3. SCIENCE AND HUMAN VALUES

1. THE PROBLEM

OUR AGE is often called an age of science and of scientific technology, and with good reason: the advances made during the past few centuries by the natural sciences, and more recently by the psychological and sociological disciplines, have enormously broadened our knowledge and deepened our understanding of the world we live in and of our fellow men; and the practical application of scientific insights is giving us an ever increasing measure of control over the forces of nature and the minds of men. As a result, we have grown quite accustomed, not only to the idea of a physico-chemical and biological technology based on the results of the natural sciences, but also to the concept, and indeed the practice, of a psychological and sociological technology that utilizes the theories and methods developed by behavioral research.

This growth of scientific knowledge and its applications has vastly reduced the threat of some of man's oldest and most formidable scourges, among them famine and pestilence; it has raised man's material level of living, and it has put within his reach the realization of visions which even a few decades ago would have appeared utterly fantastic, such as the active exploration of interplanetary space.

But in achieving these results, scientific technology has given rise to a host of new and profoundly disturbing problems: The control of nuclear fission has brought us not only the comforting prospect of a vast new reservoir of energy,

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but also the constant threat of the atom bomb and of grave damage, to the present and to future generations, from the radioactive by-products of the fission process, even in its peaceful uses. And the very progress in biological and medical knowledge and technology which has so strikingly reduced infant mortality and increased man's life expectancy in large areas of our globe has significantly contributed to the threat of the "population explosion," the rapid growth of the earth's population which we are facing today, and which, again, is a matter of grave concern to all those who have the welfare of future generations at heart.

Clearly, the advances of scientific technology on which we pride ourselves, and which have left their characteristic imprint on every aspect of this "age of science," have brought in their train many new and grave problems which urgently demand a solution. It is only natural that, in his desire to cope with these new issues, man should turn to science and scientific technology for further help. But a moment's reflection shows that the problems that need to be dealt with are not straightforward technological questions but intricate complexes of technological and moral issues. Take the case of the population explosion, for example. To be sure, it does pose specific technological problems. One of these is the task of satisfying at least the basic material needs of a rapidly growing population by means of limited resources; another is the question of means by which population growth itself may be kept under control. Yet these technical questions do not exhaust the problem. For after all, even now we have at our disposal various ways of counteracting population growth; but some of these, notably contraceptive methods, have been and continue to be the subject of intense controversy on moral and religious grounds, which shows that an adequate solution of the problem at hand requires, not only knowledge of technical means of control, but also standards for evaluating the alternative means at our disposal; and this second requirement clearly raises moral issues.

There is no need to extend the list of illustrations: any means of technical control that science makes available to us may be employed in many different ways, and a decision as to what use to make of it involves us in questions of moral valuation. And here arises a fundamental problem to which I would now like to turn: Can such valuational questions be answered by means of the objective methods of empirical science, which have been so successful in giving us reliable, and often practically applicable, knowledge of our world? Can those methods serve to establish objective criteria of right and wrong and thus to provide valid moral norms for the proper conduct of our individual and social affairs?

2. SCIENTIFIC TESTING

Let us approach this question by considering first, if only in brief and sketchy outline, the way in which objective scientific knowledge is arrived at. We may

leave aside here the question of *ways of discovery;* i.e., the problem of how a new scientific idea arises, how a novel hypothesis or theory is first conceived; for our purposes it will suffice to consider the scientific *ways of validation;* i.e., the manner in which empirical science goes about examining a proposed new hypothesis and determines whether it is to be accepted or rejected. I will use the word 'hypothesis' here to refer quite broadly to any statements or set of statements in empirical science, no matter whether it deals with some particular event or purports to set forth a general law or perhaps a more or less complex theory.

As is well known, empirical science decides upon the acceptability of a proposed hypothesis by means of suitable tests. Sometimes such a test may involve nothing more than what might be called direct observation of pertinent facts. This procedure may be used, for example, in testing such statements as "It is raining outside," "All the marbles in this urn are blue," "The needle of this ammeter will stop at the scale point marked 6," and so forth. Here a few direct observations will usually suffice to decide whether the hypothesis at hand is to be accepted as true or to be rejected as false.

