THE RATIONALITY OF VALUES

by Bruce B. Wavell

While most people today take scientific statements to be rational, objective, impartial, and based on empirical evidence, they view values and value judgments very differently. These, they assume, are expressions of individual feeling, religious belief, or social convention, which are necessarily nonrational, subjective, partial, and by their very nature incapable of being justified.

My aim in this paper is to show that this view involves a gross misrepresentation of both science and values. In the first section I argue that science, both pure and applied, is based on value judgments. In pure science the acceptance and rejection of hypotheses are based on evaluations, while major policy decisions are based on deliberation. In applied science decisions on whether to accept and use hypotheses for practical purposes are based likewise on deliberation. Some scientists are horrified at the suggestion that scientific method involves the making of value judgments. The material in this section allows me to draw a very different conclusion, namely, that because science is rational, its unavoidable dependence on values and value judgments implies that these too are rational.

In the second section I argue that there is no essential difference between the uses of values and value judgments in the humanities and their uses in science. Hence if their uses in science are rational then so also are their uses in the humanities; differences in precision and liability to bias, prejudice, and perversion do not alter this fact.

I conclude with a brief discussion of some of the practical implications of the view I am advocating, namely, that values and value judgments are rational.

VALUES IN SCIENCE

The question whether scientists, in the course of their scientific work, make value judgments has been discussed both by scientists and by

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philosophers of science for almost as long as science has existed. Those who have held that they do have employed usually one of the following arguments: (1) The decision to have a science at all implies value judgments as to the superiority of knowledge to ignorance, truth to error, and so forth. (2) Decisions by individual scientists to work on one problem rather than another involve obvious value judgments. (3) Since scientists are human their human attitudes and feelings obviously must affect their scientific activities.[1] Those scientists and philosophers of science who wished to keep values out of science, presumably because they believed that values are not rational, replied to the first two arguments by saying that such values are extrascientific and in no way affect scientific method. In answer to the third argument they admitted (somewhat reluctantly, one feels) that scientists are human but added that in the conduct of science steps are taken to minimize the effects of the individual scientist's attitudes and feelings on his results.

This is about how the situation stood until Richard Rudner, in an article in the journal *Philosophy of Science* in 1953, provided evidence for thinking that the acceptance and rejection of hypotheses in science necessarily involve the making of value judgments. The importance of this new development was that it seemed to place the making of certain kinds of value judgments at the heart of the scientific method itself; these could not be dismissed therefore like the value judgments referred to earlier. In the following passage Rudner states the essence of his view:

> Now I take it that no analysis of what constitutes the method of science would be satisfactory unless it comprised some assertion to the effect that the scientist as scientist accepts or rejects hypotheses.
>
> But if this is so then clearly the scientist as scientist does make value judgments. For, since no scientific hypothesis is ever completely verified, in accepting a hypothesis the scientist must make the decision that the evidence is *sufficiently* strong or that the probability is *sufficiently* high to warrant the acceptance of the hypothesis. Obviously our decision regarding the evidence and respecting how strong is "strong enough," is going to be a function of the *importance*, in the typically ethical sense, of making a mistake in accepting or rejecting the hypothesis. Thus, to take a crude but easily manageable example, if the hypothesis under consideration were to the effect that a toxic ingredient of a drug was not present in lethal quantity, we would require a relatively high degree of confirmation or confidence before accepting the hypothesis—for the consequences of making a mistake here are exceedingly grave by our moral standards. On the other hand, if, say, our hypothesis stated that on the basis of a sample, a certain lot of machine-stamped belt buckles was not defective, the degree of confidence we should require would be relatively not so high. *How sure we need be before we accept a hypothesis will depend on how serious a mistake would be.*[2]

Needless to say, Rudner's article rekindled the controversy about the place of values in science, and a spate of articles followed in journals. For the purposes of this paper, however, I propose to confine my comments to the passage quoted above.

