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The Cultural Part of Cognition

ROY GOODWIN D'ANDRADE
Department of Anthropology
University of California, San Diego

This paper discusses the role of cultural anthropology in Cognitive Science. Culture is described as a very large pool of information passed along from generation to generation, composed of learned "programs" for action and understanding. These cultural programs differ in important ways from computer programs. Cultural programs tend to be unspecified and inexplicit rather than clearly stated algorithms learned through a slow process of guided discovery, and involve the manipulation of content based rather than formal symbol systems. Cultural symbol systems often have affective as well as objective referents, giving them a strong directive effect. The argument is made that in the process of repeated social transmission and use, cultural programs come to take forms which have a good "fit" to the natural capacities and constraints of the human information processing system.

THE CULTURE POOL

A good part of what any person knows is learned from other people. The teaching by others can be formal or informal, intended or unintended, and the learning can occur through observation or by being taught rules. However accomplished, the result is a body of learnings, called culture, transmitted from one generation to the next, which, as Tylor stated in 1871, "includes the knowledge, belief, art, law, morals, custom, and any other capabilities and habits acquired by man as a member of society."

It is a significant fact about human culture that for the past 50 thousand years, the total amount of information transmitted from generation to generation has been increasing rapidly. Each generation has added some of its discoveries to the total stock of "pass it along" type information. In this respect, humans differ from other animals, who have relatively small and constant pools of "passed along" information. The fact that the human animal became different in this way is regarded by most anthropologists as the single most important factor in the evolution of *homo sapiens*. There is much speculation about the conditions which brought about this shift, but little consensus about what actually made the difference.

One way to measure the size and importance of this transmitted pool of information we call "culture" is to observe the things and events surrounding oneself, and note how much of one's environment is a product of this informational pool. For instance, most Americans inhabit a world of buildings, roads, vehicles, lawns, furniture, appliances, etc. which are all clearly cultural products. We in the US—unlike the Bushmen, for example—live most of our lives in a culturally manufactured, rather than a natural, environment.

It is not just physical objects which are products of culture. The institution of a learned society, the organization of its meetings, the concept of a "paper", the words used in the paper, all follow well used cultural formats and routines. Behavioral environments, consisting of complex messages and signals, rights and duties, and roles and institutions, are a culturally constituted reality which is a product of our socially transmitted information pool.

In saying that an object—either a physical object like a desk, or a more abstract object like a talk or a theorem—is a product of culture, I mean that the cultural pool contains the information which defines what the object is, tells how to construct the object, and prescribes how the object is to be used. Without culture, we would not have or use such things.

An interesting issue concerns the *size* of the cultural information pool. Quantifying information in terms of "chunks", or symbolic units which can be held in short term memory, it has been estimated that about 50 thousand chunks are required to play chess at the Master's level, or speak a language with a reasonable proficiency (Simon & Barefeld, 1969). Given this estimate, a figure of several hundred thousand chunks for all the cultural information known by a typical adult is quite conservative. Upper limits can be obtained by considering time constraints; e.g., to learn ten million chunks would require that one learn more than a chunk a minute during every waking hour from birth to the age of twenty.

This estimate of several hundred thousand to several million chunks per individual does not indicate how large the total cultural pool might be, since one of the characteristics of human society is that there is a major division of labor in who knows what. In the modern world this informational division of labor has reached a remarkable level. The total informational pool carried by the entire population of a society might be something like a hundred to ten thousand times the amount that any one person knows, yielding estimates of the total cultural information pool ranging from a few million to ten billion chunks of information.

Obviously, these estimates are highly conjectural. But certainly, the pool of cultural information in any known society is very large. Just the maintenance of such a large pool entails a number of remarkable engineering problems. For example, how can things be arranged so that all this information gets learned again and again without serious loss or distortion? How could one know if the information were lost? How can procedures be established so that the person who has the appropriate information is there when needed? How has all this been arranged in the past, and how can it be arranged in the future when it is likely there will be an even bigger pool? At present there are no clearly correct answers to these questions, although there are some interesting speculations.