But most of the important hypotheses in empirical science cannot be tested in this simple manner. Direct observation does not suffice to decide, for example, whether to accept or to reject the hypotheses that the earth is a sphere, that hereditary characteristics are transmitted by genes, that all Indo-European languages developed from one common ancestral language, that light is an electromagnetic wave process, and so forth. With hypotheses such as these, science resorts to indirect methods of test and validation. While these methods vary greatly in procedural detail, they all have the same basic structure and rationale. First, from the hypothesis under test, suitable other statements are inferred which describe certain directly observable phenomena that should be found to occur under specifiable circumstances if the hypothesis is true; then those inferred statements are tested directly; i.e., by checking whether the specified phenomena do in fact occur; finally, the proposed hypothesis is accepted or rejected in the light of the outcome of these tests. For example, the hypothesis that the earth is spherical in shape is not directly testable by observation, but it permits us to infer that a ship moving away from the observer should appear to be gradually dropping below the horizon; that circumnavigation of the earth should be possible by following a straight course; that high-altitude photographs should show the curving of the earth's surface; that certain geodetic and astronomical measurements should yield such and such results; and so forth. Inferred statements such as these can be tested more or less directly; and as an increasing number and variety of them are actually borne out, the hypothesis becomes increasingly confirmed. Eventually, a hypothesis may be so well confirmed by the available evidence that it is accepted as having been established beyond reasonable

doubt. Yet no scientific hypothesis is ever proved completely and definitively; there is always at least the theoretical possibility that new evidence will be discovered which conflicts with some of the observational statements inferred from the hypothesis, and which thus leads to its rejection. The history of science records many instances in which a once accepted hypothesis was subsequently abandoned in the light of adverse evidence.

3. INSTRUMENTAL JUDGMENTS OF VALUE

We now turn to the question whether this method of test and validation may be used to establish moral judgements of value, and particularly judgments to the effect that a specified course of action is good or right or proper, or that it is better than certain alternative courses of action, or that we ought—or ought not—to act in certain specified ways.

By way of illustration, consider the view that it is good to raise children permissively and bad to bring them up in a restrictive manner. It might seem that, at least in principle, this view could be scientifically confirmed by appropriate empirical investigations. Suppose, for example, that careful research had established (1) that restrictive upbringing tends to generate resentment and aggression against parents and other persons exercising educational authority, and that this leads to guilt and anxiety and an eventual stunting of the child's initiative and creative potentialities; whereas (2) permissive upbringing avoids these consequences, makes for happier interpersonal relations, encourages resourcefulness and self-reliance, and enables the child to develop and enjoy his potentialities. These statements, especially when suitably amplified, come within the purview of scientific investigation; and though our knowledge in the matter is in fact quite limited, let us assume, for the sake of the argument, that they had actually been strongly confirmed by careful tests. Would not scientific research then have objectively shown that it is indeed better to raise children in a permissive rather than in a restrictive manner?

A moment's reflection shows that this is not so. What would have been established is rather a conditional statement; namely, that *if* our children are to become happy, emotionally secure, creative individuals rather than guilt-ridden and troubled souls *then* it is better to raise them in a permissive than in a restrictive fashion. A statement like this represents a *relative, or instrumental, judgment of value*. Generally, a relative judgment of value states that a certain kind of action, M, is good (or that it is better than a given alternative M_1) *if* a specified goal G is to be attained; or more accurately, that M is good, or appropriate, for the attainment of goal G. But to say this is tantamount to asserting either that, in the circumstances at hand, course of action M will definitely (or probably)

lead to the attainment of *G*, or that failure to embark on course of action *M* will definitely (or probably) lead to the nonattainment of *G*. In other words, the instrumental value judgment asserts either that *M* is a (definitely or probably) sufficient means for attaining the end or goal *G*, or that it is a (definitely or probably) necessary means for attaining it. Thus, a relative, or instrumental, judgment of value can be reformulated as a statement which expresses a universal or a probabilistic kind of means-ends relationship, and which contains no terms of moral discourse—such as 'good,' 'better,' 'ought to'— at all. And a statement of this kind surely is an empirical assertion capable of scientific test

4. CATEGORICAL JUDGMENTS OF VALUE

Unfortunately, this does not completely solve our problem; for after a relative judgment of value referring to a certain goal *G* has been tested and, let us assume, well confirmed, we are still left with the question of whether the goal *G* ought to be pursued, or whether it would be better to aim at some alternative goal instead. Empirical science can establish the conditional statement, for example, that if we wish to deliver an incurably ill person from intolerable suffering, then a large dose of morphine affords a means of doing so; but it may also indicate ways of prolonging the patient's life, if also his suffering. This leaves us with the question whether it is right to give the goal of avoiding hopeless human suffering precedence over that of preserving human life. And this question calls, not for a relative but for an *absolute, or categorical, judgment of value* to the effect that a certain state of affairs (which may have been proposed as a goal or end) is good, or that it is better than some specified alternative. Are such categorical value judgments capable of empirical test and confirmation?

