UNCERTAINTY AS A PARAMETER OF ETHICS

by Dwight J. Ingle

In the story of Jean Paul Richter's dream, a man enters the vestibule of heaven and is carried to universe upon universe in endless space, until—". . . the man sighed and stopped, shuddered and wept. His overladen heart uttered itself in tears, and he said, 'Angel, I will go no further; for the spirit of man acheth with his infinity. Insufferable is the Glory of God. Let me lie down in the grave and hide me from the persecution of the Infinite, for end I see there is none.' "

This is a review of some of the limitations on knowledge, freedom, and responsibility, which have implications for ethics. Man has developed a great body of knowledge and concepts which are accepted as verities, but he cannot escape an infinitude of uncertainties. My conclusion that many ethical judgments must assume risks, not a new insight, is deducted from an account of the bases of uncertainty. Science and ethics provide aids to decision in the face of uncertainty. The principles of scientific inquiry are the best means of determining "that which is"—knowledge is necessary for morality—but do not suffice for determining "that which ought to be."

Basic Assumptions of Science

Scientists and all others seeking knowledge must begin with certain faiths which are not independently testable but are regarded as self-evident and necessary for the acceptance of all forms of inquiry. I shall mention a few. We assume the reality of the external world, our own continued personal existence, that all events take place in accordance with natural laws, and that the human mind is capable of comprehending natural laws. These and all other assumptions have been questioned at one time or another in the history of philosophical thought. There is a second order of assumptions, based in part upon our experience with the universe, which are useful in science although they are not self-evident or given a priori. For example, we may assume the uniformity of nature, that all phenomena are related by certain basic properties and natural laws, and that there exist true values

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of quantities measured in the external world. Some scientists and philosophers assume that each individual event has necessary antecedent and concomitant events and conditions. This principle of causality or of sufficient reason is not regarded as necessary by others.

Barriers to Knowledge

Theoretical Barriers.—To say that all knowledge is subjective means that it must be handled by the nervous system; no more subtle meaning is intended here. The nervous system may have inborn knowledge as instincts, but their nature and extent is debatable. Not only neurons but most, if not all, living cells of the body have stores of information, some of which may be non-chromosomal. Should non-neural information be regarded as knowledge? For the purpose of this discussion I assume that the answer is "no."

The receptor organs of man are sensitive to only a small proportion of the energy manifestations around him, and unaided perceptual processes do not permit precise quantitative measurements of mass and energy even when they fall within the sensory range. Much of science is concerned with physical aids to the detection and measurement of natural phenomena. As pointed out by Platt,[1] all sensory organs and physical aids to the collection of knowledge involve amplification, a vital process of life, evolution, and civilization. The process of amplification requires selectivity in the range of energy display, hence the process requires that the pickup of information be incomplete. If it were possible to construct amplifiers to record the behavior of all individual particles, there would be some loss of certainty in the information supplied by each amplifier, and there would have to be more amplifiers than particles.

The laws of classical mechanics do not fully predict the behavior of fine particles; there is an element of uncertainty in the behavior of each particle, so that laws describing quantum phenomena are statistical. Something more than the Heisenberg uncertainty principle is assumed here. Is nature truly capricious at the quantum level, or does the apparently random behavior of individual particles merely represent ignorance of causes? There is no way of being certain when faced with this alternative, preference being an act of faith. However, it is fashionable to believe that nature is capricious at the quantum level and that there may be a kind of capriciousness at the organismic level as well, an element of uncertainty more basic than that produced by research methods on the processes under study. Does nature evolve a new kind of capriciousness at the social level which does not depend solely on

capriciousness at the quantum and organismic levels of complexity? How can man know whether or not this is so?

Platt[2] has described two kinds of indeterminacies of the brain. By "privacy-indeterminacy" he means that it is not possible for the observer to know independently that any particular quantum or set of quanta has stimulated a sensory organ of a subject; the input is always private, and it is not possible to prove that a weak stimulus was perceived or that a behavioral reponse was caused by any particular input. "Complexity-indeterminacy" results from one brain not having enough sensory cells to determine the initial state of all of the neurons or interconnections of all of the neurons of the brain under observation. Walter[3] suggests that another source of indeterminacy of brain is the amplification of small natural fluctuations and errors into gross effects, so that some predictions of the behavior of the brain become useless.

The complexity of the human brain insures a high order of uncertainty about its functions. There are estimated to be 10^{10} neurons in the human brain, 10^{14} synapses, as many as 10^{3} points of contact on some large neurons, great diversity in structure of neurons, and several hypothetical means of coding information. It is estimated that there are more glial cells than neurons; their relationship to the functioning of neurons is obscure, but it may be an important active function. Complexity is one basis for uncertainty throughout the universe, but it becomes maximal when man examines his brain.