First, it is important to be clear about what exactly Rudner demonstrates in this passage. He shows that the acceptance or rejection of hypotheses for social or medical purposes is determined, in some cases, by ethical considerations. He does not show that their acceptance or rejection for the purely scientific purpose of advancing knowledge is in any way determined by such considerations. In other words, his thesis that scientists make value judgments is restricted to applied science; instead of claiming that scientists qua scientists make value judgments he would have done better to claim that scientists qua physicians, qua engineers, or, in general, qua applied scientists make value judgments. Second, it is important to note that the type of reasoning to which Rudner calls our attention is now an established part of statistical decision theory; we therefore may take it, for all practical purposes, as being immune to criticism. Third, we may note also that this type of reasoning has been shown, by R. C. Jeffrey, to be equivalent to a form of commonsense reasoning called "deliberation" that is used widely outside science.[3]

This leaves unanswered the question of whether scientists qua pure scientists make value judgments. If the answer to this question were "no" then those who wish to exclude values from science could easily do so by restricting what they mean by science to "pure science." Let us see whether this option is open to them by examining how hypotheses are accepted or rejected in pure science. A widely held account of how this is done is based on what is known as the hypothetico-deductive theory of scientific method. According to this theory, we start with certain phenomena to be explained, and a hypothesis is proposed from which, with the aid of information about experimental conditions, the phenomena can be deduced. The hypothesis then is tested by deducing further, as yet unobserved, phenomena from it and checking these to see whether they occur. If the hypothesis survives a sufficiently rigorous set of tests of this kind it is accepted. It is well understood by scientists that a hypothesis which passes all its tests with flying colors is not thereby proved to be true—it could fail the next test to which it is subjected, although this is unlikely. Nor is a hypothesis that fails one of the tests thereby proved to be false since its failure could be due to some interfering cause that has nothing to do with the truth or falsity of the hypothesis, although this too is unlikely.

This theory, I suggest, is only a crude approximation to the truth. The predictive success or failure of a hypothesis is only one of the factors the scientist takes into account in deciding whether to accept it. Those who are familiar with the practice of curve fitting in science will know that through any finite number of points a noncountable infinity of curves in principle can be drawn. Hence for any set of observations, which necessarily will be finite in number, there is a noncountable infinity of hypotheses from which they can be deduced. In deciding which curve to accept, the scientist chooses the simplest one. Simplicity is therefore a constituent of the criterion for the acceptability of hypotheses.

Again, if two hypotheses are equally good from the standpoint of predictive success and simplicity but one employs concepts that are totally unrelated to existing concepts in the field while the other employs concepts that are related to them, the scientist invariably will prefer the latter hypothesis to the former. His reason for this preference is that science aims at a systematic explanation of all phenomena, and hence it is important for him to accept, whenever possible, only those hypotheses that show promise of being systematically related to prior knowledge.

What all this means is that in deciding whether to accept a hypothesis a scientist must take a number of factors into consideration—predictive success or failure, simplicity, coherence with existing knowledge, and perhaps many more; he cannot take predictive success or failure to be his sole criterion of acceptability. But this implies, since the factors are of very different kinds, that he must evaluate the hypothesis. This is a procedure that is easier to employ than to explain. Here is a conjectural reconstruction of the steps involved: (1) A weight is assigned to each factor that is proportional to its degree of importance. (2) The degree of each factor for the hypothesis, that is, its degree of predictive success, simplicity, and coherence with existing knowledge, is estimated, using a common scale. (3) The weights and degrees are multiplied for each factor and the results added. (4) The total is expressed as a fraction—say, a percentage—of a perfect score. This yields an overall rating for the hypothesis which enables it to be compared with other hypotheses. Let us call this rating *R*.

The scientist is not yet in a position to accept or reject the hypothesis; for this he needs, as Rudner pointed out in the passage I quoted, a standard of acceptability for *R*. This standard, I suggest, is derived from what Thomas S. Kuhn calls, in his well-known book, *The Structure of Scientific Revolutions*, the current paradigm of the field to which the hypothesis belongs, that is, from the standard of acceptability that has been set by the standard setters in the field.[4] This of course leaves us with the problem of explaining how the standard setters set their standards. I conjecture that they do this by setting an acceptability value for *R* that is practicable and that minimizes the problems that would arise for the development of their field from accepting a false hypothesis and rejecting a true one. In other words, I conjecture that they treat it as a practical problem in which they must weigh the advantages and disadvantages of various choices and select the best one.