Consider, for example, the sentence "Killing is evil." It expresses a categorical judgment of value which, by implication, would also categorically qualify euthanasia as evil. Evidently, the sentence does not express an assertion that can be directly tested by observation; it does not purport to describe a directly observable fact. Can it be indirectly tested, then, by inferring from it statements to the effect that under specified test conditions such and such observable phenomena will occur? Again, the answer is clearly in the negative. Indeed, the sentence 'Killing is evil' does not have the function of expressing an assertion that can be qualified as true or false; rather, it serves to express a standard for moral appraisal or a norm for conduct. A categorical judgment of value may have other functions as well; for example, it may serve to convey the utterer's approval or disapproval of a certain kind of action, or his commitment to the standards of conduct expressed by the value judgment. Descriptive empirical import, however, is absent; in this respect a sentence such as 'Killing

is evil' differs strongly from, say, 'Killing is condemned as evil by many religions', which expresses a factual assertion capable of empirical test.

Categorical judgements of value, then, are not amenable to scientific test and confirmation or disconfirmation; for they do not express assertions but rather standards or norms for conduct. It was Max Weber, I believe, who expressed essentially the same idea by remarking that science is like a map: it can tell us how to get to a given place, but it cannot tell us where to go. Gunnar Myrdal, in his book *An American Dilemma* (p. 1052), stresses in a similar vein that "factual or theoretical studies alone cannot logically lead to a practical recommendation. A practical or valuational conclusion can be derived only when there is at least one valuation among the premises."

Nevertheless, there have been many attempts to base systems of moral standards on the findings of empirical science; and it would be of interest to examine in some detail the reasoning which underlies those procedures. In the present context, however, there is room for only a few brief remarks on this subject.

It might seem promising, for example, to derive judgments of value from the results of an objective study of human needs. But no cogent derivation of this sort is possible. For this procedure would presuppose that it is right, or good, to satisfy human needs—and this presupposition is itself a categorical judgment of value: it would play the role of a valuational premise in the sense of Myrdal's statement. Furthermore, since there are a great many different, and partly conflicting, needs of individuals and of groups, we would require not just the general maxim that human needs ought to be satisfied, but a detailed set of rules as to the preferential order and degree in which different needs are to be met, and how conflicting claims are to be settled; thus, the valuational premise required for this undertaking would actually have to be a complex system of norms; hence, a derivation of valuational standards simply from a factual study of needs is out of the question.

Several systems of ethics have claimed the theory of evolution as their basis; but they are in serious conflict with each other even in regard to their most fundamental tenets. Some of the major variants are illuminatingly surveyed in a chapter of G. G. Simpson's book, *The Meaning of Evolution*. One type, which Simpson calls a "tooth-and-claw ethics," glorifies a struggle for existence that should lead to a survival of the fittest. A second urges the harmonious adjustment of groups or individuals to one another so as to enhance the probability of their survival, while still other systems hold up as an ultimate standard the increased aggregation of organic units into higher levels of organization, sometimes with the implication that the welfare of the state is to be placed above that of the individuals belonging to it. It is obvious that these conflicting principles could

not have been validly inferred from the theory of evolution—unless indeed that theory were self-contradictory, which does not seem very likely.

But if science cannot provide us with categorical judgments of value, what then can serve as a source of unconditional valuations? This question may either be understood in a pragmatic sense, as concerned with the sources from which human beings do in fact obtain their basic values. Or it may be understood as concerned with a systematic aspect of valuation; namely, with the question where a proper system of basic values is to be found on which all other valuations may then be grounded.

