitive anthropologists approach their analyses with the suggestion that the behaviors that they are examining are simply surface manifestations of a deep structural level. Their use of this distinction seems to be relatively nonproblematic. However, their use of the notions of competence and performance creates difficulties.

In his programmatic statements about the study of language, Chomsky (1965, 1972) draws a distinction between a speaker-hearer's competence and performance. By competence Chomsky means the logical features of a linguistic system (Missner, 1970), or the coding principles which linguists abstract from language data (Straight, 1976): "the speaker-hearer's knowledge of his language" (Chomsky, 1965, p. 4). Performance consists of the actual production and comprehension of language by people: "the actual use of language in concrete situations" (Chomsky, 1965, p. 4). Cognitive anthropologists have sought to apply this distinction, mutatis mutandis, to the study of cognitive systems.

Cognitive anthropology claims to explicate the cognitive calculi used by informants to produce actual behaviors. To maintain that the explication of these models reflects the actual cognitive processes employed by informants is to develop a theory of performance. But to treat the study of "native models" as the explication of models used by idealized informants in idealized situations is to develop an instrumental theory—a theory of competence. From the former it is legitimate to claim that "this is how the informants go about reaching this particular set of observed behaviors." From the latter it is only legitimate to speak of idealized individuals and situations, of coding principles and of the logical features of presumed systems. It is not sound procedure to develop models of competence and then to claim that these models explicate performance. This is so because only when the situation is idealized can the processes underlying the production and interpretation of behavior be thought of as direct reflections of competence and thus taken as a unitary set of processes (cf. Straight, 1976). It appears, in fact, that people necessarily use two distinct sets of processes for interpreting and producing behavior. As Straight (1976) has shown for language, the different neurocognitive processes underlying production and interpretation in daily activity require that a theory of cognitive performance specify the processes by which individuals regulate the penetrance of the operational environment into their cognized environment, the processes by which they regulate the penetrance of their cognized environment by the operational environment, and the processes by which individual cognized environments are entrained for social action (see Table I).

Unfortunately, cognitive anthropology uses what can only be taken as idealized cognitive models and presents them as systems of cognitive performance. Cognitive anthropology seeks a theory of cognitive performance (see Frake, 1964; Spradley & McCurdy 1972), yet its meth-

Table I. Evidence for a Dichotomy Between Comprehension and Production in Linguistic Theory[a]

	Comprehension	Production
Ambiguity	Multiple, dynamic	Fortuitous
Attention	More than one input at a time	Only one input at a time
Accessibility of intended meaning	Limited by context and superficial evidence	Unlimited (except via self-monitoring comprehension processes)
Phonological features	Auditory or visual ("taxonomic")	Articulatory [plus auditory and kinesthetic features employed by feedback mechanisms ("systematic")]
Flexibility (size of vocabulary, range of sensitivity)	Necessarily great (passive vocabulary superior to active, understand much we do not produce)	Usually rather limited (neither inarticulateness nor inability to mimic hinders comprehension)
Variation	Wide tolerance and high recognizability, large number of styles or registers	Probablistic or competitive, limited number of styles or registers
Nature of the editing process	Weeding out of implausible interpretations	Back-tracking and reformulation on the basis of self-monitoring
Neurology	Wernicke's area (posterior superior temporal)	Broca's area (posterior inferior frontal)

[a] After Straight (1976 p. 536).

odological procedures produce accounts of cognitive competence at best. This confusion is in part responsible for the difficulty which cognitive anthropology has in resolving the questions surrounding the issues of cognitive sharing and psychological reality.[9]

Perspective in Cognitive Anthropology

The analysis of social regularities may come to rest on any of a number of levels, and the power of analyses at different levels may appear

[9] Cognitive anthropologists are not the only ones who have either misapplied or, in their desire to have it do as much theoretical work as possible, overextended this distinction. For instance, in a discussion of neurolinguistics Whitaker suggests that: "To the extent that the distinction has kept linguistics semi-isolated from relevant facts or language use, to that degree the distinction is no longer viable. *The attempt to correlate current descriptions with plausible psychological descriptions of language behavior has been marginally productive* as noted by Bever (1970); although structural descriptions of language behavior may be adequate representations of the *units* of language production and recognition, transformational rules do not seem to match in any systematic way the *processes* of production *and* recognition (1971, pp. 143-144, emphasis added).

