

A SCIENTIFIC PERSPECTIVE ON THE IS/UGHT PARADOX

by George Edgin Pugh

Until a few years ago the prevailing view has been that the is/ought paradox might never be really resolved. But within the last few years, at least from a decision-science perspective, the issue has almost disappeared because (in the light of our new understanding of both biological and computerized decision systems) the resolution of the paradox seems obvious. Of course within the framework of formal philosophy there are probably many unresolved issues, but from an objective scientific perspective the issue now appears to be resolved.

The new scientific perspective corresponds closely to an old philosophical insight, which is sometimes expressed as follows. "We may be free to do as we like, but are we free to choose what we will like?" The answer of course is that we cannot really choose what we like (or what we enjoy) because the sensations of liking or disliking seem to be built into us. They are such an essential part of our personality that if they were to change it would be as if we had become someone else.

Although this simple observation provides a hint of the scientific solution, the full resolution of the paradox involves three logically separate issues. The first of these can be viewed as the basic fact-versus-value dilemma: Specifically how can normative or valuative criteria of any kind (such as human desires or preferences) be generated from factual data about what is? The second can be stated as the paradox of personal preference versus social obligation: Specifically how can "oughts" or social obligations arise from our innate human motivations which at least superficially seem to be concerned only

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with likes and dislikes, preferences and desires? The third concerns the problem of a higher form of moral ought. For example, how are we able to recognize when existing social practices are in need of reform? What basic principle can explain the insight of great moral leaders? What criteria allow us to recognize the essential validity of such new moral insights?

Each of these age-old problems now appears to have at least a partial scientific answer. My purpose is to review the main scientific ideas and to show how they have developed from recent research experience. The scientific resolution of these paradoxes has emerged as a result of new developments in two apparently unrelated areas—behavioral science and computer automation of decision processes.

THE BASIC FACT/VALUE PARADOX

One of the most important lessons we have learned from our work with computerized decision systems is that the fundamental criteria of decision for any such system must be provided externally, either by the designer or the human user of the system.¹ If the system were allowed to select its own ultimate criteria of decision, its behavior would be completely unpredictable and would have no correspondence to the objectives of the designer.

It seems logical that the same principle must apply to the human brain and other biological control systems. Since evolution played the role of designer for the biological systems, it appears that the primordial criteria of decision for these systems somehow must be included as an essential part of the genetic design. This theoretical expectation has been strongly confirmed by behavioral observations in different species. Indeed statistical theories have been developed that predict the way the “behavioral tendencies” of a species evolve through the process of natural evolution. This new understanding of the genetic origin of behavioral tendencies has been summarized by Edward O. Wilson in his *Sociobiology: The New Synthesis*.²

Thus from two very different scientific disciplines there is compelling evidence that basic behavioral tendencies, or motivations, must be specified somehow in the genetic inheritance of each species. But how are we to reconcile such a genetic specification of behavioral tendencies with our personal subjective experience? From our subjective experience it seems obvious that we exercise free will as we rationally consider alternatives and make choices on the basis of our own personal preferences.

In order to relate the ideas of sociobiology to our subjective human experience it is necessary to be much more specific about how be-

havioral tendencies are transmitted. The behavioral tendencies of sociobiology derive of course from the genetic design of the brain as a biological control system. Strictly speaking it is the brain (rather than the behavior) that is genetically inherited. From a decision-theory perspective it is helpful to associate human behavioral inheritance with two genetically specified functional components of the brain, which we can think of as (1) our intellectual capacity and (2) our motivational system. The term "intellectual capacity" is intended to refer to our conscious and (subconscious) capability for rational analysis. This includes the ability to consider alternative courses of action, to predict outcomes, to make decisions, to acquire behavioral habits, and to develop value judgments. Since these "intellectual" functions are accomplished largely within the conscious mind (i.e., by the cerebral cortex together with the central part of the brain which is responsible for our sensation of personal consciousness), it is intuitively easy to understand these familiar decision processes as an important part of the human behavioral system.