The pragmatic question comes within the purview of empirical science. Without entering into details, we may say here that a person's values—both those he professes to espouse and those he actually conforms to—are largely absorbed from the society in which he lives, and especially from certain influential subgroups to which he belongs, such as his family, his schoolmates, his associates on the job, his church, clubs, unions, and other groups. Indeed his values may vary from case to case depending on which of these groups dominates the situation in which he happens to find himself. In general, then, a person's basic valuations are no more the result of careful scrutiny and critical appraisal of possible alternatives than is his religious affiliation. Conformity to the standards of certain groups plays a very important role here, and only rarely are basic values seriously questioned. Indeed, in many situations, we decide and act unreflectively in an even stronger sense; namely, without any attempt to base our decisions on some set of explicit, consciously adopted, moral standards.

Now, it might be held that this answer to the pragmatic version of our question reflects a regrettable human inclination to intellectual and moral inertia; but that the really important side of our question is the systematic one: If we do want to justify our decisions, we need moral standards of conduct of the unconditional type—but how can such standards be established? If science cannot provide categorical value judgments, are there any other sources from which they might be obtained? Could we not, for example, validate a system of categorical judgments of value by pointing out that it represents the moral standards held up by the Bible, or by the Koran, or by some inspiring thinker or social leader? Clearly, this procedure must fail, for the factual information here adduced could serve to validate the value judgments in question only if we were to use, in addition, a valuational presupposition to the effect that the moral directives stemming from the source invoked *ought* to be complied with. Thus, if the process of justifying a given decision or a moral judgment is ever to be completed, certain judgments of value have to be accepted without any further justification, just as the proof of a theorem in geometry requires that some propositions be accepted as postulates, without proof. The quest for a justification of *all* our valuations

overlooks this basic characteristic of the logic of validation and of justification. The value judgments accepted without further justification in a given context need not, however, be accepted once and for all, with a commitment never to question them again. This point will be elaborated further in the final section of this essay.

As will hardly be necessary to stress, in concluding the present phase of our discussion, the ideas set forth in the preceding pages do not imply or advocate moral anarchy; in particular, they do not imply that any system of values is just as good, or just as valid, as any other, or that everyone should adopt the moral principles that best suit his convenience. For all such maxims have the character of categorical value judgments and cannot, therefore, be implied by the preceding considerations, which are purely descriptive of certain logical, psychological, and social aspects of moral valuation.

5. RATIONAL CHOICE: EMPIRICAL AND VALUATIONAL COMPONENTS

To gain further insight into the relevance of scientific inquiry for categorical valuation let us ask what help we might receive, in dealing with a moral problem, from science in an ideal state such as that represented by Laplace's conception of a superior scientific intelligence, sometimes referred to as Laplace's demon. This fiction was used by Laplace, early in the nineteenth century, to give a vivid characterization of the idea of universal causal determinism. The demon is conceived as a perfect observer, capable of ascertaining with infinite speed and accuracy all that goes on in the universe at a given moment; he is also an ideal theoretician who knows all the laws of nature and has combined them into one universal formula; and finally, he is a perfect mathematician who, by means of that universal formula, is able to infer, from the observed state of the universe at the given moment, the total state of the universe at any other moment; thus past and future are present before his eyes. Surely, it is difficult to imagine that science could ever achieve a higher degree of perfection!

Let us assume, then, that, faced with a moral decision, we are able to call upon the Laplacean demon as a consultant. What help might we get from him? Suppose that we have to choose one of several alternative courses of action open to us, and that we want to know which of these we *ought* to follow. The demon would then be able to tell us, for any contemplated choice, what its consequences would be for the future course of the universe, down to the most minute detail, however remote in space and time. But, having done this for each of the alternative courses of action under consideration, the demon would have completed his task: he would have given us all the information that an ideal science might provide under the circumstances. And yet he would not have resolved our moral

problem, for this requires a decision as to which of the several alternative sets of consequences mapped out by the demon as attainable to us is the best; which of them we ought to bring about. And the burden of this decision would still fall upon our shoulders: it is we who would have to commit ourselves to an unconditional judgment of value by singling out one of the sets of consequences as superior to its alternatives. Even Laplace's demon, or the ideal science he stands for, cannot relieve us of this responsibility.