More immediate and answerable questions within the field of anthropology concern the way in which the information in the cultural pool is organized on the individual level. One current formulation in anthropology treats the pool of cultural information as if it were a pool of algorithms or programs, a giant stock of procedures and representational declarations embodied primarily in natural language (Geertz, 1973; Geoghegan, 1973).

This idea has been considered by a number of people besides anthropologists. The following has been taken from a delightful book for children by Delia Ephron, titled "How to Eat Like a Child" (1977):

> How to eat chocolate chip cookies: "Half-sit, half-lie on the bed, propped up by a pillow. Read a book. Place cookies next to you on the sheet so that crumbs get in the bed. As you eat the cookies, remove each chocolate chip and place it on your stomach. When all the cookies are consumed, eat the chips one by one, allowing two per page."
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> A favorite among my children is the ice cream in a bowl routine: "Stir ice cream vigorously to make soup. Take a large helping on a spoon, place spoon in mouth, and slowly pull it out, sucking only the top layer of ice cream off. Wave spoon in air. Lick its back. Repeat until all ice cream is off spoon and begin again."

Ephron has taken the idea of a cultural procedure and used it for humorous rather than serious purposes, so that the resulting descriptions have some of the "truer than true" quality of caricature. I will have more to say about these "child programs" later. First, however, the more abstract relations between "program", or informational content, and "processors", or the invariant functions of the informational processing apparatus, need to be considered.

FIT BETWEEN PROGRAM AND PROCESSOR

The question of the relation between programs and processors is related to the question of what it is that cognitive anthropologists do, and how this differs from what cognitive psychologists do, and how these both are related to the field of cognitive science.

To a certain extent, I feel the need to apologize for using the well worn human/computer analogy. However, I believe there is still much to be learned from the comparison. It seems to me that the invention and development of the computer has acted upon the behavioral sciences in the way science fiction writers speculated that the presence of aliens from outer space would. A variety of science fiction stories have presented scenarios in which contact between humans and aliens stimulate psychologists and other social scientists to rethink their ideas about the nature of intelligence and humanity. The computer has had just such an effect.

It could be argued that any aspect of the study of culture is a part of cognitive science, since culture consists of the shared information—the cognitive content—upon which cognitive processes operate, and, hence, the study of culture is basically involved in a science of cognition. However, this is like arguing that anyone who does mathematics is doing cognitive science, since the basic study of algorithms is mathematical, and algorithms are the content upon which computers operate. This argument lacks plausibility, however. There are both mathematicians and anthropologists who do not appear to be doing cognitive science.

In my view, the cognitive part of cognitive anthropology is in its concern with the way in which cultural content "interfaces" with psychological processes. Cognitive anthropology and cognitive psychology are both concerned with the interaction between processing and information, except that the cognitive anthropologist wants to know how cultural information is constrained and shaped by the way the brain processes such information, while the cognitive psychologist wants to know how the machinery of the brain works on all types of information, including cultural information.

An important assumption of cognitive anthropology is that in the process of repeated social transmission, cultural programs come to take forms which have a good fit to the natural capacities and constraints of the human brain. Thus, when similar cultural forms are found in most societies around the world, there is reason to search for psychological factors which could account for these similarities.

Let me give an example from the area of kinship, specifically with work concerning the classification of kin.

The modern era of work in kinship classification was initiated by Floyd Lounsbury. In the fifties, when Lounsbury began work on kinship terminologies, it was known that different cultures had quite different systems of classifying kin. Geneaologies collected in different societies showed that our system of classifying kin was only one among a variety of ways by which relatives could be grouped. However, there was then no method by which one could achieve a feature analysis of the classification system. What Lounsbury, Ward Goodenough, Kim Romney, and others in the field of anthropological linguistics did was to develop a method, called componential analysis, by which one could typically work out conjunctive definitions for the entire set of kin terms (Lounsbury, 1956; Goodenough, 1956).