Although the genetically inherited motivational system is also an important part of the brain, it is not contained within the "conscious mind" (the motivational system appears to be distributed through other parts of the brain such as the limbic system, the hypothalamus, and perhaps the frontal lobes of the cerebral cortex). We therefore have little intuitive understanding of how this system operates. Nevertheless the system plays a very important role in our conscious experience. It is responsible for all of the subjective value sensations that determine our personal preferences. The value sensations (supplied by the motivational system) include not only basic sensations such as pain, discomfort, hunger, and sensual pleasure but also pleasant and unpleasant emotional responses such as joy, sorrow, pride, and shame. It is in these subjective value sensations that the behavioral tendencies of the human species are coded.

From this new perspective the human motivational system is seen as a surprisingly complex structure. The way our emotions and other value sensations respond to specific situations is determined by very complex, genetically defined rules. (In sociobiology such rules are referred to as "epigenetic" rules because they are defined by genetic inheritance but go beyond the actual chemical composition of the genes.)

To clarify the behavioral importance of such epigenetic rules, it may be helpful to consider their role in another species. At present of course we can only guess at the underlying aesthetic and emotional motivations in any other species. However, the tendency to collect and

hide nuts that is observed in the common tree squirrel could be explained easily by a strong emotional response that rewards the squirrel when her nuts are neatly stored in a hollow tree. Indeed the squirrel may find such stores of nuts so emotionally and aesthetically pleasing that she is reluctant to consume the store until really driven to do so by extreme hunger. Note that the actual motivation (in this case an emotional or aesthetic response to stored nuts) is very different from the underlying evolutionary objective of providing food for the long winter. The use of such indirect motivational mechanisms is seen again and again both in the structure of human motivations and in the design of other biological systems. Similarly in the design of computerized systems we are finding again and again that such indirect specification of goals provides the most efficient way of encoding behavioral tendencies.

When we look objectively at the human brain as a biological control system, it is apparent that the two functional components—the intellectual capacity and the motivational system—are actually complementary parts of an overall system design. In effect the brain operates as a value-driven decision system. The intellectual capacity allows the brain to develop a mental model of the environment so that it can predict probable outcomes and make “rational” decisions. The motivational system contains the primordial criteria of decision that are genetically encoded in the neurological design.

At least in broad outline the answer to the basic fact/value paradox is now clear. The subjective value sensations which are encoded (factually) in the genetic design of the human species provide the primordial criteria of decision for the species. These innate value sensations have evolved over the ages to motivate a form of behavior that has proved to be genetically productive for the human species. As a result of daily experience with these genetically defined value sensations (such as the emotional responses and pain and hunger) each individual develops a set of personal preferences or likes and dislikes, which motivate his behavior and decisions. As the individual gains experience, he organizes his preferences into a complex network of value criteria that guide his decision processes.

FREEDOM VERSUS DETERMINISM

Before moving on to the issue of social oughts as opposed to personal preferences, I must consider briefly the issue of freedom versus determinism. Any scientific theory of behavior inevitably seems to raise this issue. If behavior can be predicted (even on a statistical basis and within a rather large range of uncertainty) can we be really free?

But if behavior cannot be understood or predicted within such range of uncertainty, then it appears we do not have a useful understanding of behavior. Thus the question inevitably arises whether the present scientific interpretation of behavior is compatible with our traditional concept of free will.

As we shall see, within the commonsense definition of free will, the answer is clearly yes—perfectly compatible. Our commonsense definition of free will is simply that we are free to decide (and to do what we want) on the basis of our own internal preferences, obligations, likes, and dislikes. Indeed according to the new scientific view this is what we must do because this is how we are designed as biological decision systems. The scientific view says only that we do not decide what feels good, what social experiences we will enjoy, or what aesthetic experiences we will prefer, for it is in the structure of these basic emotions and value sensations that the behavioral tendencies of the human species are coded.