In drawing this picture of the Laplacean demon as a consultant in decision-making, I have cheated a little; for if the world were as strictly deterministic as Laplace's fiction assumes, then the demon would know in advance what choice we were going to make, and he might disabuse us of the idea that there were several courses of action open to us. However that may be, contemporary physical theory has cast considerable doubt on the classical conception of the universe as a strictly deterministic system: the fundamental laws of nature are now assumed to have a statistical or probabilistic rather than a strictly universal, deterministic, character.

But whatever may be the form and the scope of the laws that hold in our universe, we will obviously never attain a perfect state of knowledge concerning them; confronted with a choice, we never have more than a very incomplete knowledge of the laws of nature and of the state of the world at the time when we must act. Our decisions must therefore always be made on the basis of incomplete information, a state which enables us to anticipate the consequences of alternative choices at best with probability. Science can render an indispensable service by providing us with increasingly extensive and reliable information relevant to our purpose; but again it remains for us to *evaluate* the various probable sets of consequences of the alternative choices under consideration. And this requires the adoption of pertinent valuational standards which are not objectively determined by the empirical facts.

This basic point is reflected also in the contemporary mathematical theories of decision-making. One of the objectives of these theories is the formulation of decision rules which will determine an optimal choice in situations where several courses of action are available. For the formulation of decision rules, these theories require that at least two conditions be met: (1) Factual information must be provided specifying the available courses of action and indicating for each of these its different possible outcomes—plus, if feasible, the probabilities of their occurrence; (2) there must be a specification of the values—often prosaically referred to as utilities—that are attached to the different possible outcomes. Only when these factual and valuational specifications have been provided does it make sense to ask which of the available choices is the best, considering the values attaching to their possible results.

In mathematical decision theory, several criteria of optimal choice have been proposed. In case the probabilities for the different outcomes of each action are given, one standard criterion qualifies a choice as optimal if the probabilistically expectable utility of its outcome is at least as great as that of any alternative choice. Other rules, such as the maximin and the maximax principles, provide criteria that are applicable even when the probabilities of the outcomes are not available. But interestingly, the various criteria conflict with each other in the sense that, for one and the same situation, they will often select different choices as optimal.

The policies expressed by the conflicting criteria may be regarded as reflecting different attitudes towards the world, different degrees of optimism or pessimism, of venturesomeness or caution. It may be said therefore that the analysis offered by current mathematical models indicates two points at which decision-making calls not solely for factual information, but for categorical valuation, namely, in the assignment of utilities to the different possible outcomes and in the adoption of one among many competing decision rules or criteria of optimal choice. (This topic is developed in more detail in section 10.2 of the essay "Aspects of Scientific Explanation" in this volume.)

6. VALUATIONAL "PRESUPPOSITIONS" OF SCIENCE

The preceding three sections have been concerned mainly with the question whether, or to what extent, valuation and decision presuppose scientific investigation and scientific knowledge. This problem has a counterpart which deserves some attention in a discussion of science and valuation; namely, the question whether scientific knowledge and method presuppose valuation.

The word "presuppose" may be understood in a number of different senses which require separate consideration here. First of all, when a person decides to devote himself to scientific work rather than to some other career, and again, when a scientist chooses some particular topic of investigation, these choices will presumably be determined to a large extent by his preferences, i.e., by how highly he values scientific research in comparison with the alternatives open to him, and by the importance he attaches to the problems he proposes to investigate. In this explanatory, quasi-causal sense the scientific *activities* of human beings may certainly be said to presuppose valuations.

Much more intriguing problems arise, however, when we ask whether judgments of value are presupposed by the body of scientific *knowledge*, which might be represented by a system of statements accepted in accordance with the rules of scientific inquiry. Here presupposing has to be understood in a systematic-logical sense. One such sense is invoked when we say, for example, that the

statement 'Henry's brother-in-law is an engineer' presupposes that Henry has a wife or a sister: in this sense, a statement presupposes whatever can be logically inferred from it. But, as was noted earlier, no set of scientific statements logically implies an unconditional judgment of value; hence, scientific knowledge does not, in this sense, presuppose valuation.