Several phenomena of interest emerged from work in componential analysis. Anthony Wallace noticed that although the societies which had been studied varied from small hunting and gathering bands of several hundred people to modern nations with populations in the millions, the number of kinship terms used in each society was relatively invariant, ranging from 14 to 40. Wallace speculated that this invariance was due to limitations found in human cognitive processing. Transforming these figures into information theory terms, Wallace concluded that humans could not discriminate more than about six bits of information simultaneously—and, in presenting a draft of his paper in 1960 discovered that George Miller had anticipated his finding (Miller, 1956). Wallace also discussed how a variety of cultural sets appeared to be affected by this limitation, such as the number of types of players or pieces in games, the number of phonemes in a language, the number of cards in a deck, the number of lexical items in number systems, the number of military ranks, etc. (Wallace, 1961).

Other questions arose concerning cognitive processing issues. It was found, for example, that for some kin term systems, several different analyses yielded equally good formal results. In order to try to find a method to resolve the question of which componential analysis had "psychological reality", Kim Romney and I did a study using semantic similarity ratings and multidimensional scaling. We assumed that the more features the two terms had in common, the more they would be judged similar. Based on the relative number of common features, we made predictions from each of the different componential models, and found that the similarity judgments made by our respondents gave clear results in favor of one analysis. The scaling results appeared to be so well formed, in fact, that we concluded that semantic features corresponded to psychological discriminations on the individual level, and that one could reasonably study certain aspects of semantics with multidimensional scaling techniques (Romney & D'Andrade, 1964, see also Romney, Shepard & Nerlove, 1972).

Another important aspect of Lounsbury's work with kinship terminologies was his use of the concept of a "basic" or "prototypic" object within a class, along with a set of rules by which membership could be "extended" to other objects within the class. For example, in some societies, the term for "aunt" includes not only one's mother's sister and one's father's sister (who would be defined in a feature analysis as "collateral female consanguineals of the first ascending generation"), but also one's father's sister's daughter, one's father's sister's daughter's daughter, one's father's sister's daughter's daughter's daughter, etc. This inclusion of the father's sister's daughters and their daughters as "aunts" seems strange to us, since it results in old men and women calling what we would consider a "great-grand niece" by the term for "aunt". To account for terms of this type, Lounsbury developed the notion of a definitional process by which the meaning of term could be extended from a basic object through recursive extension rules.

Since the classical definition of a class by "criterial" features is based on *just* set intersection, it became clear from Lounsbury's work that at least for kin terms, the classical view had to be modified. The notion of a class defined as a basic object with extensions, developed by Lounsbury, was later used by Berlin in his work on plant taxonomies (1972). Berlin found that similar ideas were used by biologists in systematic taxonomy. Kay and Berlin also used it in their work on color terminology (Berlin & Kay, 1969); and Eleanor Rosch used it in her work on the psychological processes involved in prototypes and classification (Rosch, 1975).

Thus, various aspects of kinship terminology have been found to have a relatively important "interface" with psychological processes involving classification, and encourage us to believe that it is reasonable to search for ways in which process and content fit together.

DIFFERENCES BETWEEN COMPUTER PROGRAMS AND CULTURAL PROGRAMS

Specificity

Given the assumption of a good fit between widespread cultural forms and psychological processes, differences in processing between humans and computers can be used to explore the ways in which cultural programs should differ from computer programs. And, on the other side, differences between computer programs and cultural programs can be used to explore the ways in which humans and computers should differ in processing operations.

For example, one major difference between cultural and computer programs is in the degree of precision with which computer programs must be stated. For almost all computer programs, there must be an exact and unambiguous specification of the steps to be taken to accomplish the task, while what it is that is being accomplished does not have to be represented at all in the program. For humans, however, what is to be accomplished is usually represented in detail, while how to do the task is usually given only incompletely and ambiguously, if at all.

The lack of specification is very apparent in human socialization and enculturation. A great deal of cultural learning takes place by the child trying to match some performance of the adult. Rarely is anyone taught by specifying the exact steps to be taken to accomplish something. Of course, there are some exceptions, such as the way we teach a few special skills, such as long division, figure skating, and the like. But most things are "taught" to a child in the way language is taught to a child—by letting the child learn it through observation, modeling, trial and error, and occasional instruction.

Even in so-called "formal instruction", such as in college courses, most learning is done through the student's active trial and error efforts. The experience that most of us have had with teaching is that no matter how beautifully we specify what is to be learned, students do not retain what is said, or know how to use what was said unless they engage in a very active integrative process.

