DOCUMENT RESUME

ED 306 129 SE 050 534

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TITLE	Values in Science.
PUB DATE	89
NOTE	18p.
PUB TYPE	Viewpoints (120)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Codes of Ethics; Credibility; *Ethics; Integrity; *Moral Values; Researchers; *Research Problems; *Scientific Research; *Scientists; *Value Judgment; Values

ABSTRACT

Many people feel that the making of value judgments is an important aspect of the work of science. This paper explores some of the arguments in support of the claim that scientific work requires individual and social values and raises significant moral questions. Discussed here are: (1) the constitutive value of science; (2) the ethics involved in scientific work; (3) the decisions and risks of hypothesis acceptance; (4) theory appraisal; and (5) the significance of science values. The final section considers the implication of the presence of values and norms in scientific activity for the objectivity of scientific results. (CW)

Values in Science

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> The slightly juvenile conception of the coldblooded, emotionless, impersonal, passive scientist mirroring the world perfectly in the highly-polished lenses of his steel rimmed glasses. . . is no longer, if it ever was, adequate.
> --Richard Rudner[1]

This paper explores and develops some arguments in support of the claim that scientific work, like most other human activities, requires individual and social values and raises significant moral questions. The final section considers the implications of the presence of values and norms in scientific activity for the objectivity of scientific results.

In his 1982 Presidential Address to the Philosophy of Science Association, Ernan McMullin identified four possible grounds for the claim that the making of value-judgments is an essential part of the work of science.[2] The first is that discovering and acquiring knowledge are central values of science, perhaps even constitutive values. Second, successful scientific work makes substantial ethical demands on scientists; for example, requirements of honesty and fair-mindedness. This is closely related to a point made by Nicholas Rescher, namely that ethical questions are raised and ethical decisions often required in choosing scientific agendas, selecting research methods and experimental designs, and allocating credit for successes.[3] Third, in applied science deciding whether a hypothesis is worthy of acceptance sometimes depends partly on estimates of the risks to people's welfare that will exist if a decision to accept the hypothesis turns out to be wrong (a point made without the restriction to applied science by Richard Rudner[4]). Fourth, the appraisal of scientific theories is best understood as a matter of making value-judgments about theories on the basis of evaluative criteria such as predictive accuracy, internal coherence, and unifying power. McMullen suggests that the fourth item provides the strongest reason for speaking of "values in science."

I. Knowledge as a Constitutive Value of Science

One way of arguing that values are central to scientific work involves pointing to the goal of such work, namely acquiring knowledge in certain areas. This valued goal is so central to scientific activity that it helps to constitute the nature of that activity. One can no more learn how to engage in science without learning about the goal of acquiring knowledge than one can learn how to play basketball without learning about the goal of putting the ball through the hoop.

Constitutive values or norms help define the nature of activities, practices and institutions. Cooking, for example, has as its constituting goal (or "regulative ideal") the preparation of foods that are tasty and nutritious. Additionally, cultures, regions and even families may have their own values concerning how particular dishes should be prepared. A cook who presents a dish to assembled eaters implicitly certifies at least that it is fit to eat, that it is nutritious and nonharmful. If the dish obviously falls short of cultural, local or family standards for how such a dish should come out, food presentation may be accompanied with apologies. In addition to goals and standards for successful outcomes, there are prescribed procedures that are believed to lead to successful results. For example, certain ways of cooking vegetables or of preparing gravies may be prescribed as reliable means of obtaining good results. Such prescriptions are at least partially justified by reference to the constitutive goals of cooking. This is a role frequently played by constitutive goals. Nonconstitutive values are also important here since cooking is regulated by morality and law. For example, all cooks are obligated morally and legally to avoid harming or killing people by serving poisonous food. Cooks in institutions are governed by a much wider body of legal regulations. To summarize, we have at least four types of values governing cooking (and we will find the same types of values governing science as well):

1. The constitutive goals of the activity: that cooks should seek to prepare food that is nutritious and tasty.
2. Prescribed procedures for obtaining successful results.
3. Standards for how particular dishes should come out, for what qualities they should have.
4. Moral and legal norms restraining the activity, e.g., the prohibition of harming or killing with one's food.