Thus in accepting or rejecting hypotheses the pure scientist, like the applied scientist, is obliged to make value judgments, and thus science is based on value judgments. This obligation occurs also, I now shall proceed to show, when he makes major policy decisions concerning the future of his field. From time to time a branch of science goes through a revolutionary phase in which its basic conceptual framework has to be changed. This occurred in the twenties when classical atomic physics was replaced by quantum mechanics, and it occurred slightly earlier when Newtonian physics was replaced by relativity physics. At these times scientists are in limbo because such fundamental changes in their field can be justified neither by the old theory nor of course by any of the candidates to replace it. Kuhn put forward the suggestion that in such revolutionary periods the changes of direction in science are determined by nonrational factors such as personal influence, politics, and the pressures for recognition exerted by a younger generation of scientists.

I do not doubt that all these factors have some influence on the major policy decisions in science, but it is difficult to believe, if one examines the journals of the time, the correspondence among leading scientists, and the conferences that were held to ventilate the issues, that their influence is decisive. The impression I get is that the leading scientists engage in a debate in which they attempt to discover and weigh all the relevant pros and cons of each of the feasible alternatives open to them. In other words, I get the impression that they deliberate about what they should do, taking into account the relevant advantages and disadvantages of different possible lines of action. In doing this they of course are making value judgments.

I propose to end this section by drawing a conclusion from the material I have presented that will be useful to us in the following section. Those who deny that value judgments are rational do so largely because they assume that science, which they regard as the paradigm of rational thinking, excludes value judgments. We have seen on the contrary not only that science employs value judgments but also that their role in science is so basic that the commonsense procedures of evaluation and deliberation, which are based on value judgments, are essential to pure science, while deliberation is essential to applied science. Consequently from the rationality of science we can draw the very different conclusion that the commonsense procedures of evaluation and deliberation are rational and hence that values and value judgments also can be rational.

Values in the Humanities

Before we can argue from the rationality of values and value judgments in science to their rationality outside it, it is necessary to review briefly the kinds of value judgments that occur in nonscientific contexts. The branch of philosophy that studies values is ethics, and so I will begin this section by stating the kinds of value judgments that are recognized in ethics.

The basic division in the subject, if we ignore the methodological distinction between normative ethics and metaethics, is between the theory of obligation and the theory of value. The theory of obligation investigates judgments in which an action is judged to be right, wrong, obligatory, forbidden, permissible, and the like. It is important to note that all of these terms can be employed in either a moral or nonmoral sense. Take, for example, the word "right." If I say, "The right thing for you to do is to pay Jones the $100 you owe him," I am making a moral judgment, whereas if I say, "The right way to plane a piece of wood is with the grain," then I am making a nonmoral judgment. The theory of value investigates judgments in which something is judged to be good, bad, better, worse, excellent, and so forth. Again all of these terms can be used in either a moral or a nonmoral sense. If I say, "Albert Schweitzer was a good man," then I am making a moral judgment, whereas if I say, "The 1977 Caprice Classic is a good car," then I am making a nonmoral judgment.

Now these distinctions divide ethical judgments into four classes, namely, judgments of obligation, moral and nonmoral, and judgments of value, moral and nonmoral. Clearly only the last of these four classes, that is, nonmoral judgments of value, are analogous to the judgments a scientist makes when he evaluates a hypothesis in the course of deciding whether to accept it. Let us briefly explore the degree of closeness of this analogy to see whether it justifies the conclusion that nonmoral judgments of value in ethics are rational.