Thus, part of the "joke" of the "algorithms" described in Ephron's "How to Eat Like a Child" is the idea that these procedures have to be specified.

Children usually learn without the steps being specified. Another part of the "joke"is that what children learn may not always be what we wanted them to learn—or what we thought we were teaching them. A third part of the "joke" is that although children learn many things "on their own", they end up learning to do exactly the same things—almost as if the behavior *had* been precisely specified.

The degree to which programs are clearly specified is inversely related to the difficulty in finding out what the programs are. It is relatively easy—at least in theory—to find out what programs a computer is using, and to determine the content of these programs. But since most of the cultural programs learned by humans are acquired by subtle and complex processes, it is typically very difficult to determine exactly what has been learned.

The problem of determining what has been learned is found throughout the behavioral sciences. In a variety of fields, from the study of natural grammars to the study of political action, the controversial issues are often over different hypotheses about the content and organization of learned cultural schemata. This problem also occurs in constructing many computer simulations of intelligent human behavior, where the programmer must "put into" the program complex scripts, gambits, grammars, and world knowledge with the assumption that without much evidence that these structures correspond to scripts, gambits, grammars, and beliefs of the humans whose behavior is being simulated.

Learning Cultural Programs by Guided Discovery

While it is the case that people learn most of their cultural programs for representation and action without these programs being specified in detail by the socializing agents, this does not mean that such programs are learned—or could be learned—without any guidance.

The evidence for this assertion is extensive. Looking at cross-cultural studies of socialization, one is struck with both the small amount of explicit step by step instruction and the large amount of occasional correction that characterizes cultural learning all over the world (Whiting & Whiting, 1973). These learning conditions are so ubiquitous that only in unusual settings does one get a chance to see what would happen if things were otherwise.

One example of what can happen when things are otherwise comes from the special world of psychological experiments. Several years ago at the University of California, San Diego, Marc Eisenstadt and Yakov Kareev carried out a series of studies on cognitive processing in the games of Go and Gomoku. They taught undergraduates the rules of the game, and then had them play a computer program which could be beaten, but not easily. As cognitive psychologists, they were interested in processing issues concerning top down and bottom up processing, search procedures, and memory chunking. To study these processes, they set up a number of experimental conditions involving such things as different time constraints on moves, board rotation, look-ahead screening, differential payoffs, etc. (Eisenstadt & Kareev, 1975). Subjects played large numbers of games, and in all conditions exhibited high levels of interest and strong motivation. However, one thing that I noticed was that, while the various experimental conditions showed clear effects, in no condition did the subjects really get to be good at the games. In Gomoku, for example, subjects won less than 20 percent of their games. What was curious here was that, in contrast to the subjects, experimenters were very good at the games. In fact, all the people in the laboratory seemed to be able to "beat the computer". So, how did this come to happen?

When I asked around about how come, I was given a variety of answers, some of which seemed wrong, such as the suggestion that undergraduates are dumb, or that playing against a computer throws people off. What Eisenstadt and Kareev suggested is that they and other people in the laboratory knew "winning patterns", and the subjects did not. Thus, the laboratory people knew that in Gomoku you had to block "double-threes" and try to set up "double-twos". From the data on games there was no evidence that subjects knew about the "double-two" and "double-three" strategies. But this raises another question as to how the laboratory people knew winning patterns, and the subjects did not. The subjects played long and hard, and the experimental conditions encouraged thoughtful look-ahead and even thoughtful look-back-to-see-what-went-wrong-and-replay-from-there.

My view of why the subjects did not know the patterns is that abstracting them is not so easy to do by oneself. Perhaps, if subjects had been asked to try to find winning patterns, rather than to try to win games, they would have learned to do better. But notice that most of the laboratory people did not have to learn everything by themselves. They talked to each other, had a terminology for the different kinds of winning patterns, and formed an effective social and cultural group. Thus they learned about Go and Gomoku the way most people learn most things—you try some of it by yourself, and other people help by giving occasional procedural advice and crucial instruction in classification when you get stuck.