to vary widely. However, an adequate and complete explanation can only be rendered by considering all levels of organization present in the interaction of an individual and the environment (Rubinstein & Laughlin 1977; Wimsatt 1980; Rubinstein & Tax 1981). Insofar as cognitive anthropology attempts to explain social behavior by reference to a single level of analysis it must be said to lack the explanatory perspective necessary for the full understanding of behavior.

THE ANTHROPOLOGICAL STUDY OF COGNITIVE PERFORMANCE

The thrust of the preceding discussion is not to suggest that the techniques of cognitive anthropology are not useful for anthropological analysis. Rather, it suggests that cognitive anthropology, qua theory of cognitive performance, cannot be attained through these methods. It is because the existing work in cognitive anthropology has produced a formal theory of cognitive competence rather than a realist theory of cognitive performance, that it is necessary to look for an alternative theoretical approach to serve the anthropological study of human cognition.[10]

Laughlin and d'Aquili (1974), d'Aquili (1972), Rubinstein and Laughlin (1977), Laughlin and Brady (1978), d'Aquili, Laughlin, and McManus (1979), and Rubinstein (1979a, 1979b) have begun to formalize a theoretical position within anthropology that should help resolve the difficulties facing the development of an anthropological account of cognitive performance. This theoretical position, biogenetic structuralism, is a special instance of the broader theoretical school of thought that has elsewhere been called evolutionary structuralism (Rubinstein, 1976; Laughlin & Stephens, 1980). In general, evolutionary structural thinkers may be said to hold to the proposition that the explanation of observed phenomena must be made by reference to ontologically real, knowable, but often rarely observable structures that are systemic in function, pan-human or pan-societal universals, and usually, but not always, unconscious to the actors. In addition, the evolutionary structuralist approach to these structures is developmental, biologically grounded, and neurophysiological or cognitive in attributing the locus of structure.

The remainder of this section will review some of the theoretical tenets of the biogenetic structural expression of evolutionary structuralism, explicate its major concepts, and suggest how it enables us to develop an account of cognitive performance.

[10]Some material in the following section is modified from Rubinstein, Laughlin, & McManus (n.d.).

Biogenetic Structuralism

Biogenetic structuralism advances four major claims: (1) Human behavior is the result of a dialectic between the central nervous system, primarily the higher cortical functions, and the environment. (2) "Cultural" and "purely learned" behavior really are diverse manifestations of universal structural models. These models are understood to be neuroanatomically based structural configurations many of which are at first wholly, and later partially, determined by genetic coding and are susceptible to the pressures of natural selection. (3) That modes of "thought," "reason," "cognition," "sciencing," "mythologizing," "magical causation," and the like are the behavioral equivalents of internal, neurophysiologically structured, and systematic channels of sensory association and processing characteristic of humans. (4) Most such cognitive processing occurs outside of awareness (Laughlin & d'Aquili, 1974, pp. 195-196).[11]

The Cognized and Operational Environments

On this view the major function of the brain is the modeling of reality. This function is carried out so efficiently that we are hardly ever aware that the world we experience is not a world of objective reality. Yet there are good reasons to suppose the existence of such an objectively real world—a world of multidimensional processes in dynamic interaction, undergoing change through time. This is clearest through example. Thus, tiny mesobiota, nematodes, are so numerous that they cover virtually all solid surfaces on the earth. Overgaard-Nielsen (Odum 1971, p. 369) estimated that their population may become so dense that between 1 and 20 million may live within one square meter of soil. It had been said that if everything on earth but nematodes were to vanish suddenly, we would see the outline of virtually everything through the veneer of nematodes remaining.