There is another logical sense of presupposing, however. We might say, for example, that in Euclidean geometry the angle–sum theorem for triangles presupposes the postulate of the parallels in the sense that that postulate is an essential part of the basic assumptions from which the theorem is deduced. Now, the hypotheses and theories of empirical science are not normally validated by deduction from supporting evidence (though it may happen that a scientific statement, such as a prediction, is established by deduction from a previously ascertained, more inclusive set of statements); rather, as was mentioned in section 2, they are usually accepted on the basis of evidence that lends them only partial, or "inductive," support. But in any event it might be asked whether the statements representing scientific knowledge presuppose valuation in the sense that the grounds on which they are accepted include, sometimes or always, certain unconditional judgments of value. Again the answer is in the negative. The grounds on which scientific hypotheses are accepted or rejected are provided by empirical evidence, which may include observational findings as well as previously established laws and theories, but surely no value judgments. Suppose for example that, in support of the hypothesis that a radiation belt of a specified kind surrounds the earth, a scientist were to adduce, first, certain observational data, obtained perhaps by rocket-borne instruments; second, certain previously accepted theories invoked in the interpretation of those data; and finally, certain judgments of value, such as 'it is good to ascertain the truth'. Clearly, the judgments of value would then be dismissed as lacking all logical relevance to the proposed hypothesis since they can contribute neither to its support nor to its disconfirmation.

But the question whether science presupposes valuation in a logical sense can be raised, and recently has been raised, in yet another way, referring more specifically to valuational presuppositions of scientific *method*. In the preceding considerations, scientific knowledge was represented by a system of statements which are sufficiently supported by available evidence to be accepted in accordance with the principles of scientific test and validation. We noted that as a rule the observational evidence on which a scientific hypothesis is accepted is far from sufficient to establish that hypothesis conclusively. For example, Galileo's law refers not only to past instances of free fall near the earth, but also to all future ones; and the latter surely are not covered by our present evidence. Hence, Galileo's law, and similarly any other law in empirical science, is accepted

on the basis of incomplete evidence. Such acceptance carries with it the "inductive risk" that the presumptive law may not hold in full generality, and that future evidence may lead scientists to modify or abandon it.

A precise statement of this conception of scientific knowledge would require, among other things, the formulation of rules of two kinds: First, *rules of confirmation*, which would specify what kind of evidence is confirmatory, what kind disconfirmatory for a given hypothesis. Perhaps they would also determine a numerical *degree* of evidential support (or confirmation, or inductive probability) which a given body of evidence could be said to confer upon a proposed hypothesis. Secondly, there would have to be *rules of acceptance:* these would specify how strong the evidential support for a given hypothesis has to be if the hypothesis is to be accepted into the system of scientific knowledge; or, more generally, under what conditions a proposed hypothesis is to be accepted, under what conditions it is to be rejected by science on the basis of a given body of evidence.

Recent studies of inductive inference and statistical testing have devoted a great deal of effort to the formulation of adequate rules of either kind. In particular, rules of acceptance have been treated in many of these investigations as special instances of decision rules of the sort mentioned in the preceding section. The decisions in question are here either to accept or to reject a proposed hypothesis on the basis of given evidence. As was noted earlier, the formulation of "adequate" decision rules requires, in any case, the antecedent specification of valuations that can then serve as standards of adequacy. The requisite valuations, as will be recalled, concern the different possible outcomes of the choices which the decision rules are to govern. Now, when a scientific rule of acceptance is applied to a specified hypothesis on the basis of a given body of evidence, the possible "outcomes" of the resulting decision may be divided into four major types: (1) the hypothesis is accepted (as presumably true) in accordance with the rule and is in fact true; (2) the hypothesis is rejected (as presumably false) in accordance with the rule and is in fact false; (3) the hypothesis is accepted in accordance with the rule, but is in fact false; (4) the hypothesis is rejected in accordance with the rule, but is in fact true. The former two cases are what science aims to achieve; the possibility of the latter two represents the inductive risk that any acceptance rule must involve. And the problem of formulating adequate rules of acceptance and rejection has no clear meaning unless standards of adequacy have been provided by assigning definite values or disvalues to those different possible "outcomes" of acceptance or rejection. It is in this sense that the method of establishing scientific hypotheses "presupposes" valuation: the justification of the rules of acceptance and rejection requires reference to value judgments.