Although there are some limited exceptions, we are not in general free to decide what will feel good. When we put a finger on a hot stove it hurts. We do not have to decide that it hurts. The sensation of pain is built into us. Similarly we do not have to decide what our emotional response to various social experiences will be. The emotional response happens, and we learn from the experience what we enjoy and what we do not enjoy. What we learn from this experience (with our own value sensations) is converted through intuitive and conscious mental processes into the goals, ambitions, objectives, and value principles that guide our daily decisions.

It is through the innate value sensations (and for the most part only through these sensations) that evolution influences our conscious, rational decisions. In all other aspects we are free to decide. We decide what theoretical concepts to accept, what ethical principles to live by, and what ethical principles to advocate for others to live by.

THE MOTIVATIONAL ORIGIN OF SOCIAL OUGHTS

We are now ready to turn our attention to the way the concept of ought arises out of the innate human motivation system. As we shall see, the basic concept of a social ought is an inevitable consequence of human innate emotional responses.

Although psychology has long recognized the importance of emotions in human behavior, the emotions usually have been treated separately from any theoretical understanding of their functional role in the behavioral system. In the new scientific interpretation the emotions (and other human value sensations) are treated functionally as

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an essential component of the behavioral system. From this new perspective the emotional system is seen as a very complex structure which evolved over millions of years to motivate effective cooperative behavior in primitive human society. The way our emotions respond to specific social stimuli is governed by a remarkably complex set of epigenetic rules.

For example, consider the human smile and its effect on behavior. When an infant's basic need for nourishment and warmth are met some built-in epigenetic rules cause the infant to feel good and to smile. The infant's smile releases an emotional response in the mother which (in accordance with the epigenetic rules in her motivational system) causes her to feel good. Thus the mother is motivated to care for the infant. Similarly, when an older child helps a parent, the parent is pleased and smiles. The parent's smile rewards the child by making the child feel good. Thus the child is motivated to seek the approval of the parent. In a very similar way, especially in a primitive society, the young adult is motivated to seek the approval of his peers and elders.

The interaction of epigenetic rules as they govern human facial expressions, emotional response, and social behavior is exceedingly complex. The foregoing examples only hint at the total interactions. The structure of a primitive human society appears to be in large measure a direct consequence of the totality of epigenetic rules that govern human social responses.

Since the human motivational system appears to be designed to produce cooperative behavior within a primitive society, it tends to reward behavior that is approved and accepted by the society, and it punishes behavior that is not accepted or approved. For example, consider the extreme discomfort of a sensitive child who blushes in a classroom when he fails in an assignment. As a result of such epigenetic emotional responses, the child and the young adult develop a strong desire for approval and thus are motivated to conform to the behavioral norms of the society. Because of this desire for social approval, the individual's personal decisions inevitably involve a conflict between the behavior that he personally would "prefer" (if he did not consider the desire for social approval) and the behavior which is more likely to be socially approved.

This basic human ethical dilemma, which is addressed in the moral teachings of primitive society, can be seen therefore as an inevitable consequence of the genetic design of the human motivational system. Although the specific concepts of morality vary widely across cultures, the existence of the ethical dilemma is universal.

THE EVOLUTION OF SOCIAL BEHAVIOR

Before discussing a more absolute or higher concept of ought, I find it appropriate here to bring up some of the genetic selection mechanisms that can lead to a complex form of social behavior, involving a mixture of selfish, cooperative, and occasionally even altruistic behavior. The theory of genetic evolution makes it clear that natural selection favors only those forms of behavior that are genetically productive (i.e., that contribute positively to the survival and reproduction of the individual and his direct genetic descendents). In view of this essentially "selfish" genetic selection criteria there has been a great deal of theoretical discussion about how such a selection criteria can lead to a genetically motivated form of social behavior which includes important elements of both cooperative and altruistic behavior among individuals that may be only distantly related.

In such a theoretical discussion it is important to distinguish carefully between "cooperative" and "altruistic" behavior. Altruistic behavior in this context is defined as behavior in which one individual sacrifices personal survival or reproductive opportunities for another. Cooperative behavior is defined as behavior that contributes positively to the survival and reproduction of both cooperators.