Most people, however, with the probable exception of some microbiologists, do not conceptualize nematodes in their everyday view of the

[11]Note the similar theoretical direction of Moyer (1973). He says, ". . . the brain contains inborn neural systems that, when active in the presence of particular stimuli, results in aggressive behavior toward those stimuli" (1973, p. 35). [Moyer's model differs from biogenetic structuralism in that he posits localization of these structures in a single secion of the brain; a position rejected by biogenetic structuralism.] There is certainly a good deal of evidence to suggest that such models play a role in human behavior. For example, Salk (1973) demonstrates that there is a biological tendency for human mothers to hold their infants in particular fashions which would have adaptive value for the species [see also, Count (1973)].

world. They do not, this is to say, include nematodes as part of their model of reality. Yet it is unlikely that they would wish to say that because they have not modeled them, nematodes do not, therefore, exist.

This distinction between the world comprised of models within our brains, and the world that is objectively real and modelable is fundamental to the biogenetic structural view, and is captured in the distinction between the *cognized environment* and the *operational environment.*

The cognized environment (E_C) consists of all the information modeled in an individual's nervous system through the operation of which the individual recognizes, processes information about, and responds to processes in the operational environment (E_O). Because this distinction is pivotal it is helpful to explore briefly a few of the more interesting implications of this perspective. Before doing so, however, the fundamental distinction between structure and content within the cognized environment must be made.

In the cognized environment *structure* is any system that processes and orders information, while *content* is the information upon which an individual acts (Cole & Scribner, 1975; Schroder, Driver & Streufert, 1967). To give a simple analogy, a system of pipes provides the structure that orders the flow of water through a building. The pipes provide structure, the water content. A structure is *latent* if it is not actively processing information (a pipe system would be a latent structure if no water was flowing to the faucets). It is *functioning* if it is processing information. It is axiomatic on the biogenetic structural view that there can be no content without concomitant and underlying structure, but that there can be latent structure without content (see, e.g., Rubinstein and Tax 1981).

The cognized environment develops; it grows, in a biological sense, as a specific function of the general processes of individual development (Piaget 1971b, 1977). Thus, the acquisition and development of structure is the construction of neural models within the individual's nervous system. As a result, the principles directing the construction of neural models, and therefore, the emergence of knowledge, also place constraints on the nature of the individual's knowledge about the operational environment.

Much of the potentially modelable operational environment is internal to the individual. There are, for example, many aspects of our own organism that we commonly do not model: the microbiota that inhabit our alimentary canal and aid our digestion, the melanocytes that produce our skin and hair color, the countless billions of molecules that comprise our bodies. This consideration suggests that any particular aspect of an individual's organism may or may not be modeled within the cognized environment. Thus, it is possible to distinguish a special aspect of the cognized environment which is the "cognized self," which includes portions of both the internal and external operational environments.

Just as there are aspects of an individual's internal and external operational environments that are not modeled in the individual's cognized environment, an individual may construct models that have little or no correspondence to objects or events in the operational environments. For purposes of this discussion at least, examples of such models might include leprechauns, salvation, hobbits, gods, nymphs, transsubstantiation, and the Easter Bunny. Elsewhere it has been shown that many models combine veridicality and delusion in adaptation to certain aspects of the operational environment (Laughlin & Stephens, 1980).

To some degree the structure and content of an individual's cognized environment models the elements and relations between elements in the operational environment. Thus, as the cognized environment develops, it is at different times more or less isomorphic with the operational environment. Because the concept of isomorphism is important, and because its use is special, I here offer two definitions of it (and related concepts). The first sets out the important intuitive aspects of the concept, the second gives a more formal, set theoretic version.

Isomorphism refers to the correspondence between the elements and relations comprising a particular system, and the elements and relations comprising another system of a different form. Of course, while there exists a correspondance between the organization of one system vis-à-vis another, the actual elements and relations comprising each system are made of different stuff. When we describe the relationship between nematodes and bacteria the elements and relations comprising one system (our descriptions) are signs (words, numbers, and the like) and logical relations, while the elements and relations comprising the other system are organisms and biotic relations. Yet, the way we arrange the signs and logical relations in the former system in some sense models—is isomorphic with—the arrangement of organisms and biotic relations in the world. Thus, for example, while the brain models the operational environment by discrete arrangement of neural tracts, the aspects of the operational environment being modeled have precious little to do with these neural tracts. Nonetheless, there exists a kind of correspondence between the arrangement of neural tracts comprising the cognized environment and the arrangement of objects and events in the operational environment (Pribram, 1971).