The constitutive values or goals of an activity make that activity the kind of activity that it is. To return to our analogy, if the goal of cooking came to be the preparation of hallucinogenic chemicals rather than the preparation of tasty and nutritious food, cooking would be a different activity than it is today--even if it still involved knocking around in the kitchen with pots, pans, bowls and spoons. Knowing the general constitutive goal of cooking is not to know very much; it certainly doesn't mean that one knows how to cook. Learning to cook requires one to learn the values that are intimately connected with particular kinds of cooking, as well as the techniques required to achieve those values in what one cooks.

If we placed constitutive values at one end of a continuum, at the other end we might place values that are not only external to an institution but antithetical to it.

Internal Values of a Practice		External values	
Constitutive	Nonconstitutive	Compatible	Antithetical

The fact that a value influences an institution does not necessarily make it part of that institution. For example, the fact that many people value the consumption of alcoholic beverages has a great influence on the activities of the Salvation Army, but this value is nevertheless not a value of (not a value internal to) the Salvation Army. It is rather an antithetical value. For a value to be internal to an institution it need not be constitutive, but it must at least be a value that is directly relevant to the activities of the institution and that most participants in the institution would endorse. Effective fundraising is an internal value of many organizations, even though it is not constitutive of most of them.

General constitutive values of natural science are not much harder to formulate than those of cooking, but they are not much more illuminating either. We might formulate the most general constitutive goal of the natural sciences as something like systematic knowledge of the physical universe through empirical means. The concepts used in formulating this constitutive goal are somewhat vague and open to interpretation. For example, "systematic" can be interpreted in a loose way that requires little more than consistency between branches of theory in an area or in a strong way that views reduction to a single axiomatic system as the appropriate long-term outcome. Particular sciences such as chemistry or geology have more specific constitutive goals, and learning these is part of learning these disciplines. The constitutive goals of particular sciences are infrequently formulated, except perhaps in introductory textbooks.

The idea of constitutive values for science may be rejected on the ground that it commits one to some form of essentialism, one that implies that the nature of science cannot change in important ways over time. But no such implication follows from constitutive values if we remember that we are merely speaking of what is constitutive of an activity or practice at a particular time. If the nature of science is partly defined by one set of constitutive values at one time and a partly or wholly different set at a later time, science will be a somewhat different sort of activity at these two times--even if we use the word "science" to apply to these activities during both of these periods, or even if some elements remain constant. Furthermore, constitutive values often express only the most general and abstract dimensions of an activity; because of this an activity can change very greatly in its more specific elements without changing its constitutive values. Some scientific revolutions may go so deep that they change the constitutive goals of a discipline, but I suspect that much more frequently the revolutionary struggle is at lower levels of abstraction.[5]

The significance of constitutive values in scientific work is twofold. First, knowing the constitutive values of an activity gives us a perspective for evaluating practices within that activity. For example, tools, techniques, and evidential rules within science can be evaluated and justified in terms of their contribution to the realization of general or specific constitutive values of scientific activity. The perspective provided by constitutive values is internal to the practice of science and is therefore not easily assailed as subjective or arbitrary. Hence, this perspective can serve as an intersubjective ground for making other evaluations, including evaluations of rules or norms.

Second, constitutive values provide a basis for excluding other values as alien, for asserting that scientific work should be insulated from certain kinds of considerations. For example, the activity of promoting Christian beliefs ("evangelism") is a different activity than engaging in science, and attempts to encourage scientists to evaluate their conclusions in terms of whether they will foster evangelism can be rejected as alien, as encouraging scientists to give up science and do something else. Notice, however, that this way of arguing is severely limited in its power. It merely says, "When you are trying to do science, you can't take what will promote Christianity as your goal." It doesn't say that one should spend one's energies on science rather than Christian evangelism, nor that science should prevail when it conflicts with Christian evangelism, nor that it would be disastrous to change the constitutive values of science so that they would be largely the same as those of Christian evangelism. These are weaknesses of arguments that are based merely on a value's being the constitutive goal of an activity.[6] For stronger arguments one has to have premises about the superior value of scientific activities.