The evolution of cooperative behavioral tendencies within a species does not pose any theoretical dilemma because such behavior obviously is favored by genetic selection. Indeed when human behavior is analyzed carefully one finds a very large amount of such "cooperative" behavior and by comparison only a very small amount of "altruistic" behavior, except within close family groups. Outside family groups almost all the behavior that is commonly characterized as altruistic can be described more accurately as a form of "cooperation" called reciprocal altruism, in which there is a formal or informal understanding that "favors" will be returned. In terms of genetic theory such behavior is mutually beneficial and should be genetically favored like any other form of "cooperation." With this clarification of definitions we are left with only a very small amount of true "altruism" between unrelated or distantly related individuals that poses any real problem for genetic theory.

The existence of a small amount of such true altruism is explained easily when we take into account the actual motivational mechanisms that are genetically inherited. Each motivational mechanism, such as the emotional response to a smile, contributes to a wide range of social behavior. The emotional response to the smile contributes to the development of close emotional bonds which result in altruistic behavior within the family group, thus enhancing genetic fitness. It contributes

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to cooperative behavior within the larger tribe or band which also enhances genetic fitness. But as a by-product this same emotional response also motivates a limited amount of true altruism both to the tribe or band as a whole and to specific individuals in the tribe that may not be closely related. Because a single motivational mechanism contributes to such a wide spectrum of behavior, the contribution of the motivational trait to genetic fitness has to be evaluated in terms of the full spectrum of behavior to which it contributes. In the case of the emotional response to a smile it seems clear that the positive contribution of genetic fitness resulting from altruistic and cooperative behavior within the family, and cooperative behavior within the social group, is far greater than any negative contribution to genetic fitness that might result from the by-product altruism to nonrelatives in the social group. Thus on balance the behavioral trait should be genetically favored even though some of the resulting behavior may not contribute positively to inclusive genetic fitness.

The common tendency to try to apply arguments concerning genetic fitness individually to every detailed element of behavior (rather than to the actual motivational traits that are inherited) is fundamentally wrong and can lead to a great deal of unnecessary confusion.

Finally it is worth noting that because of the actual structure of primitive human society a certain amount of behavioral altruism may in fact be required by the criterion of inclusive genetic fitness. The primitive human social group has a strong tendency to be hostile to individuals who fail to contribute cooperatively and even altruistically to group welfare. The innate human tendency to become angry and to evict, attack, or ostracize individuals who fail to contribute acceptably to the group clearly contributes to the genetic fitness of the individuals that remain in the society; so such social intolerance should be genetically favored. Given such an intolerant social environment, one might expect that individuals who lack reasonable motivation for altruistic behavior (within the group) would be in fact less successful in survival and reproduction and thus would be selected against in the evolutionary process.

Because emotional responses and primitive society have evolved side by side over millions of years, the human motivational system has adapted genetically to the primitive social environment, and of course the primitive social environment is determined in large measure by the operation of the human motivational system. Thus to understand the origin of human emotions the emotions must be functionally interpreted within the context of a primitive human society.

The relationship between the innate social motivations and the primitive human social structure cannot be fully understood without

taking into account the way social norms tend to emerge in human society. Because man is a verbal animal his social experiences and his understanding of value criteria are socially communicated, and they are incorporated into the cultural environment. In modern societies this value-oriented information has been formalized in religion, in jurisprudence, and in many of the formal disciplines that we label as the humanities.

Even in primitive societies the innate individual motivations are channeled by a complex network of social values, conventions, and taboos. It is important to emphasize that the social and ethical values appropriate for human society are not directly contained in our genetic inheritance. The social values and social conventions must be worked out on the basis of reason, intuition, and experience within each society. The values and conventions that are likely to be adopted, however, are strongly influenced (if not governed) by the human motivational system. Thus to some extent the social-value criteria in any culture can be predicted on the basis of the primordial emotions and value sensations that are encoded in the human motivation system.