In addition to barriers to the collection of information by the human nervous system, there are limitations in conceptual span, there is distortion of information, information may be hidden in the unconscious, the memory curve is one of decay, and attention can be focused on only one factor at a time. Man is not directly aware of gaps or limitations in sensory range or conceptual span. Sensations are perceived as closed patterns, and concepts become satisfying meanings. It is generally true than man adjusts to information of the external world by excluding it from consciousness (directing attention elsewhere) or attaching a satisfying meaning to it. Although the ability of the brain to collect, store, retrieve, and manipulate information is extended by machines, there are no means of circumventing some of the barriers to complete knowledge.

The foundations of logic are based on intuition and can be made no more secure than is intuition. Kurt Gödel has recognized and demonstrated that it is impossible to establish the logical consistency of any deductive system as complex as natural number theory except by assuming principles of logic, the internal consistency of which is as

open to questions as that of the system itself.[4] The possibility that there is an inner flaw in the system cannot be excluded. There are greater limitations in systems of inductive logic. It is not possible to compel acceptance of a generalization, for alternative explanations can be developed which are supported equally well by logic; man chooses a generalization which he judges to fit best his experience with nature.

Except for the fact that many phenomena occur outside the range of our sensory equipment and instruments, most of us are not greatly concerned by other theoretical barriers to complete knowledge. These are more likely to concern the scientist who studies the world of fine particles.

Despite the several theoretical bases of human uncertainty, the physical world is almost completely orderly except at the quantum level. Order emerges as a statistical reality out of the disorder of particles, and the behavior of the system is so orderly that for all practical purposes description of properties and sometimes means of prediction and control can be added to man's list of verities. Even in biology we have a great deal of knowledge that can be reconfirmed as factual because the process can be made to occur upon demand.

Practical Barriers.—It is never possible to study all members of a population, hence a sample should be chosen in such a way that we are willing to argue from it to its population. We can argue from a sample only to the population from which it was drawn. Each sample is, to some unknown degree, not representative of its population, but appropriate statistical design enables the experimenter to estimate the error of sampling. In addition to statistical errors, certain ethical considerations stand in the way of drawing representative samples of human populations. It is required by medical ethics that informed consent—full knowledge of risk—of each individual must be granted before he can become the subject of experimentation. Volunteers are commonly not representative of a population. Knowledge of the nature of the experiment and its objectives may affect the behavior of the subject. The guiding principle is not that of seeking the greatest good to society by risking injury to individuals but to protect the rights, freedoms, and privacy of individuals.

When new information can be expressed in quantitative terms, the scientist may use the language of mathematics, but everyone concerned with knowledge must also communicate qualitative ideas by the choice of words which connote rather than denote explicit meanings. Many words have several meanings; none may precisely fit the intended description of a new idea. Words are symbols which are intended to re-integrate whole meanings but are likely to do so imperfectly.

Just as some circularity is inherent in systems of logic, it seems probable that no system of definitions can be complete within itself, that to define a word of complex meaning requires the use of other words of complex meaning that also need explanation. If a debater can bait his opponent into defining his terms, he can, in theory, keep him on the defensive endlessly. Since ethics involves the use of language, it cannot be made more secure than are the definitions of values.

The errors which man makes in sampling, measurements, judgments, and communication can be facilitated by suggestion. This is the imparting of an idea in such a manner that it is accepted uncritically. Suggestion is the basis of propagandism and of dogma. The investigator must learn to control the influence of suggestion upon himself, his subject, and other observers, such as the physician who is judging the response to therapy. Although the usefulness of testing new drugs by the double-blind placebo technique is recognized in clinical investigation, it sometimes conflicts with medical ethics by withholding a possibly beneficial therapeutic agent from a control group of patients.

Most laboratory scientists fail to face the need to have their measurements and judgments in the laboratory checked by procedures which minimize the effects of suggestion on themselves. Persons engaged in any form of inquiry are likely to make subjective errors of perception and judgment, all of which can be enhanced by suggestion.

One of the greatest contributions of research in social psychology has been the demonstration of the lability of attitudes and beliefs, and the importance of suggestion in shaping them. Beliefs may become cherished possessions, and a threat to them may arouse defensive behavior. Decisions on right and wrong are especially likely to be emotionally charged and can be affected by suggestion. The use of suggestion is not in all cases harmful. It has an important use in treating psychological and even physical ills and in gaining the co-operation of the patient and in establishing favorable attitudes toward recovery. It is a tool of leadership which can be used for either good or evil.