Formally this notion may be expressed as follows. A relationship between two structures S and S' is isomorphic just in case cardinality is the same for both, and there is a one-to-one correspondence of their relations. That is, S is isomorphic with S' just in case S may be mapped onto S': $R_S = S'$.

Complete isomorphism means that the organization of one system completely maps the organization of another, and vice versa. But complete isomorphism rarely exists. Thus, the cognized environment is never more than partially isomorphic with the operational environment. The concern, then, is with the partial mapping of one system by another. To illustrate: the relationship between the signs and symbols on a road map on the one hand, and the towns, roads, and other objects in the geographic area covered by the map on the other hand, is partial at best. The road map is then only partially isomorphic with the operational environment processes being modeled. By extension, the entire cognized environment is only partially isomorphic with the operational environment.

The relationship of partial isomorphism may be formally described as follows. A structure S is partially isomorphic with a structure S' just in case $S = S'$, and every function in S' is a restriction of a function of S' to S. Put differently, S is partially isomorphic with S′ just in case S may be mapped into S': $R_S \in S'$.

Even this does not fully describe the complexity of the situation. Because the construction of knowledge about the operational environment in the form of cognized environmental models is a biological phenomenon (it is the nervous system which provides this function for an individual), it is open to selection. Hence, the cognized environment can be said to be adaptively isomorphic with the operational environment when the degree of "fit" between the cognized environmental model and the operational environment process leads to the minimal biological fitness of the individual; that is, it leads to the individual's survival and production of offspring.

More formally, the cognized environment is adaptively isomorphic with the operational environment when, (1) N represents the total set of neural models within the brain of an individual; (2) $E_C = N$, $E_O \neq 0$; (3) $R_{E_C} \in E_O$; and (4) $E_C \supset E_O$ is a sufficient condition for the biological survival of the individual.

Variations in an operational environment may be of three general types. They may be caused by unique events, they may be ongoing, and more-or-less progressive (such as in the increase in population density or the normal acquisition of language by a child), or they may occur in a repetitive sequence that has a more or less predictable range of frequency and character (such as periods of drought which occur annually or typhoons and hurricanes). The maintenance of adaptive isomorphism between an individual's cognized environment and a changing operational environment of the first two types may be accomplished by simple equilibration of the cognized environmental models (Piaget, 1977; Laughlin & Brady, 1978). In the face of repetitive shifts in the operational environment, however, there is a tendency to maintain adaptive isomorphism by modeling the change by recurrent shifts in the structure and content of the cognized environment. This tendency has elsewhere been termed *diaphasis* (Laughlin & Brady, 1978, p. 21).

The cognized environment can model itself; in other words, it may construct models of its own models. Just as models within the cognized environment are typically partially isomorphic renditions of operational environmental processes, the secondary model will be only partially isomorphic with the primary model, and so on. With each remove from the initial modeling, the secondary model will lose some closeness of fit. This does not necessarily mean that secondary models are less adaptive. In fact, the opposite may well be the case. For example, it was thought that cognition was based upon language (Watson, 1920). Our present understanding is that cognition is evolutionarily and ontogenetically prior to language, and that language models cognition. Nonetheless, language serves as an important process for bringing about the adaptive isomorphism of cognized models with operational environmental processes. In a sentence, cognition is a simplification of the operational environment, and language is a simplification of this simplification.