II. The Ethical Dimensions of Scientific Work

There are values and norms that guide scientific work and ethical decisions that must be made by scientists in the course of their work.

A. Norms Internal to Science It has often been argued that the successful pursuit of scientific knowledge requires that scientists generally adhere to prescriptions such as the following:

1. Scientists should be honest in reporting their work; presenting fraudulent data is a cardinal sin in science.
2. Scientists should publish their work so that it can be subjected to critical scrutiny and used as a stepping stone to future discoveries.
3. Scientists should give credit where it is due to others whose work they have used or profited from; in particular, scientists must not present someone else's work as if it were their own.

Here the justification of these norms is in terms of the constitutive values of science; it is held that following these norms is the best way of realizing the goal of obtaining systematic knowledge of nature through empirical means. It is because the justification of these norms makes reference to the constitutive values of science that we can classify these as "internal norms." Items A and C are parts of general morality as virtues of honesty and justice. These virtues apply to scientific work not only as generally applicable moral standards but because there is a special justification for them within science. Of course a person may endorse these virtues both because they are conducive to scientific progress and because they are morally justified.

The fact that a norm is an internal norm of science does not necessarily give it priority if it conflicts with external norms. The scientific duty to publish one's finished results may conflict, for example, with national security, and the fact that the first norm is internal to science and the second external implies nothing about which should prevail.

The allocation of credit for scientific work is another area where moral values come into play. The social and political importance attached to scientific discoveries is suggested by the fact that a recent meeting between an American President and a French Prime Minister included announcement of the resolution of a controversy between French and American researchers about how to divide credit for the discovery of the AIDS virus. Rescher mentions the allocation of credit for scientific discoveries as a set of evaluative problems relating to scientific research, but concentrates on the question of how to allocate to individuals credit for work that was performed by groups or contributed to by many. This is a very narrow focus on a much broader subject. A more comprehensive view would recognize that this is an area of values in science where normative concepts such as property, desert, and justice come into play. Although moral concepts are being used, the context is one in which the justification for their use is at least partly in terms of the constitutive values of science.

Benefits to be distributed within university science departments and scientific research institutes include jobs, income, tenure, promotions, publication of writings, research support, honors and prizes. Allocations of these benefits can be criticized as unfair or unjust either in their procedures or in their outcomes. An example of the former would be the charge that articles submitted by women researchers are not evaluated fairly by a journal's reviewers. An example of the latter would be the charge that the person receiving honor for a particular discovery is not really the one who deserves the credit, or the sole credit.

In dealing with issues such as these we must rely not only on constitutive values but on more specific values as well. In order to evaluate the merits of a discovery and compare these merits with those of other discoveries, we have to know the values and goals of a particular area of scientific inquiry. To decide who most deserves an honor it will be necessary to ask specific questions about the significance of discoveries, the quality of work, the reliability of methods, and the cleverness of experiments. As will be argued below, these matters centrally involve questions of value.

Moral and evaluative issues also arise at the macro level when one looks at a country's system for rewarding scientific work. Questions here include:

1. Does the system of rewarding scientific work provide adequate incentives for scientific work? This is a matter of investment in science and efficient use of resources.

2. Is the system for rewarding scientific work generally fair and rational? In a society in which nepotism, bribery and corruption are common, one might ask whether these practices also plague scientific institutions.

3. Is the overall system of inequalities of income and status that includes the system of scientific rewards tolerably just? One might wonder whether, for example, scientists and scientific work should receive less support so that more public resources could be diverted to providing a social minimum.

B. <u>External Norms Called into Play by Scientific Decisions</u> A related argument, found in Rescher, observes that choices that are part of scientific work often have ethical dimensions because, for example, they have major consequences for public or individual welfare or raise questions about the proper allocation of public resources. Rescher thinks that scientists' decisions about research activities and goals, research methods, standards of proof, dissemination of research findings, control of scientific misinformation, and credit for research accomplishments raise "questions of a strictly ethical nature."[7] It is possible, of course, that some scientists will fail to recognize the moral dimensions of their choices, but the assertion is that they ought to recognize these dimensions and take them into account.