Take, for example, the statement, "This is a good carving knife," which is a nonmoral judgment of value. To determine whether this statement is true we proceed in the same way that the scientist proceeds in evaluating a hypothesis. The qualities that make a carving knife more or less suitable for the purpose for which it is required are listed first. This purpose is not merely that it will be used for carving meat but that it shall be bought by a particular person for use under particular circumstances for carving meat. Hence the list will include not only such things as size, shape, weight, balance, construction, and the materials of the handle and the blade, which will make the knife more or less efficient, durable, and easy to maintain, but also its price and aesthetic appearance. Degrees of these qualities for the particular knife being judged relative to the class of all carving knives then are estimated on a common scale, and each quality is assigned a weight proportional to its degree of importance. From these degrees and weights an overall rating for the knife is arrived at as in the scientific case. To determine whether the carving knife is a good one we make use of the fact that the meaning of the word "good" is given in the dictionary as "better than average." We therefore employ as a standard of comparison the average rating for all carving knives. If the rating for the knife we are evaluating is higher than this average rating it is good; otherwise it is not.[5]

It might be objected that the degrees and weights that are assigned to the qualities of the carving knife are imprecise, and so the analogy between this case and the scientific case breaks down. This objection is misplaced because the scientist can be no more precise about the degrees and weights he assigns to predictive success, simplicity, and coherence with existing knowledge than the judger of carving knives can be about the degrees and weights he assigns to their relevant qualities. However, there is another objection which is not so easily dismissed. In scientific evaluation only objective properties of hypotheses are taken into account, whereas in the case of the carving knife account is taken of the price and aesthetic appearance of the knife, which are subjective properties. The objection is that this difference makes the inference from the rationality of scientific evaluation to the rationality of nonmoral, ethical evaluation invalid.

Two things need to be said in reply to this objection. First, the fact that there are subjective factors in the ethical case does not change the fact that the evaluation procedures are the same in the two cases. Hence if the scientific procedure is rational so is the ethical procedure. Second, it must be admitted that in the ethical evaluation, unlike the scientific evaluation, both objective and subjective factors are present. But this merely shows that different kinds of factors are relevant to the two cases. The subjective factors are needed in the ethical evaluation because they are relevant; if they were omitted then we would have good reason to say the evaluation is nonrational.

We come now to the second of the four classes of ethical judgments, namely, the class of moral value judgments, of which "Albert Schweitzer was a good man" is an example. One would expect that the moral character of this judgment would make the procedure for determining its truth quite different from the procedure that applies to nonmoral value judgments, but this is not at all the case; the two procedures are exactly the same. The only difference between the two kinds of value judgments lies in the kinds of factors that are relevant to their truth; in the nonmoral case they were nonmoral factors, whereas in the moral case they are moral qualities such as honesty, unselfishness, reliability, kindness, and so forth. Indeed moral value judgments are in one important respect closer to scientific than to ethical nonmoral value judgments: Their relevant factors are all objective. Whether a person has a certain moral quality is determined by behavioral criteria; the attitudes and feelings of the determiner are irrelevant.

This leaves us with the two classes of judgments of obligation, one moral and the other nonmoral. Nothing I have said so far about science would suggest that there is any connection at all between scientific value judgments and ethical judgments of obligation, moral or nonmoral (I am ignoring applied science in saying this). There is such a connection, but to bring it to light I must amplify what I said in the preceding section about value judgments in science.

One of the clichés one finds in elementary textbooks of science is that scientific laws are not really laws at all because it is unscientific to believe that nature obeys laws. The books usually add that what are called scientific laws are merely well-established descriptive generalizations. Similarly, the books say, scientific principles are merely descriptive generalizations that are better established than laws and logically more basic to the systems of generalizations that constitute scientific theories.

I suggest, in opposition to this view, that scientific laws are just that—laws—which are addressed, however, to scientists rather than to nature. What I mean by this is that scientists are required in their research to treat scientific laws as inviolable, within a certain limit. This implies that if they observe a phenomenon which seems to conflict with the law, they must assume that some unknown counteracting cause or law is at work rather than that the law has been falsified. The limit is this: If a law seems repeatedly to be falsified by observation and there are good reasons for thinking that there are no counteracting causes at work, then—and only then—it may be dropped.