The modern theory of genetic evolution makes it clear that the existence of conflicts of interest within a species is an inevitable consequence of the genetic selection process. In those species that reproduce through standard male-female relationships, the genetic selection process inevitably tends toward a motivational structure in which conflicts of interest exist between individuals, between age groups, and between the two sexes.³

As expected, even within primitive human society there are inevitable conflicts of interest between the individual and the society and between individuals within the society. Any successful culture must develop a set of social values and social norms which facilitate the resolution of such conflicts without excessive cost to society. Once such a set of social values and social conventions has been developed, it becomes a vital asset of the society, and the transmission of these values to each new generation becomes one of the most important functions of the educational process.

Because the development and evolution of cultural norms in any society is a slow process, the origin and rationale for the norms are spread over many generations. Within any single generation therefore the norms and social values inevitably will appear to be of absolute or authoritarian origin, and individuals will feel intuitively that they should be able to "explain" the norms or the oughts in terms of some absolute or authoritative source. In fact from our scientific

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perspective the social oughts did not originate from any such authoritative source. They represent the accumulated cultural wisdom of the society, together with the genetic information accumulated in the human species.

THEORETICAL BASIS FOR A HIGHER MORAL OUGHT

On previous occasions when I presented the foregoing ideas, some listeners objected that the theory did not appear to include any kind of absolute ought. Indeed, as developed so far, "morality" would appear to be simply a matter of following existing social conventions.

But a really satisfactory theory of values should be able to explain the role of moral and religious innovations. How is the need for social reform to be recognized?

If we are to have a satisfactory theory we should be able to identify some basic moral principle that could have been applied by great moral leaders such as Christ or Confucius to generate new moral concepts. Moreover, it should be possible to use the same basic moral principle to explain how individuals within a society are able to recognize the validity of new moral concepts when they are presented. This issue of the higher ought or an ultimate criterion of human social values is an area where scientific ideas are in an early stage of development. Nevertheless the issue is of such importance that I believe it must be discussed.

The absence of any generally accepted ethical or moral principle that goes beyond local cultural traditions is probably the most critical problem in modern ethical theory. The problem is not limited to ethics or morality. The same basic difficulty is one of the most serious problems encountered by government officials in the assessment of social policy alternatives.

An adequate statement of the problem in any analysis of policy alternatives requires at least two basic elements: (1) constraints and (2) policy goals (or objective function). Although our growing understanding of innate human motivations provides an improved understanding of some of the practical constraints (that need to be taken into account in any realistic social policy), it does not define any theoretical goal or measure of merit that can be used to evaluate alternatives. This lack of a theoretical goal (or objective function) for social policy is essentially the same problem that must be solved if we are to develop a theoretical understanding of ethics and social values.

Given the long-term importance of social and ethical values, it seems appropriate to give careful theoretical consideration to the

problem. At present there is no general agreement even on the principles that should be used to recognize a valid ethical theory or to validate an ethical concept. Moreover, given a choice between two or more social, ethical, or legislative alternatives, there is no agreement on what criteria should be used to select a preferred alternative.

The long search for oughts or ultimate value principles in the universe appears to have failed. The only value criteria that have been found anywhere in nature are contained in the genetically defined value sensations that guide the behavior of the higher animals. How are we therefore to find an appropriate theoretical criterion for evaluating social policy alternatives?

After considerable struggle with this dilemma it occurred to me that it might be possible to use the innate human value structure itself not only to specify some of the practical constraints but also to define a theoretical social objective. Although it is too soon to be sure of the validity of this approach, the preliminary results have been most encouraging because the value criteria generated by the approach seem to have a remarkably good correspondence with traditional social and ethical values.

Before proceeding any further, however, let me call attention to the obvious fact that innate human value sensations cannot be used in any naive or simple way. This genetically defined human value structure does not contain any logically consistent or compatible set of ethical principles. Indeed from genetic theory we know that these inherited value sensations are specified by "epigenetic rules" that reflect only the amoral selective pressures of biological evolution. Although our innate value sensations include certain motivations for cooperative behavior and for altruistic behavior, such socially beneficial motivations are included only to the extent that is consistent with the amoral logic of evolutionary selection and inclusive genetic fitness.