Rescher's argument might be reconstructed as:

Premise 1: Some scientific choices have foreseeable moral dimensions (because, for example, they have substantial and foreseeable consequences for human welfare or raise questions about the allocation of public resources)

Premise 2: If any scientific choice has foreseeable moral dimensions, these should be considered in making that choice.

Conclusion: Some scientific choices have moral dimensions that should be considered in making those choices.

Corollaries of this conclusion are that scientists ought (morally) to engage in ethical deliberations as part of their scientific work and that scientific work ought not (at least in many cases) to be done in a way that sets all value and ethical considerations aside.

Here we have values "in" science not in the sense that scientists _must_ consider them but rather in the sense that they _should_ consider them. It is not claimed that the goals of science are promoted by careful attention, say, to the safety of human research subjects. It is rather claimed that moral norms apply to scientific work independently of its specific or general aims. This is a case where values and goals other than those of science limit the ways in which science can be conducted. There is nothing surprising about this since almost all institutions and activities are limited in this way.

As an example of this sort of issue, consider the choice of agendas for scientific work. The agenda of a field can be seen, descriptively and minutely, simply as a list of topics or questions in that area that are addressed by researchers. More generally and abstractly, the agenda of a field can be seen as a brief list of large questions or concerns that were occupying mainstream researchers during a given period. Agendas are chosen by both individuals and by the agencies that fund science. Individual researchers select fields and topics as those that will receive their attention. Collectivities such as governments select fields and topics for endorsement and funding.

Agendas may not seem to be chosen; they may appear more as holes that one falls into--for good or ill--or as topics arising in the history of a discipline and imposing themselves on current researchers. But even if scientists may emphasize limits to their selections of topics, this is not to say that they have no choices at all. One can ignore a serendipitously presented problem or solution, or choose to pursue problems not currently central to one's discipline.

When a scientist works alone, spending his own time and money to pursue topics of interest, choices of agenda may be purely individual choices. But few people do science in this way today. Government funding of research is central to contemporary science, and this means that choices of agendas are collective as well as individual. The government and other granting agencies decide what sorts of work to fund, and individual scientists then make choices of research in light of the resources available. When scientific work in various areas is socially endorsed as permissible and desirable and made part of important institutions such as government, business and education, the characteristic goals, methods and results of scientists are part of what is being endorsed. Thus, many of the values in science are both social and institutional values. When scientific knowledge and research are socially valued and endorsed, this endorsement covers both the value of advancing knowledge in field F and of engaging in study and research in F. If government funds support education and research in F, this is a further endorsement of the value of knowledge of F.

The most obvious reasons for raising funds through taxation are to promote the general welfare and to protect people's rights. Taxation to promote scientific knowledge is much more controversial. Of course promoting scientific knowledge in some areas is a good way of promoting the general welfare, and hence no conflict will arise between doing the one and doing the other. But in many other areas of science payoffs for the general welfare are uncertain at best, and hence one may have to face the issue of whether public resources should be spent on areas of science that promise little by way of payoffs for the general welfare. Addressing this question requires balancing internal values against external ones.

IV. Hypothesis Acceptance and Risk

Thirty-five years ago, Richard Rudner claimed that the acceptance of a hypothesis should depend not only on the available evidence but also upon consideration of what bad consequences for human welfare would follow if one were wrong in accepting the hypothesis. Rudner's example is as follows: "[I]f 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."[8] Rudner thought that this argument showed not merely that ethical values are somehow involved in science but that they are part of the most central part of science, its methods of confirming and rejecting hypotheses.