In the cases where the hypothesis under test, if accepted, is to be made the

basis of a specific course of action, the possible outcomes may lead to success or failure of the intended practical application; in these cases, the values and disvalues at stake may well be expressible in terms of monetary gains or losses; and for situations of this sort, the theory of decision functions has developed various decision rules for use in practical contexts such as industrial quality control. But when it comes to decision rules for the acceptance of hypotheses in pure scientific research, where no practical applications are contemplated, the question of how to assign values to the four types of outcome mentioned earlier becomes considerably more problematic. But in a general way, it seems clear that the standards governing the inductive procedures of pure science reflect the objective of obtaining a certain goal, which might be described somewhat vaguely as the attainment of an increasingly reliable, extensive, and theoretically systematized body of information about the world. Note that if we were concerned, instead, to form a system of beliefs or a world view that is emotionally reassuring or esthetically satisfying to us, then it would not be reasonable at all to insist, as science does, on a close accord between the beliefs we accept and our empirical evidence; and the standards of objective testability and confirmation by publicly ascertainable evidence would have to be replaced by acceptance standards of an entirely different kind. The standards of procedure must in each case be formed in consideration of the goals to be attained; their justification must be relative to those goals and must, in this sense, presuppose them.

7. CONCLUDING COMPARISONS

If, as has been argued in section 4, science cannot provide a validation of categorical value judgments, can scientific method and knowledge play any role at all in clarifying and resolving problems of moral valuation and decision? The answer is emphatically in the affirmative. I will try to show this in a brief survey of the principal contributions science has to offer in this context.

First of all, science can provide factual information required for the resolution of moral issues. Such information will always be needed, for no matter what system of moral values we may espouse—whether it be egoistic or altruistic, hedonistic or utilitarian, or of any other kind—surely the specific course of action it enjoins us to follow in a given situation will depend upon the facts about that situation; and it is scientific knowledge and investigation that must provide the factual information which is needed for the application of our moral standards.

More specifically, factual information is needed, for example, to ascertain (a) whether a contemplated objective can be attained in a given situation; (b) if it can be attained, by what alternative means and with what probabilities ;(c) what side effects and ulterior consequences the choice of a given means may have apart

from probably yielding the desired end; (d) whether several proposed ends are jointly realizable, or whether they are incompatible in the sense that the realization of some of them will definitely or probably prevent the realization of others.

By thus giving us information which is indispensable as a factual basis for rational and responsible decision, scientific research may well motivate us to change some of our valuations. If we were to discover, for example, that a certain kind of goal which we had so far valued very highly could be attained only at the price of seriously undesirable side effects and ulterior consequences, we might well come to place a less high value upon that goal. Thus, more extensive scientific information may lead to a change in our basic valuations—not by "disconfirming" them, of course, but rather by motivating a change in our total appraisal of the issues in question.

Secondly, and in a quite different manner, science can illuminate certain problems of valuation by an objective psychological and sociological study of the factors that affect the values espoused by an individual or a group; of the ways in which such valuational commitments change; and perhaps of the manner in which the espousal of a given value system may contribute to the emotional security of an individual or to the functional stability of a group.

Psychological, anthropological, and sociological studies of valuational behavior cannot, of course, "validate" any system of moral standards. But their results can psychologically effect changes in our outlook on moral issues by broadening our horizons, by making us aware of alternatives not envisaged, or not embraced, by our own group, and by thus providing some safeguard against moral dogmatism or parochialism.

Finally, a comparison with certain fundamental aspects of scientific knowledge may help to illuminate some further questions concerning valuation.

If we grant that scientific hypotheses and theories are always open to revision in the light of new empirical evidence, are we not obliged to assume that there is another class of scientific statements which cannot be open to doubt and reconsideration, namely, the observational statements describing experiential findings that serve to test scientific theories? Those simple, straightforward reports of what has been directly observed in the laboratory or in scientific field work, for example—must they not be regarded as immune from any conceivable revision, as irrevocable once they have been established by direct observation? Reports on directly observed phenomena have indeed often been considered as an unshakable bedrock foundation for all scientific hypotheses and theories. Yet this conception is untenable; even here, we find no definitive, unquestionable certainty.

For, first of all, accounts of what has been directly observed are subject to error that may spring from various physiological and psychological sources.