Thus, the nervous system operates upon the operational environment as a unit, but many of the information processing systems operating within the nervous system do so beyond the boundaries of consciousness. We may not be aware of the structure or of the information being processed by that structure, or we may be aware of the information but not aware of the mediating structure. Quite typically the conscious aspect of the cognized environment constructs models of the individual's own nervous system function and structure. This cognized environment modeling of itself produces an ego, the cognized self. In modeling its own functioning, the cognized environment inevitably resorts to transposition. The ego is a simplification of self, the notion of "scientific method" is a simplification of the natural processes of cognition, and so on. This is important, for when the individual operates from the cognized model *the model may constrain the functioning of the system to the simplified elements and relations cognized.* It is for this reason that not only is our knowledge of the operational environment fallible, but our knowledge of the operating structures themselves must be fallible.

The cognized environment operates as a system (Harvey, Hunt, & Schroder, 1961; Piaget, 1971; Laughlin & d'Aquili, 1974). The individual will function to maintain the integrity of that system, or any subsystem thereof, when it is confronted by anomalous input from the operational environment (McManus 1979a, 1979b). It will do so in a variety of ways including distorting the information for assimilation into the system (Wallace, 1957; Turiel, 1966; Rubinstein, 1976, 1979), rejection of the information (Hastorf & Cantril 1956, Festinger, Riecken, & Schacter, 1956), and holding the information within memory in, as it were, encapsulated form, without assimilating the information into the cognized environment.

The cognized environment remains relatively open to information input and action output vis-à-vis the operational environment. This occurs through a feedback-feedforward system involving sensory modalities and motor systems in complex tests of the goodness of fit of the models [Laughlin & d'Aquili (1974) have called this sytem the Empirical Modification Cycle]. It is through the testing, evaluation, and modification of neurocognitive models that individuals maintain the adaptive isomorphism of their cognized environment with the operational environment. The remarkably complex process underlying this system and thus serving to maintain the internal integrity of the cognized environment while simultaneously allowing the system to undergo change is equilibration (Piaget, 1977).

For analytic purposes, transformations can be divided among three types. A developmental transformation increases or decreases the complexity of the operating structures in ontogenesis, or in the day-to-day functioning of the cognized environment (Piaget, 1952). Within any level of cognitive complexity information may be processed by a partial set of neural subsystems entrained in a functional array (Luria, 1976). A change in the organization of neural subsystems in the array is a surface transformation. Such surface transformations are characterized by a system remaining at the level of organizational complexity at which it was prior to the transformation, yet undergoing a repatterning of the arrangement among elements in the array, or a shift in the value placed upon specific elements. As a result, a very negative view, for example, can transform to its opposite yet maintain the same structural characterictics.

Changes in the information passing through the system may be called a sensory transformation. To a significant degree, it is the structure itself which determines the nature of the information which enters it. Thus, the surface structure and developmental level will define in part the information the individual "sees" and the mode through which the information is integrated into the system. There appears to be a general tendency for the system to distort the information to fit that already encoded, and to process it in terms of the system's complexity of organization (McManus 1979a, 1975).

The disparity between individuals' ability to experience effects and their relative inability to directly experience causes is the zone of uncertainty of the cognized environment. This follows from the inevitable partial isomorphism of cognized models with the operational environment. The ancient Egyptians, for example, were acutely aware of the yearly flooding of the Nile Valley, but had no direct knowledge of the cause of that flooding. Knowing that we must inevitably die does little to explain why we die, nor does it necessarily entail an experience of the agent of death. Generally speaking, then, if a salient effect has no directly perceivable cause, one will be provided by the conceptual system [d'Aquili (1972) called this the cognitive imperative]. Thus, ancient Egyptians attributed the annual flooding to the gods, and many cultures attribute death to sorcery, possession, and the like. Once formulated the cognitive sytem will operate to maintain its integrity, at times in the face of instances of overwhelming disconfirmation.

The cognized environment operates upon sensory elements which are models constructed from aspects of the operational environment. The operation by which a model of the total operational environmental process is constructed from, and later evoked by, partial information about the operational environment is the symbolic function (Laughlin, McManus, & Stephens, 1980). Put differently, the symbolic function is the operation through which the whole is inferred from the part. A model may be evoked by a stimulus in the internal or external operational environments. In either case, the evoking stimulus is normally called a symbol. The information contained within the model evoked by the symbol is the intentionality of that symbol—roughly, its "meaning." It is critical to note that a symbol never evokes the operational environmental process itself, but a model of the process. Hence, the same stimulus may "mean" different things to different people. Clearly the evoked model will at best be partially isomorphic with the operational environment, and the intentionality of a symbol may include information having little or no correspondence to aspects of the part of the operational environment being modeled. This an obvious source of epistemological error that has concerned many generations of phenomenologists.