A principle in science, such as the principle of the conservation of energy, is even more inviolable than a law. If a principle is found to be in conflict with a law the law will have to be abandoned. However, if the principle is found to conflict with a number of laws and there are good reasons for thinking that the laws should not be abandoned, then the principle will have to go. What all this means is that scientific statements have an order of precedence or priority. Principles have the top priority, laws the middle priority, and empirical generalizations the lowest priority. The relations among these three classes of scientific statements can be stated briefly by saying that principles override laws, and laws override empirical generalizations.

This relation of overriding plays an important role in the procedure for accepting and rejecting hypotheses, a role we have not hitherto noted. Suppose that a scientist has evaluated a hypothesis *H* on the basis of its predictive success, simplicity, and coherence with existing knowledge and has rejected it because its overall rating is not high enough but later discovers that it can be deduced from a law. In this case the fact that *H* can be deduced from a law provides the scientist with a reason for accepting the hypothesis that overrides his former reason for rejecting it. It is important to note that his reasoning here is an elementary form of deliberation. The scientist is trying to decide whether to accept the hypothesis. The fact that the hypothesis can be deduced from a law provides him with a pro, and the fact that the rating of the hypothesis is too low provides him with a con. Since the pro overrides the con, the right thing for him to do is to accept the hypothesis.

We are now in a position to see the connections between scientific method and ethical judgments of obligation. The basic characteristic of moral principles—and incidentally civil laws—is that they take precedence or priority over, and hence override, nonmoral reasons for acting. For example, if I have borrowed some money from a friend and promised to repay it by a certain date then, when the time comes to settle the debt, I might have any number of nonmoral reasons for not repaying the money, but the fact that I have promised to repay it by that date imposes on me a moral obligation to do so. In other words, it provides me with a reason for repaying the money which overrides all my nonmoral reasons for not repaying it. The rational thing for me to do therefore is to keep my promise unless there is some other moral reason for not repaying the money which overrides my promise.

Again the elementary form of deliberation that the scientist employs in accepting the hypothesis, in which a pro and con are present and the pro overrides the con, is merely a special case of the kind of reasoning that is employed in everyday life in making rational decisions that involve moral considerations. At this point I could give examples of such moral reasoning, but this would create the misleading impression that moral deliberation is radically different from other kinds of deliberation. In fact, deliberation is a kind of reasoning that can be used to make decisions and choices of any kind, moral or nonmoral. The only way that moral deliberation differs from nonmoral deliberation is that it contains moral reasons, and the only thing that distinguishes moral reasons from nonmoral reasons, so far as the deliberative procedure is concerned, is that they have a higher priority than nonmoral reasons.

In view of these considerations I propose to devote the remainder of this section to a schematic description of the procedure of deliberation which will make clear why it is applicable equally to moral decision making and to the scientific cases that I described earlier, in which the pure scientist makes major policy decisions when the conceptual framework of his field needs changing and the applied scientist decides whether to employ a particular hypothesis for a certain medical or social purpose.

"To deliberate," the dictionary tells us, "is to consider reasons for and against a thing in order to make up one's mind." The kinds of things that deliberation can be used to make up one's mind about, if written out fully, would make a very long list. We deliberate to decide which of several actions we could do is the right one to do, whether we ought to do a given action, whether a certain proposition is true, whether the accused is guilty, whether a certain piece of legislation should be enacted, and so on. Deliberation is the basis of all public decision-making procedures, from the Congress down to the local council, insofar as these bodies make their decisions rationally, as Colonel Henry Roberts tells us in his *Rules of Order*. It forms the foundation of the legal trial procedure because this procedure consists of the presentation of pros and cons by two opposing attorneys to a jury that is charged with the responsibility of weighing the evidence presented to it and arriving at a verdict based on it. It is a procedure that everyone, consciously or half-consciously, employs again and again, especially in making important decisions such as whether to buy a house and whether to marry a particular person. And finally it is fundamental to the methodologies of every subject that is taught in a college or university; every scholar frequently must weigh evidence in deciding what to accept as a fact, whether to accept a proposed theory, and so forth. We have seen that deliberation is employed in science; it is employed no less in the humanities.