In order to use innate human values as an ethical or social value criterion it is necessary to be realistic and to use innate values only within the context of a broad system-design perspective concerning the structure of human society. To provide a simple model of individual behavior we assume that (within any social structure) each individual will be guided by his own motivation system. That is, he will seek to maximize his own satisfactions (as they are defined by his innate motivation system) within the physical and social context of his society.

It is the task of ethical and social theory, based on this conception of human behavior, to find a combination of laws, ethical principles, and social norms that will satisfy three basic criteria:

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1. *Stability.* Once the principles are present in the society it should be in the personal interest of the individuals in the society to support the principles so that they will tend to be perpetuated by the society.
2. *Behavioral Compliance.* Although one must expect occasional violations of norms, it should be generally in the best interest of each individual to respect the established norms.
3. *Maximal Human Satisfaction.* Within the foregoing basic constraints the principles are to be chosen so that individuals within the society can find the maximum level of personal satisfaction that is possible among the alternative social and ethical concepts.

In this formulation the first two conditions can be viewed as a statement of the practical constraints, while the third specifies the social goal of objective function. The third criterion therefore can be viewed as a simple statement of a "higher moral principle" that can be used to evaluate existing norms and existing social policy.

It would not be appropriate here to go further into the details of the approach. The approach seems to provide very reasonable results when applied to classical ethical issues such as euthanasia, abortion, and the use of drugs. In addition, I have found that it provides a useful framework for analyzing some difficult practical issues such as the meaning of "equality of educational opportunity" for gifted or handicapped children or the redistribution of wealth through taxation and welfare payments.⁴ If the results continue to be favorable in this way we may be able to say that we have found a scientific concept that has a good correspondence with the intuitive concept of a higher morality. Moreover, although the specific social context and social solutions may differ, the same ultimate moral principle appears to be universally applicable in any human society.

It is worth noting that this scientific formulation of value theory does not provide (and does not appear to require) an absolute or authoritarian ought. It appears to provide a satisfactory explanation of human moral behavior and traditional moral concepts without invoking an absolute or authoritarian form of ought. On the other hand, one must recognize also that it does not logically exclude the existence of such an absolute ought that might be derived (in accordance with religious tradition) from an ultimate moral authority.

From a pragmatic policy perspective, however, the source of human moral knowledge may not be of great importance so long as there is agreement on the practical ethical principles. Therefore in a society with pluralistic religious commitments the existence of a good correspondence between scientifically founded ethical principles and

more traditional ethical concepts can be of considerable practical value.

TRADITIONAL HUMAN SOCIAL ORGANIZATION

Having completed a brief review of the basic theoretical concepts, I think it appropriate to consider briefly the traditional form of cultural solutions to the problem of human social organization. To convey the basic principles, I will describe the traditional solution in a very simplified form. In broad perspective the solution can be understood in terms of three separate clusters of values:

1. *Personal Values.* As always, we begin with the values that are defined for the individual by his innate motivation system. We will call this set of values (including the entire network of related or derived values) a personal value system. Obviously if each individual were to operate in terms of this personal value system, without any preexisting cultural norms, chaos would result.
2. *Cultural Norms.* To channel individual activity into paths that are socially desirable the society maintains a set of cultural norms, standards, and laws which inhibit antisocial activities and encourage positive contributions to the society. But the issue of stability has to be considered. We need to know how these norms are maintained. At least in primitive human societies, gossip plays a very important role. The people within the society are very busy telling everyone else how they ought to behave. Because the individual is motivated by a desire to be respected and approved, his behavior inevitably is influenced by the prevailing social norms. Indeed in order to achieve personal satisfaction (as it is defined by his innate motivation system) the individual is almost compelled to comply with the standards that are accepted by the rest of society.
3. *Philosophical and Religious Values.* The social norms, cultural standards, and laws inevitably place the individual within a somewhat uncomfortable harness. To help the individual adapt to these social constraints (and to harshness of the environment) the society also provides a set of religious and philosophical concepts that make the individual feel more comfortable and at peace with the society and the environment.