The Penetration Hypothesis

Because the cognized environment is a dynamic system in interaction with the operational environment, at least four levels of organization are implied: neurological, cognitive, and societal infrastructures, and surface structure (see Fig. 1). The cognized environment effects and is affected by the adjoining levels; it organizes the neurological structures of which it is comprised, and adapts to the effects of those operational envrionmental structures external to it (Laughlin & Brady, 1978; Rubinstein & Laughlin, 1977; Rubinstein, 1979a).

This is the notion of penetrance (McManus, Laughlin, & D'Aquili 1979). The penetration hypothesis states that each level of structural organization operates as a buffer and regulator between structures molecular to it and structures, equivalent and molar, external to it. Thus, the cognized environment operates as a regulator between the operational environment and the neural systems, subsystems, and models comprising the cognized

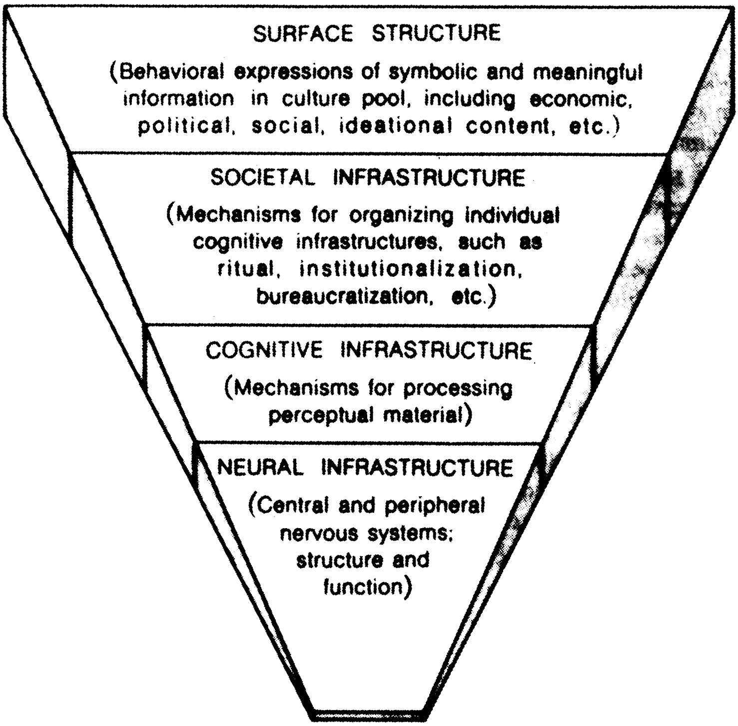

Fig. 1. Deep and surface structure: levels of structure operating in the human organism as actor in a social system (after Laughlin & Brady 1978).

environment. The penetration hypothesis has several important implications for the anthropological study of cognitive performance.

1. The integrity of any structure is directly related to its degree of permeability to penetrance. Total penetrance is synonymous with non-structure at any level.

2. The neurological systems comprising the cognized environment may be penetrated directly by the operational environment without mediation by the cognized environment.

3. The notion of cognitive boundary refers to the resistance of the cognitive system to penetrance.

4. Penetrance may be via information or structure. Structure is how the cognized environment is organized and the information is what is known about the operational environment. Penetrance may result in a decrement in cognitive complexity, or simply in the assimilation of information into cognized environmental models.

5. Adaptive cognized environments are semipermeable to penetrance. A cognized envrionment totally closed to penetrance will not long survive in a changing operational environment. On the other hand, a cognized environment too open to penetrance is vulnerable to disruption and ultimate discorporation. As implied by the notion of diaphasis, an adaptive cognized environment exhibits a range of permeability appropriately flexible in relation to the vicissitudes of the operational environment.