In view of the enormous flexibility of the deliberative procedure I am obliged to confine my description of it to only one of its many uses, but this is sufficiently broad to cover all the cases of deliberation I have mentioned. This use is to determine which of several actions that an agent could perform in a given situation is the right action for him to perform. The procedure consists of three phases: First, the agent assembles all the reasons that are relevant to the performance of each of the actions he could perform, that is, all the reasons for and against the performance of each possible action; second, he assigns its proper priority and weight to each of these reasons; third, he employs a decision procedure which enables him to determine, from these priorities and weights, the right action to perform.[6]

In the first stage the reasons for or against the performance of an action may be classified into three groups, which I call "antecedent," "proper" and "consequential" reasons. An antecedent reason for or against the performance of an action is that by some prior action the agent has incurred an obligation either to perform or to refrain from performing the present action. Examples of antecedent reasons are promises, legal contracts, and professional and parental duties, all of which, by virtue of past actions, place restraints on the agent's present actions. A proper reason is one which derives from the character of the present action itself. Thus it is a proper reason against the performance of an action that it is a case of lying, theft, arson, or murder. And a consequential reason is one that stems from the consequences of the present action. That an action will produce pleasure to the agent or others, further the agent's or others' careers, or promote the agent's or others' health is a consequential reason for performing the action. That it will produce pain either for the agent or for others, or cause harm in some other way, is a consequential reason against performing the action.

In the second phase the agent assigns due priorities and weights to all the foregoing reasons. Every reason for or against the performance of an action has a due priority and weight. The significance of priorities, as we have seen, is that a reason of higher priority always overrides any reason of lower priority, irrespective of their relative weights. Weights come into play only when reasons of the same priority are balanced against one another. By saying that reasons have due priorities and weights I mean that priorities and weights are not arbitrarily assigned to the reasons. Both in science and in other areas of culture the relative priorities and weights of some reasons are more or less fixed, even if not very exactly, by the culture and so are more or less the same for all of its members. The priorities and weights for the remaining reasons are inferred intuitively from those with fixed priorities and weights.

An examination of the system of priorities and weights employed in the English language reveals something of their underlying rationale. Priorities are assigned to reasons on the basis of categories to which the reasons belong. For example, there are legal reasons against selling top secrets to a foreign power, committing a burglary, and running a red light. The first is an act of treason, the second a felony, and the third a misdemeanor. This difference of categories assigns a higher negative priority to the first reason than to the second, and a higher negative priority to the second than to the third. Weights are assigned to reasons on the basis of the degrees to which the reasons possess the characteristics which define their categories. Thus the reasons against stealing five thousand dollars and five dollars belong to the same category—they are both felonies—but their weights are different. In general, moral reasons have the highest priority, which is why in moral deliberations one usually can ignore nonmoral considerations.

The third phase is the decision procedure for determining the right action to perform given all the actions one could perform in the circumstances and given the priorities and weights of all the reasons for and against the actions. To explain this procedure as briefly as possible without sacrificing clarity I propose to use numbers to represent priorities and weights. This involves a departure from commonsense practice, but it does not distort the logic of the procedure in any important way. Table 1 lists three actions (A_1, A_2, A_3) and their respective pros and cons, where *R* is type of reason (antecedent *a*, proper *p*, or consequential *c*); *P/C* is pro (+) or con (−); *Pty*. is priority (3 high, 1 low); *Wt.* is nominal weight of reason; *Prob.* is probability of occurrence of consequence; *Wt.* × *Prob.* is weight times probability, that is, effective weight of consequential reason. Each row gives all the information that is required in the procedure for a single reason. The need to introduce probabilities in the case of consequential reasons arises from the fact that the consequences of actions are not, as a rule, certain. If, for example, an agent performs an action with the object of gaining pleasure from it, but his chances of obtaining the pleasure in this way are small, then the effective weight of this consequential reason for performing the action will be less than its nominal weight; it will be equal in fact to the product of the nominal weight assigned to the pleasure and the probability of his obtaining it by performing the action.