The point is that it is easy to overlook the way a small amount of guidance can drastically affect the success and direction of the learning process. Often, people who study cognitive processing talk as if various cognitive schema were acquired in total isolation from the culture. Thus Schank & Abelson (1977), in a book which is otherwise notable for its innovativeness, perception and clarity, often speak of the learning of scripts as if this were an isolated learning process rather than the guided discovery of cultural knowledge. Furthermore, the kind of knowledge used in "scripts" is not just shared, but "institutionalized", in that this kind of knowledge is knowledge one is *expected* to know. One would be negatively *sanctioned* if one did not know it.

Another experimental example of the principle that people need guidance was told to me by Eleanor Rosch. Among the many things she was interested in while working among the Dani of New Guinea was the way cultural classification of number affects performance and ability. The Dani are unusual but not unique in having a counting system which has very few numerals—1, 2, 3, many. Rosch wondered what would happen if she gave her informants two piles of stones of different sizes, and asked them if there was the same number or a different number of stones in the two piles. Her informants created various solutions to this problem, such as using rhythmic counting and trying to remember how long it had taken to count each pile. One man, perhaps a genius of a certain sort, discovered the problem could be solved by putting stones into one-to-one correspondence. When given the same task later, however, he was unable to remember his fine solution, and went back to less adequate heuristic methods.

Thus, a discovery which is novel for our own time and place can easily be lost. It is a great help to have a name already there for a newly achieved schema, so that what has been discovered can be "addressed" and "retrieved" when needed. Generally, the things we discover are not novel, and already have names. Part of the method of guided discovery is having ready for the discoverer information about what has been learned, and how it is labelled.

Typically, cultural systems not only label what is a good thing to know or do, they also classify and label the kinds of errors people make. John Roberts, an anthropologist who has made a number of ingenious studies of small, well formed cultural systems such as trap shooting, playing eight ball, and flying a plane, has found that such cultural systems have a rich classification of kinds of errors or unseemly behaviors. For example, Roberts found a complex domain of descriptive terms for types of errors in flying a four engine patrol plane. Experienced pilots group errors into distinct clusters, such as errors of misjudgment versus performance slip-ups, serious errors versus trivial errors, and errors which reflect courage and adventurousness versus errors which reflect general lack of ability or timidity (1980). Thus while the learner is learning "on his own", he is also being guided by information about what it is he learned and the kinds of errors and mistakes he could be making.

It is almost a paradox that we work so hard to discover what is already known. One instantiation of this principle can be seen when a graduate student explains with excitement his latest discovery—which is what you have been trying to tell him for months. This common event can be understood as an Oedipal problem on the part of the student, or paranoia on the part of the professor, or as an example of the shortcomings of human social equity judgments on the part of both. However, it is, I am arguing, part of the human condition to work hard to discover what is already known. Of course, what is learned may be slightly and importantly different than what was taught. The less than certain human method of guided discovery may make up through innovation what it lacks in quality control.

Three generalizations have been made about the relation between humans and cultural programs. First, culturally based programs for action and understanding are rarely well specified and explicit; second, people typically learn these culturally based programs through a process of informally guided discovery; and third, people are very good at discovering what they must learn under conditions of informally guided discovery, and not so good when they must learn entirely on their own.

How does this great difference between the highly specified computer program and the learned-by-guided-discovery cultural program relate to differences in human versus computer processing characteristics? Among other things, this difference may have to do with the fact that humans must learn their programs, while computers "load" theirs. Since learning is very slow, leaving the process up to the learner frees a very large percentage of the population who would otherwise have to spend all their time teaching.

But further, one can speculate that the characteristics of guided discovery are part of an adaptive solution to some of the cultural engineering problems mentioned above. That is, this curious combination of self-initiated yet other-dependent learning typical of people acquiring their culture appears to yield properties of both "flexibility" and "sharedness". The "flexibility" comes through potential selectivity on the part of the learner with regard to what is learned, and the potential of adding to the information pool anything newly discovered. The "sharedness", on the other hand, appears to be at least partially the result of needing other people for guidance, who can teach only what they know.