6. All else being equal, the more complex the organization of a cognized environmental system the less permeable that system is to structural penetrance. More complex cognized environments will admit, assimilate, organize, and even hold separate more information from the operational environment than will simpler cognized environments. Thus, complex cognized environments are more stable and flexible (have a greater range of control over penetrance) and are less vulnerable to structural change under impact from the operational environment.

7. Cognized environmental systems have sensitivities to penetrance which are peculiar to each system because each system level has stimulus defining properties. Both neurocognitive and operational environmental constraints exert principal influences upon the content and functioning of any component system.

8. A minimal amount of operational environmental complexity (or in a negative sense, noxiousness) is necessary to stimulate the optimal functioning of any cognized environmental system. Likewise, an over-abundance of novelty in the operational environment may cause a decrement in the functional capacity of the sytem (Schroder et al., 1967; Schroder & Suefeld, 1971; Rubinstein, 1976; d'Aquili et al., 1979). The interpenetration among adjoining levels of structure will take the form of mutually interacting U-curve functions, the vulnerability of each system being contingent upon the strength and complexity of that system. High penetrance is signaled by a closing of a system to complex or contradictory input, a concretization of functioning, and, perhaps, an exceptionally high rate of internal activity.

The notion of penetrance clearly pesents a complex view of cognized environment functioning. Many philosophers and scientists have noted that the human mind manifests a seeming drive to know, an epistemic imperative that has led to progressively greater fields of awareness and knowledge. This drive is accounted for, at least in part, by the penetration hypothesis. As the hominid brain has evolved to greater complexity, *H. sapiens* has taken an active part in increasing the range of experience providing information upon which the cognized environment may base its modeling function (Rubinstein & Tax 1981). Not only has information been organized in progressively more complex ways, the extension of processes and relations between processes encompassed in time and space by cognized environmental models has become progressively vast (Tielhard de Chardin, 1959). Science is the more or less conscious applications of pnetrance—the inquiring cognized environment penetrating and, in turn, being penetrated by operational environment processes.

CONCLUSION

The task of cognitive anthropology is the development of a realist theory of cognitve performance. To be adequate such a view must be multilevel in structure (Rubinstein, 1979a, 1980). For a number of logical and empirical reasons, the standard ethnoscientific approach to the anthropological study of cognition fails to provide such a view. The alternative approach outlined here, evolutionary structuralism, holds the promise of overcoming the difficulties inherent in the ethnoscientific view of cognition.

The evolutionary structural alternative suggests that we need to be prepared to "see" beyond the constraints imposed by ethnoscientific theory, that we should provide the most complex and fully isomorphic model of the operational environment possible for use as an approach to the study of cognition. As Thomas Blackburn has aptly said

> What is urgently needed is a science that can comprehend complex systems without, or with a minimum of, abstractions. To "see" a complex system as an organic whole requires an act of trained intuition, just as seeing order in a welter of numerical data does. . . . the intuitive knowledge essential to a full understanding of complex systems can be encouraged and prepared for by: (i) training scientists to be aware of sensuous clues about their surroundings; (ii) insisting on sensuous knowledge as part of the intellectual structure of science, not as an afterthought; and (iii) approaching complex systems openly, respecting their organic complexity before choosing an abstract quantification space into which to project them. (1971, p. 1007)

I take this "trained intuition" to mean that anthropologists should be capable of transcending constraints imposed on their own cognized environments by theoretical approaches normatively accepted by their discipline, and hence of entering into a direct and complex act of penetration constrained only by the limits of their operational structures. This is "seeing" in the Buddhist sense, viewing an aspect of the operational environment without projection of normative knowledge associated with that aspect. Granted, I here speak about a relative, not an absolute isomorphism, yet, the payoff can only be a more effective penetrance, resulting, in turn, in more fully isomorphic models of the operational environment. Certainly one way of facilitating this relatively more complex penetrance is by application of a view that recognizes the limits it places on, and the predilection it has for inquiry. It is to that end that the evolutionary structural approach to the study of human cognition outlined here is directed.

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