As Richard Jeffrey noted, one can distinguish between the activity of performing the scientific task of assigning probabilities to hypotheses and the extrascientific task of deciding whether to accept a hypothesis for certain practical purposes on the basis of those probabilities.[9] This need not be simply an arbitrary division between scientific and extrascientific activities made for the purpose of keeping values out of science; Jeffrey notes that a product might be used for different purposes requiring different degrees of caution and that a scientist could not be expected to know what all of these uses are. Thus Jeffrey suggests that scientists should stick to probabilities and let others factor in the utilities.[10]

But scientists are users as well as producers of hypotheses; experiments cannot be conducted without accepting certain hypotheses for designing or using equipment of for purposes of testing other hypotheses. Important and scarce resources may be wasted if these hypotheses are wrong, or workers, experimental subjects and the public may be exposed to risks. Rudner gives a good example of this sort of case: "It would be interesting and instructive . . . to know just how high a degree of probability the Manhattan Project scientists demanded for the hypothesis that no uncontrollable pervasive chain reaction would occur, before they proceeded with the first atomic bomb detonation or fist activated the Chicago pile above a critical level." At least these sorts of cases require that the scientist take into account both probabilities and utilities or ethical norms as part of scientific work.

V. Appraising Theories as a Matter of Value Judgments

It is now widely recognized that criteria for theory choice are values or norms and hence that appraising theories as unfounded or speculative or as well-confirmed or reliable is a matter of applying these values or norms to cases, of making "value-judgments."[11] Evaluations of theories, like hypothesis acceptance or rejection, is an activity that is clearly central to the scientific role; there is no way that these activities can be held to be extrascientific. Evaluations of theories and hypotheses are central to debates within scientific communities and to the formation of consensus about what has been accomplished in a scientific field and what still needs to be done.

Criteria or values for evaluating scientific theories include "predictive accuracy," "internal coherence," "external coherence" or "conservatism," "unifying power," and "simplicity."[12]

These criteria function as "principles" rather than as "rules": the presence or absence of any one of them provides evidence, but not usually conclusive evidence, for or against the claim that a theory is a good one. They are "good making" rather than conclusive. Further, principles or good-making considerations may be present in varying degrees and have different weights; thus we may have to deal with the weight, pro or con, of having, for example, a moderate degree of predictive accuracy or a small amount of unifying power.

McMullin follows Kuhn in arguing that these criteria are values by showing that they function as good-making characteristics, as principles rather than as rules.[13] He thinks that applying criteria such as "predictive accuracy" or "unifying power" is like making a value judgment in two ways. First, he suggests that there is no strict rule or algorithm for applying these criteria; their application unavoidably requires the discriminating judgment of a trained person. Second, he points out that different scientists may assign different weights to these criteria; for example, one scientist may put the most weight on empirical adequacy while another may emphasize unifying power. McMullin agrees with Kuhn that criteria for theory choice are principles rather than rules.[14]

But these two features, while ensuring that something is a judgment, don't ensure that it is a value judgment. For example, suppose that we are trying to determine from a long distance (100 meters) whether a small animal in a vineyard is a cat or a rabbit. Size, shape, and color are the relevant features. Adams thinks that it's a cat because it is very large; Barry thinks it is a rabbit because it seems to have big ears; and Cahn thinks it is a cat because it seems to be gray with white stripes. There isn't any algorithm for doing this; knowledge and judgment have to be used in applying these criteria at 300 meters (Is the animal really striped or is it mottled? Is it really larger than most rabbits? Are we seeing large ears or is that something in the brush behind it?) Further, the observers can disagree in the weight they assign to these criteria (Cahn, for example, might think that having white stripes is much more important than size, since rabbits are much more likely to be big than striped).

This example shows, I think, that judgments can have the features McMullin mentions without being value judgments. Hence we need additional arguments to show that appraisals of theories are judgments of value. To do this we need to focus not just on their role but also on their character. Judgments whether something is a cat or a rabbit, as well as the criteria on which such judgments are based, aren't usually themselves evaluations, nor do they usually support evaluations (Although of course they could: "If it's a rabbit it's probably the lousy varmint that's been eating the tender young grape vines that we spent so much time planting").

A judgment that a theory is, say, externally consistent is itself a value judgment, since it depends on assessments about what external things the theory ought to be consistent with, and it serves to support partially a value judgment, namely whether the theory should be accepted or rejected. For another example, saying that a theory has great unifying power is itself to say something favorable about that theory and to provide one reason--a "good making characteristic"--for saying that the theory is a good one. These claims are analogous to asserting that a paring knife has a "conveniently shaped blade" and using this as one reason for judging it to be a good paring knife. Both the reason, and the conclusion it supports, are evaluations.