Content-based Abstraction Versus Abstraction by Recoding

Another example of a major difference between human and computer programs is the strong tendency for human problem solving procedures to be highly local and content specific, rather than global and formal. Partly in reaction to Piaget, there has accumulated over the past two decades a large body of experimental findings that show that small changes in the semantic content of various cognitive tasks result in large changes in performance (Cole et al., 1980). This does not seem to be a "necessary" fact about human learning, since people can be taught to use formal procedures which have wide applicability, such as formal logic, probability theory and statistics, algebra, and other formal systems. However, despite the potential effectiveness of these formal procedures, humans appear to have difficulty learning, applying, and retaining such procedures.

There appear to be two different kinds of abstraction at work in human problem solving. The first can be illustrated in normal chess playing, in which the player develops a repertoire of patterns or configurations. These patterns may be quite "abstract" in the sense that they apply to a wide range of situations and specific material. However, these patterns are still coded within the semantic and iconic domain of chess, and no recoding into a different symbol system is involved. That is, the chess player's cognitive operations appear to be performed on "mental models" which are analogic representations of the board and chess pieces. In fact, some experienced chess players report that playing with pieces which are novel or unusual in form is more difficult than playing with standard pieces.

The second kind of abstraction involves recoding the problem into a different symbol system. For example, to solve a problem about two people of different ages whose age relationships change between different times, one typically "translates" the problem into algebraic form, and then solves the algebra problem. In a similar manner, the game of chess can be recoded into the formal structure of a decision tree, with a numeral evaluation of each node and a specific process by which an optimal move is selected.

There appear to be a number of strong differences in human performance between these two types of abstraction. The first—content based abstraction—does not seem to require paper and pencil—that is, an external memory system—but the second—formal language abstraction—often does. Although the first, content based abstraction, requires "guided discovery", it appears to the learner to develop "naturally" as problems are solved, while formal language abstraction appears to be "unnatural", and requires explicit instruction for learning (Lave, 1979).

On the cultural level, formal language abstraction is the product of "schooling", where there is a division of labor between the "theorists" who develop and teach the formal system, and the "engineers" or "applied people", who work on the interface between the formal system and the content problems. Content based abstraction, on the other hand, appears to be the product of "experience", where the division of labor is a blurred distinction between the old hands versus green horns, and instruction involves on the job training and a personal relationship between the "master" and the "apprentice".

For computers, it appears that abstraction by recoding into a formal system is the usual procedure at every level, since, in most cases, input does not constitute an "analog" representation of the real world objects being referred to.

The frequent use by humans of abstraction by refinement and the infrequent use of abstraction by recoding has an important implication for the cross-cultural study of cognition. If it were the case that abstraction by recoding was a commonly used cultural procedure, one would expect to find pervasive cultural differences across different types of content. Given common abstraction by recoding, one might expect, for example, that in one culture people might minimize costs, in another maximize gain, and in a third "satisfice". Within a given culture, these differences would be consistent across a wide variety of decision problems, since each culture would use a consistent method of problem solving, although different cultures would use different methods.

However, what we actually find in cross-cultural research is that a group is not consistent across tasks in the way it solves problems (Quinn, 1975). One reason for this inconsistency is the fact that abstraction by refinement makes the procedures learned to handle one kind of content unlikely to generalize to another kind of content, because with abstraction by refinement, the symbols operated on are different for each kind of content. In general, one finds greater variability in problem solving methods and abilities across cultural content within cultures than one finds across cultural groups in similar content areas.

The Role of Feeling in Cultural Programs

Another important difference—often mentioned—between computers and people is the fact that people have emotions and feelings. I am not sure this is a necessary truth. Perhaps, when we understand emotion better, we will create programs which have emotions. But while computers do not have emotions, this does not mean that emotions are outside the realm of information processing.

It is sometimes suggested that feelings and emotions are part of the "lower", less "intelligent", "animal" part of the human. In the television series *Star Trek,* Spock, a most cerebral character, displays no feelings except surprise, and continually remarks that feeling and emotion are incompatible with reason and rational calculation. Spock embodies one set of beliefs about the relation between reason and emotion commonly found in Western culture—that reason and emotion are in opposition, and that feelings and emotions interfere with efficient problem solving.