Obviously the dividing line among the three clusters of value concepts tends to be vague, and the three systems tend to be mutually reinforcing. Nevertheless I think this division of the values into three clusters seems to be a useful way of clarifying the traditional cultural solution.

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We must recall that during the course of human evolution the interaction between genes and cultures has been a two-way street. Not only do the genes determine the human capacity for culture, but the continuing presence of culture in human experience has influenced genetic selection, so that the innate human motivations are quite well adapted, at least to the social structure of a primitive hunter-gatherer society. Indeed it is probable that the human motivational system includes many behavioral tendencies (or epigenetic rules) whose main function is to facilitate the emergence of a cultural solution of the foregoing traditional form.

Although human motivations are probably quite well adapted to the primitive hunter-gatherer society, it seems likely that they are less well adapted to the transient and impersonal relations that are characteristic of a large urban society. Thus, as urban centers become large in size, the innate social motivations for acceptable behavior become less effective, and the society tends to become more dependent on formal law enforcement and legal sanctions.

One of the major challenges of modern social policy concerns the development of an urban cultural environment within which the innate human social motivations can operate more effectively, reducing the dependence on formal law enforcement and providing a social context within which human beings can find more purpose, more meaning, and more personal satisfaction.

INFORMAL VERSUS SCIENTIFIC KNOWLEDGE OF HUMAN VALUES

The idea that science cannot contribute to knowledge of values has been one of the prevailing convictions of modern Western thought. Recent developments in decision science and sociobiology, however, have begun to cast doubt on this long-standing dogma. Although the rigid view that science cannot contribute to knowledge of values no longer appears to be justified, we should not expect that science will outmode or replace evolution's informal and intuitive methods.

The present embryonic state of value theory is suggestive of the state of physical science at the time of Isaac Newton. Given the accuracy of Newton's law in predicting the trajectory of a baseball, one might have expected the new theory to produce much better baseball players. Of course it did not. Formal education in Newton's laws has never been of much value to the intuitive baseball player. Similarly we should not expect too much of a scientific theory of values, especially in familiar areas where common sense and experience can be applied easily. On the other hand, in relatively difficult areas of social policy, ethical theory, and really new ethical problems arising from modern

medicine and technology, we can expect some very practical applications for the theory.

In general, reliance on intuitive knowledge cannot be avoided in the field of ethics and social policy because the required scientific knowledge is not available. There is not now, and I believe there never will be, a formal mathematical method by which ethical principles can be derived from our genetic motivations. The deductive process in ethics and social policy appears to require creative insight, analogous to that involved in the development of a scientific hypothesis. Once a hypothesis has been suggested, it may be possible to test it on a scientific basis either experimentally or theoretically. But in most cases we can expect that the final test will use traditional methods of judgment within the political process.

Even when we approach the problems of ethics and social reform from a purely scientific perspective, it is apparent that we must rely heavily on the "well-winnowed" wisdom and experience of the past as it is expressed in cultural traditions, in jurisprudence, and in the ethical principles and religious systems of our own culture. The teaching of cultural traditions and ethical principles remains an essential part of a balanced education. The fact that the traditions are different in different cultures does not invalidate the local social norms. Each culture is like a work of art. The individual traditions make sense and harmonize within the total context of the culture. Within any culture progress and reform are to be expected, but it does not follow that what is good in one cultural context is necessarily good in another.

NOTES

1. George Edgin Pugh, *The Biological Origin of Human Values* (New York: Basic Books, 1977).
2. Edward O. Wilson, *Sociobiology: The New Synthesis* (Cambridge, Mass.: Harvard University Press, 1975).
3. Richard Dawkins, *The Selfish Gene* (Oxford: Oxford University Press, 1976).
4. George Edgin Pugh et al., *Educational Opportunity: The Concept, Its Measurement and Application* (NCES 78-201) (U.S. National Center for Educational Statistics, Department of Health and Welfare, 1978). My work on the optimal balance of taxation and welfare is in progress.