To determine which of the actions A_1, A_2, and A_3 in the table is the right one to perform, the agent considers the reasons of all three actions in order, beginning with those of the top priority. There is only one reason for priority 3 and this is negative. Hence, the agent immediately can eliminate A_1, to which this reason applies, and ignore the lower-priority pros and cons for this action since they all are overridden by the priority-3 reason. The agent next considers the priority-2 reasons. Only A_2 has any of these, and they neutralize each other; they too can be ignored. Finally he moves down to the

TABLE 1

PROS AND CONS FOR THREE ACTIONS

ACTS	R	P/C	PTY.	WT.	PROB.	WT. × PROB.
A_1	a	−	3	2	—	—
	p	+	2	6	—	—
	c	+	1	18	1/3	6
	c	−	1	6	1/2	3
A_2	a	+	2	5	—	—
	p	−	2	5	—	—
	c	+	1	20	1/2	10
	c	+	1	6	1/3	2
	c	−	1	8	1/2	4
A_3	c	+	1	10	1/2	5
	c	+	1	12	2/3	8

priority-1 reasons for acts A_2 and A_3. He finds the net effective weights for these acts by adding the figures in the last column, allowing for the fact that some are negative. For A_2 he gets $10 + 2 - 4 = 8$, and for A_3 $8 + 5 = 13$. The right action to perform is the one with the greater net weight, that is, A_3.

It should be noted that in some cases this procedure may result in the selection of two actions having equal priorities and equal net pro weights; if this is so then it does not matter, from a rational standpoint, which is performed—one could settle the matter by tossing a coin. In other cases the procedure may eliminate all of the actions. If this is so then, if one is free to do nothing, this is the right thing to do; if, on the other hand, one has to perform one of the actions, it is right to perform the one that is least objectionable in terms of the priorities and weights.

I have provided reasons for thinking that science, pure and applied, is based on value judgments and that if these value judgments are rational, which they must be if science is to be rational, then the procedurally analogous value judgments that are made outside science, in morality, politics, government, and other areas of everyday life, also must be rational. This conclusion has two important implications.

First, if value judgments are rational, then it should be possible to make their logic explicit, refine them, and eventually develop them with the aid of existing or as yet undiscovered branches of mathematics. To some extent this already has been done. The English mathematician Thomas Bayes, who lived in the eighteenth century, developed a model of deliberation which has since been refined and developed into the statistical theory of decision making. However, this model takes account only of what I have called "consequential" reasons; what is needed is a broader theory that covers antecedent, proper, and consequential reasons and applies equally to moral and nonmoral forms of deliberation.

Second, if a comprehensive theory of deliberation (and evaluation) can be developed, we then shall have the tools to make rational decisions about a great many practical matters which, because they are so complex, are at present decided by emotion, tradition, prejudice, and self-interest. That political, economic, and other public decisions should be to some extent irrational did not matter very much in previous centuries when the penalties of irrationality were only moderately heavy, but now that science and technology are increasing these penalties at an alarming rate, it no longer can be tolerated. The only way in which we can live safely and effectively in a scientific world is to make ourselves and our institutions more rational, so that we become able to control the multiplying uses of science and technology for the common good.

NOTES

1. Richard Rudner, "The Scientist qua Scientist Makes Value Judgments," *Philosophy of Science* 20 (January 1953): 1-6.
2. Ibid., pp. 1-2.
3. R. C. Jeffrey, *The Logic of Decision* (New York: McGraw-Hill Book Co., 1965), pp. 1-14.
4. Thomas S. Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1962).
5. For a fuller account of evaluation see my *Language and Reason* (in press), sec. 5.4.
6. See ibid., chap. 1.