Indeed, it is often possible to check on the accuracy of a given observation report by comparing it with the reports made by other observers, or with relevant data obtained by some indirect procedure, such as a motion picture taken of the finish of a horse race; and such comparison may lead to the rejection of what had previously been considered as a correct description of a directly observed phenomenon. We even have theories that enable us to explain and anticipate some types of observational error, and in such cases, there is no hesitation to question and to reject certain statements that purport simply to record what has been directly observed.

Sometimes relatively isolated experimental findings may conflict with a theory that is strongly supported by a large number and variety of other data; in this case, it may well happen that part of the conflicting data, rather than the theory, is refused admission into the system of accepted scientific statements—even if no satisfactory explanation of the presumptive error of observation is available. In such cases it is not the isolated observational finding which decides whether the theory is to remain in good standing, but it is the previously well-substantiated theory which determines whether a purported observation report is to be regarded as describing an actual empirical occurrence. For example, a report that during a spiritualistic séance, a piece of furniture freely floated above the floor would normally be rejected because of its conflict with extremely well confirmed physical principles, even in the absence of some specific explanation of the report, say, in terms of deliberate fraud by the medium, or of high suggestibility on the part of the observer. Similarly, the experimental findings reported by the physicist Ehrenhaft, which were claimed to refute the principle that all electric charges are integral multiples of the charge of the electron, did not lead to the overthrow, nor even to a slight modification, of that principle, which is an integral part of a theory with extremely strong and diversified experimental support. Needless to say, such rejection of alleged observation reports by reason of their conflict with well-established theories requires considerable caution; otherwise, a theory, once accepted, could be used to reject all adverse evidence that might subsequently be found—a dogmatic procedure entirely irreconcilable with the objectives and the spirit of scientific inquiry.

Even reports on directly observed phenomena, then, are not irrevocable; they provide no bedrock foundation for the entire system of scientific knowledge. But this by no means precludes the possibility of testing scientific theories by reference to data obtained through direct observation. As we noted, the results obtained by such direct checking cannot be considered as absolutely unquestionable and irrevocable; they are themselves amenable to further tests which may be carried out if there is reason for doubt. But obviously if we are ever to form any beliefs about the world, if we are ever to accept or to reject, even provisionally,

some hypothesis or theory, then we must stop the testing process somewhere; we must accept some evidential statements as sufficiently trustworthy not to require further investigation for the time being. And on the basis of such evidence, we can then decide what credence to give to the hypothesis under test, and whether to accept or to reject it.

This aspect of scientific investigation seems to me to have a parallel in the case of sound valuation and rational decision. In order to make a rational choice between several courses of action, we have to consider, first of all, what consequences each of the different alternative choices is likely to have. This affords a basis for certain relative judgments of value that are relevant to our problem. If *this* set of results is to be attained, this course of action ought to be chosen; if *that other* set of results is to be realized, we should choose such and such another course; and so forth. But in order to arrive at a decision, we still have to decide upon the relative values of the alternative sets of consequences attainable to us; and this, as was noted earlier, calls for the acceptance of an unconditional judgment of value, which will then determine our choice. But such acceptance need not be regarded as definitive and irrevocable, as forever binding for all our future decisions: an unconditional judgment of value, once accepted, still remains open to reconsideration and to change. Suppose, for example, that we have to choose, as voters or as members of a city administration, between several alternative social policies, some of which are designed to improve certain material conditions of living, whereas others aim at satisfying cultural needs of various kinds. If we are to arrive at a decision at all, we will have to commit ourselves to assigning a higher value to one or the other of those objectives. But while the judgment thus accepted serves as an unconditional and basic judgment of value for the decision at hand, we are not for that reason committed to it forever—we may well reconsider our standards and reverse our judgment later on; and though this cannot undo the earlier decision, it will lead to different decisions in the future. Thus, if we are to arrive at a decision concerning a moral issue, we have to accept some unconditional judgments of value; but these need not be regarded as ultimate in the absolute sense of being forever binding for all our decisions, any more than the evidence statements relied on in the test of a scientific hypothesis need to be regarded as forever irrevocable. All that is needed in either context are *relative* ultimates, as it were: a set of judgments—moral or descriptive—which are accepted at the time as not in need of further scrutiny. These relative ultimates permit us to keep an open mind in regard to the possibility of making changes in our heretofore unquestioned commitments and beliefs; and surely the experience of the past suggests that if we are to meet the challenge of the present and the future, we will more than ever need undogmatic, critical, and open minds.