I disagree with this assumption. In the first place, there is a strong positive correlation phylogenetically between intelligence and emotionality. Thus vertebrates show more emotional communication and intelligence than the invertebrates (with that interesting creature the octopus as an exception), and mammals more emotional communication intelligence than reptiles and fish. Among the mammals, the higher primates have a more complex emotional communication system than the rodents, herbivores, and even carnivores. In my opinion, the emotional signalling system of the human, involving the components of facial expression, gesture, and paralinguistic cues, is much more complex in each of its components than that of any of the higher primates. Along with this increase in the emotional signalling system, there is an increase in the relative and absolute size of the brain structures thought to be involved in emotions (Izard, 1979). The limbic system, for example, generally considered to be a major structure involved in emotional arousal, increases fivefold in size from the monkey to the human, while corresponding motor pathways increase only twofold (personal communication, Robert B. Livingston).

Why should there be a positive correlation between intelligence and emotion? It seems to me that intelligence necessarily involves a delay between stimulus and response, a delay which permits time for complex information processing. As intelligence increases, the representation of external events relies more on internal processing, and response to events is determined more by learned and recalled connections instead of innate stimulus-response bonds. This processing takes time and requires delay.

Given that living creatures need to take care of themselves, they need information about how things are going with respect to their own needs (Norman, 1980). In simple creatures such information is automatically linked to external responses. In more intelligent creatures, this information about how things are going with respect to a variety of kinds of needs appears to give rise to internal responses, which we call feelings and emotions, such as hunger, pain, thirst, boredom, fear, disgust, amusement, surprise, and so on. These feelings and emotions have the potential of acting as powerful prompts to action, but are not automatic elicitors of external responses (Mandler, 1975). What one does to hunger, for example, is dependent on time, place and inclination, not a genetically determined "go to the nearest McDonalds" response. Feelings and emotions tell us how the world is in a very vivid way, typically increasing the activation of various schemas for action and evaluation, while still permitting delay so that planning, goal sequencing, reappraisal, and other complex procedures can occur.

The more these complex procedures, which we consider the mark of intelligence, are used to cope with the environment, the more the creature needs an information holding system such as feelings to permit the required delay. Feelings and emotions, in my view, are like reverberating loops. They hold information in an active form, so that it doesn't go away, and yet does not pre-empt everything else.

Of course, one can imagine a creature which knows that it is hungry in the same way it knows there is a book on the table—as a representational fact which doesn't have to be in consciousness all the time, but which could be recalled. The problem with such a creature is that it might not remember that it was hungry, and die of starvation with a good thought on its mind about topology.

The beauty of feelings and emotions is that they permit delay, but work against forgetting. Feeling and thought are parallel systems of processing which permit one to reason *while* being hungry or angry (Zajonc, 1980). If feelings and emotions were representations of the same order as propositions and images, the serial nature of the processing of such representations would make it impossible to both delay and not forget (Simon,1980).

Thus, in my view, emotions and reasoning are not at all incompatible. In fact, as a total information processing system, emotions and thoughts are, I am arguing, interacting parallel processes which have evolved together. Of course, since feelings about many things are learned, and since what is learned can have a bad fit to the real world, feelings about some things can lead one to want to do the inappropriate thing. But this is the price of plasticity, a price which propositional thought must also pay.

Feelings and emotions function as information systems not only within individuals, but between individuals. The cross-cultural evidence indicates that particular facial expressions are universally understood to express certain emotional experiences, with some culturally specific overlay (Ekman, 1971). Thus by face and also by tone of voice, feelings and emotions can be signalled to others in parallel with what one wants to say in words, or in the case of the infant, before one even has words. Unfortunately, not much research has been carried out on the social functions of emotional communication. I would guess that the information conveyed by emotional expression is crucial in maintaining group loyalties, and in determining what others are really likely to do, so that groups deprived of this channel would be transient and uncoordinated (Collins, 1980).

Emotions and feelings also have important information functions on the cultural level. These functions appear to involve the "directive" or "control" aspect of culture. The directive aspect of culture refers to the fact that cultural procedures not only tell the individual how to carry out certain operations, they also have a directive force which pushes the individual to carry out these operations under appropriate circumstances.