Attempts to develop a body of knowledge may fall into error by any of a host of fallacies. It is wrong to claim that fallacious reasoning always leads to untruth; it may lead to a correct conclusion. One of the best known but most commonly committed fallacies is *Post hoc, ergo propter hoc* ("After this, therefore because of this"). Here a causal relationship is inferred between what has been done in relation to what follows. Since many kinds of events, including human problems, are self-limiting, attempts to change them may either have been effective or merely associated in time with the change. It is fallacious to assume that an association or correlation proves a causal connection

between events. The simplistic and reductive treatment of complex phenomena, the so-called fallacy of reduction, is a common error in the search for knowledge. The reductionist is prone to ignore or deny the existence of that which is difficult to define.

Complexity of Cause-and-Effect Relationships.—A cause of an event is any necessary antecedent or concomitant event or condition. Since only too frequently man searches for a single factor as a sufficient cause of an event, this definition is intended to focus attention upon complexity in open systems. "Open" means that the system exchanges energy and/or mass with the outside. All living systems are open.

I have previously written of permissive causes as differing from active causes.[5] For example, the role of a lubricant in a machine permits the operation but does not generate or convert energy in the system as does an active cause. In biological systems, such substances as hormones and vitamins may permit the function of the organism by supporting the normal reponsiveness of cells and tissues to active stimuli. This is a difficult but important distinction and cannot be easily clarified and explained in a few words. Interested readers should consult the reference just cited.

We assume that there must be spatiotemporal continuity between cause and effect; if a causal connection obtains between two events that are not contiguous, there must be intermediate links in the causal chain such that each is contiguous to the next. It is common to focus attention upon one important overt response to a stimulus and to ignore mechanisms of action.

There is a multiplicity of factors in each causal system. Any causal pattern includes stable conditions as well as active and sometimes permissive causes. Similarly, there is a multiplicity of responses to any potent stimulus. As the waves from a stone cast into a pool of water spread to all parts of the system, so can either a potent biological or social stimulus cause changes in many of the structures and functions of a system. But the impact of a threatening stimulus may be dampened and even masked or rendered ineffective by homeostatic mechanisms in either biological or social bodies. In biological systems, these built-in mechanisms for maintaining a constant internal environment not only dampen the effects of a stimulus but, since several mechanisms are involved in regulating each important function, damage to one of them may not seriously impair the function due to compensatory responses by other homeostatic mechanisms.

The same general response or pattern of responses may be elicited by any one of several stimuli. This principal of the non-specificity of causes relates to the principle of equifinality, which states that in open

systems the same final state can be reached from different initial conditions and different paths. It is well illustrated by the cycles of metabolism known in biochemistry and by the statement that "there is more than one way to kill a cat." For more than forty years, Klüver[6] has emphasized these points in discussions of equivalence on the perceptual, cognitive, affective, and other levels of behavior. Insofar as model building is limited by specificity of cause-and-effect relationships, its validity is insecure because it is apparently always possible to find groups of heterogenous stimuli producing the same behavioral or psychological effect as well as groups of diverse actions and reactions referable to the same stimulus or stimulus constellation. It is therefore hopeless to reduce "similarity" to an identity of parts or simple cause-and-effect relationships.

Nothing that I have said or could say will fully explain the role of "purpose" and goal-directed behavior as causes at the psychological and social level. Goal-directed sorts of freedom must be based upon a higher determinism, which can include the area of self-knowledge as a basis of responsible choice and of ethics. Uncertainty becomes maximal when we try to describe the psychical parameters of purpose; we do not know how thoughts lead to action.

Limitations on Explanation.—The barriers to the collection and manipulation of knowledge make it impossible to advance explanations of natural phenomena that are complete in breadth and depth. It is meaningful and useful to know that a finger will bleed when cut—there are many certainties of this sort—but it is not possible to trace the history of all antecedent events or to know and explain all that happens at the cellular level; it is even less possible at the molecular level, less at the atomic level, and less at the quantum level. Similarly, it is possible to achieve meaningful, useful information about some causes of human conflict and to make value judgments about them only to lose comprehension by seeking complete knowledge of underlying events.

It is one of the implications of a review of the complexity of cause-and-effect relationship that *it is theoretically as well as practically impossible to prove the completeness of any mathematical or physical model of a living or social system.*

Physical and Biological Bases of Freedom and Responsibility

In one sense, the word "freedom" is linked with uncertainty; "freedom" is made possible by the capriciousness of nature. In another sense, "freedom" refers to the capacity of an organism to make a choice, a kind of freedom expanded by knowledge and biological and social

competence and more dependent upon certainty. Morality with choice-making.

In addition to the uncertainties of knowledge, there are many physical and biological limitations on the freedoms of man. He is not free to live without oxygen, water, and food. He is not free to jump ten feet into the air or lift a house or become young after being old. The microcephalic is not free to acquire higher education. Freedoms are extended by tools and knowledge, and this is what much of civilization is about. Freedoms are limited by the nature of inborn drives, likes, and dislikes. Much behavior is determined by the pleasure-pain principle. Attitudes and choices are shaped by learned behavior. The burned child is no longer free to seek the fire. Some human likes and dislikes can be explained as representing simple conditioning. Others are more subtle: "I do not love thee, Dr. Fell / The reason why I cannot tell."

Other limitations on freedoms arise out of conflict of choices by the individual with the choices of other individuals and groups. There is an axiom that two bodies cannot occupy the same space at the same time, and it is supposed that the action of one body has an impact, however slight, on all others.

When is the individual responsible for his acts? Society accepts the idea of incompetence and irresponsibility for the very young, the senile, the feebleminded, and the insane. Most rules of society hold the criminal responsible for his acts. However, wisdom now in fashion is that the criminal is not responsible for his crime; society is responsible, for it did not provide a favorable environment. The implication is that society, but not the criminal, is endowed with freedom to choose between right and wrong and could have behaved differently if it were not perverse and asinine. But how does society, which is made up of individuals, achieve freedom of choice, which is lacking in the criminal? There is more at issue here than the principle that man is innocent until he acquires knowledge. How can ethics resolve the paradox of the aim to maximalize freedoms by using force, the paradox of lofty ideals linked with destructive actions, or the dilemma of equality versus freedom to seek self-fulfilment by competitive performance?

The old dilemma between freedom of the will and determinism endures. I do not believe that a significant step toward resolution of this problem has been taken since development, more than twenty-five hundred years ago, of the Indian concept "Athman-Brahman" (the personal self equals the omnipresent, all-comprehending external self). Man is the embodiment of all that he has inherited and acquired by experience—all of the internal and external past and present causes. He is neither an unchanging black box in which the output is determined

solely by input, nor is he flotsam, but he is a dynamic changing learning organism with a memory for scanning great stores of information and the capacity for invention. Capriciousness in nature at the quantum level and probably at gestalt levels averts predestination and permits important degrees of freedom but does not explain purposeful behavior and apparent freedom of choice. The principle of feedback makes it possible to resolve the apparent conflict between determinism and goal-directed behavior which affects decisions. But deep mystery remains, and it includes awareness, the most intimate and least understood aspects of our nature. I am awed by all of this but am left with a faith that freedom, purpose, and determinism are not mutually exclusive and that among men are varying degrees of freedom and responsibility that relate to awareness, knowledge, and to biological and cultural competence.

Risk and Morality

Uncertainty has been described as blind and cruel, but it is not entirely so, for as an important factor in natural selection it has permitted, indeed, has been essential for, evolution. There is uncertainty in the adjoining of one egg and one sperm of millions produced. It is nearly maximal when a mutation, a rare event, occurs. It is characteristic of non-genetic events as well which add to genetic factors to produce a never-to-be-repeated individual. It is a means of evolutionary progress by providing the variant patterns essential for selection. Ethics and other goal-directed behavior, the highest products of evolution, cannot escape the use of trial, error, and chance success in choice-making. The development of knowledge and insights favor the reduction of errors, but uncertainty remains, and it represents both risk and freedom. All of us can say that nothing is certain but death and taxes and can recognize uncertainty in other ways. Our laws require that guilt be proved beyond reasonable doubt but not beyond conceivable doubt; it cannot guarantee ultimate rightness. We know, also, that concensus on morality does not endure for all time. And yet, in our search for escape from the consequences of error we tend to hope and pretend that risk can be avoided.

In the practice of medicine the physician must daily make judgments based on information that does not always meet the requirements of proof. It was not anticipated that the widesperad use of antibiotics would bring organisms resistant to their action, that diagnostic X-ray would increase the incidence of malignancy, or that public health measures would become a cause of over-population. There is risk of error in making a diagnosis, there is risk in the administration of any

drug and in any major surgery. There is risk of error in most decisions made by man on human welfare. Certainty is not required when to withhold a decision or advice involves greater risk of harm to the individual or society. Agencies of government gain increasing control over therapeutic agents and medical and surgical interventions by promising to reduce risks to near zero, thereby increasing the likelihood of impeding medical progress.