One could imagine a culture in which the information transmitted had no directive component. In such a culture one would learn how to represent and classify certain things, and how to carry out certain operations, but whether or not one did so or not would be unrelated to what one had learned culturally. People would learn to play chess, for example, but whether or not one tried to win would be idiosyncratic, dependent only on individual whim.

One of the general findings of anthropology is that while performance of some procedures in every culture is a matter of option or convenience, the performance of most cultural procedures is motivated by culturally learned "values". These values are a complex association of symbol and affect—that is, of representations of states of affairs associated with feelings and emotions. In our culture, it is normal to try to win at chess because winning at chess represents having intelligence, skill, concentration, and maybe luck, as well as a defeated opponent, and having intelligence, skill, concentration, luck, and a defeated opponent are states of affairs which feel "good", while being dumb, inept, and scatterbrained, unlucky, and a loser are states of affairs which feel "bad". Of course, "good" is not a feeling. "Feeling good" means that the feelings involved are good ones.

While many social scientists break cultural representations into two components—"affective" and "ideational"—this is an analytic, not a normal distinction. Most cultural representations fuse "ideational" and "affective" components into a single symbol. Thus, ordinary people say the stove is "hot", fusing together a representation of how things are with how we feel about them. One could say that the stove is 200 degrees Celsius, and that objects at this temperature will cause pain if touched, thereby separating propositions about the "affective" state from propositions about the factual external condition. However, people usually don't talk this way. Similarly, in ordinary language one says

"Joe is a crook", not "Joe took some funds in a manner which could be prosecuted by law, and this has made me angry and I want him punished."

Thus, culture gives us terms by which both the external event and internal reactions are simultaneously represented. Extensive work by Charles Osgood and his associates has demonstrated beyond reasonable doubt how universal and ubiquitous this "affective" and evaluational component of meaning is in natural language (Osgood et al., 1975).

A result of the fusion of fact and affect cultural representations is that they imply what should be done as well as evaluating how things are. To say a stove is "hot" or that someone is a "cheat" encodes not only a representation of the speaker's feelings, but also directs how the listener should act by virtue of assumption of intersubjectivity. That is, the assumption that anyone would react the same way to the stove or the man.

The "affective" component of human information processing appears to be deeply embedded in cultural representations. By fusing fact and "affective" evaluational reaction, cultural schemata come to have a powerful directive impact as implicit values. What advertising tries to do with problematic success, culture does with great effectiveness—an effectiveness which I think is due to the fact that the "affective" component is communicated through face and voice by the important people in one's line.

CONCLUSION

In summary, I have tried to present the view that culture, as the source of most of the shared representations and procedures with which we do our thinking, is part of the basic material to be studied within the framework of cognitive science. I have also attempted to illustrate, using examples involving human learning, kinds of abstraction, and "affective" processes, how the human processing system interacts with cultural representations and procedures.

At this point in the study of cognition, the most important problem facing us is thought to be the discovery of how the human cognitive processing system works or how the brain operates. Investigating how cultural material is cognitively organized is generally thought to be an endeavor of lesser importance. A measure of the importance of each area can be assessed from the relative numbers of investigators. My estimate, based on listing names I know, is that for each person working primarily on questions of cultural organization, there are at least 20 people working primarily on cognitive processing questions.

The qualification "working *primarily* on cognitive processing questions" is made because a considerable amount of anthropological and linguistic research has been carried out by psychologists and AI researchers who found that they had to analyze the structure of their task materials in order to understand the performance of their subjects. For example, excellent research on the organization of political beliefs, the structure of the lexicon, the grammar of simple stories, the nature of diagramatic representation, the structure of world knowledge, and the structure of various games has been carried out by people whose primary interests were in cognitive processing.

It may well be that a twenty to one ratio is not an irrational allocation at present. Many aspects of the cognitive organization of cultural materials cannot be investigated until further theories about processing have been developed. Certainly, as more becomes known about cognitive processes, more can be understood about how cultural forms are shaped, which will make the field more interesting. There is much to be discovered about the cognitive organization of culture, and the charter of *Cognitive Science* issues an invitation to explore.

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