Medical ethics is guided by reverence for the life of the individual patient. The risk of intervention is balanced against the risk of not intervening. Thus, a surgeon would not replace a diseased but curable organ but might assume high risk of failure of a transplant if the alternative was almost certain early death of the patient. On such a basis, public health measures as vaccination, sanitation, etc., have been generally accepted after first being opposed. It is in line with present-day medical ethics that an informed individual may volunteer to accept some risk of injury such as organ donation to help another.

The claims of the individual and the claims of society to rights and freedom are sometimes in conflict. As far as biological interventions are concerned, society assumes the right to limit the freedom of an individual carrier of a contagious disease. But society is not assumed to have the right to experiment upon the individual without his informed consent, although the failure to do research upon representative samples of human populations may have the consequence of impeding gains in knowledge.

Value judgments are commonly made before the resources for gaining relevant knowledge have been exhausted. Propagandism and dogma are then used to conceal the risk that such value judgments may be in error. An outstanding example is the current dogma that social problems have only environmental bases and that biological differences among individuals and groups are generally unimportant in human affairs. Herein is a departure from the aim to cherish and defend freedom of scientific inquiry and debate. It is rationalized by the claims of certain groups or individuals to special insights into the needs of society and that they have the responsibility to help actualize their faiths as to what is most conducive to the cultural development and survival of the species. It is generally implied and sometimes even overtly claimed that, since knowledge can be misused, there can be wisdom greater than that based upon truth. Such are the faiths which set light to fascism, communism, and various other isms and brought accompanying flames.

When freedom of debate and inquiry are impeded, an unnecessary

source of uncertainty is introduced into ethics. In addition, there are inescapable sources of uncertainty represented by theoretical and practical barriers to knowledge and by limitations in systems of logic according to which a system cannot be both complete and consistent. Since the consequences of actions by either individuals or groups cannot be predicted with certainty, freedom of debate and inquiry remain basic to morality. The pilot study or test is a most valuable means of gaining information which will improve the accuracy of predictions as to the consequences of action. The experimental method is applicable to many questions as to how to improve human welfare and to reduce the risk of actions going awry.

Closing

The bases of uncertainty are apparent degrees of capriciousness inherent in nature and barriers to the knowability of all of nature by the mind of man. The orderliness of nature should be emphasized above capriciousness; the two do not represent antinomy, for some freedom in nature is necessary for the evolution of order, choice-making, and morality. The human mind is capable of establishing practical certainties and insights at certain levels of complexity but cannot gain complete knowledge.

The wise application of moral principles requires education for uncertainty. Inquiry and knowledge can be used to reduce uncertainty and to aid decisions in the face of uncertainty. A guiding principle is to judge the risk of an action on human welfare as compared to the risk of an alternative action or the risk to human welfare of no action. The experiment or the pilot study is a means of increasing the accuracy of predictions. When freedom of debate and inquiry are impeded, when dogma and authoritarianism triumph over truth, when the mind retreats to the non-think in the face of infinitude, and when human choice is emotionally charged, there is increased risk of a moral judgment going awry.

Biological evolution has endowed man with means of tolerating uncertainty. Such are the will to survive, the joy of living, the love of others, and altruism. Self-styled moralists sometimes chide their fellows for not living in constant remorse and sorrow at the wrongs, ills, and uncertainties of the world, but the normal nervous system has evolved so that fear and sorrow tend to be ephemeral. Did these emotions not quiet with time and give way to the joy of living, hope could not triumph over despair. Is not acceptance of reality to be preferred to forms of flight, escape, and even fantasy of a perfect

world after death? Education for uncertainty should be a part of continuing education to support evolving humanness in a changing world where each person and each cross-section of existence is unique.

NOTES

1. J. R. Platt, "Amplification Aspects of Biological Response and Mental Activity," *American Scientist,* XLIV (1956), 180–97.

2. J. R. Platt, "Man and the Indeterminacies," *Perspectives in Biology and Medicine,* X, No. 1 (Autumn, 1966), 67–80.

3. Donald O. Walter, "The Indeterminacies of the Brain," *Perspectives in Biology and Medicine,* XI, No. 2 (Winter, 1968), 203–7.

4. P. W. Bridgman, *The Way Things Are* (Cambridge, Mass.: Harvard University Press, 1959), pp. 6–7.

5. D. J. Ingle, *Principles of Research in Biology and Medicine* (Philadelphia: J. B. Lippincott Co., 1958), pp. 23–41.

6. Heinrich Klüver, *Psychological Specificity—Does It Exist? Macromolecular Specificity and Biological Memory* (Cambridge, Mass.: M.I.T. Press, 1962), pp. 94–98.