VI. The Significance of Values in Science

When it has been shown that values are central to scientific work, the next question is "So what?" This is a question about the significance of the presence of values in scientific work. There are three points that I want to make about this.

First, understanding that values are central to scientific work, just as they are central to cooking, helps us remember that scientific work is a human activity not so different from other human activities. It has goals, values, recognized procedures, products, successes and failures. In particular, science cannot be "sanitized" in a way that removes values and other sources of controversy from its center.

Second, knowing that scientific knowledge is produced and certified by a process requiring values and norms allows us to see that scientific facts and values are intertwined in ways that have often been ignored. There is no need to deny that we can draw distinctions between facts and values and between descriptive and evaluative statements, or to deny that these distinctions may be useful for some purposes. What is needed instead is to understand that neither side of the distinction can stand alone: we can't get values without beliefs about how the world is, and we can't get facts without values to guide us in selecting them as worthy of attention and certifying them as worthy of belief.[15]

Third, the shaping of scientific work by individual and social values raises the worry that this shaping undermines the objectivity of scientific results. Since values are often thought to be subjectively variable and impossible to justify, one may conclude that if values are central to scientific work then the conclusions of science will be impossible to justify. This point of view is represented by the argument that if the justification of scientific claims is possible there must be justified values and norms (e.g., norms specifying the conditions under which a claim is worthy of belief); that there are no justified values or norms; and therefore that the justification of scientific claims is not possible.

This argument is deductively valid but its second premise is obviously controversial. Thus an obvious way to attack its alleged soundness is to attack the second premise. A broad attack might assert that many kinds of values, including those central to science, can be justified. A narrow attack might hold that there is only one sort of value that can be justified but suggest that this is just the sort of value needed for the justification of scientific propositions. I will discuss this second, narrower, view.

One mode of justification that is often taken to be unproblematic is justification of a rule, procedure or device in terms of its ability to promote some goal or end (E) that is accepted or endorsed. This sort of justification is <u>instrumental</u> in the sense that something is justified in terms of its ability to serve as a means to E. It has often been thought that this sort of justification can provide all the justification needed for science. A scientific method or standard can be justified by showing that it is the best means of realizing some accepted goal of science. "Best means" is interpreted as meaning something like "most efficacious in realizing E" or "has the best ratio of performance to cost among ways of realizing E." In this way instrumental justification can be explicated, or largely explicated, in non-evaluative empirical language.

This sort of justification need not proceed in every case by reference to a single goal of science; local and subordinate goals will be called on in many cases. But constitutive values will provide an anchor for many of the local and subordinate goals. Constitutive values are attractive as sources of justification for standards as well as local and subordinate goals because there is likely to be little disagreement about them among people interested in science--although there may be substantial disagreement about their exact formulation and interpretation. For example, if these values include acquiring a large amount of systematic knowledge of the physical universe through empirical means, we can then justify scientific procedures and standards of evidence in terms of their superior propensity to contribute to the realization of this goal. If someone asks, "Why are you using method M?" the reply can be, "Because it best promotes our goal G, which is uncontroversial since it is a constitutive goal of science."

Suppose that we can justify epistemic criteria instrumentally by reference to the constitutive goals of science. This would leave other values in science without justification. For example, we would still need to justify values relating to agenda setting or the allocation of credit for scientific work.

One response to this worry is that these values are irrelevant to the objectivity of science or to the reliability of conclusions judged well-founded in accordance with epistemic criteria.[16] As long as epistemic criteria are instrumentally justified by reference to the constitutive goals of science, scientific work that follows them will produce reliable results, whatever values are used to choose its subject matter or reward its practitioners. Even if social utility were the basis of agenda choice and radical egalitarian principles the basis for rewarding scientists, the results--whatever they happened to be about--would still be reliable.

A second response to this worry is that these other questions about values could also be decided in terms of what was most instrumental to maximizing the satisfaction of the constitutive goals of science. Thus we might base agenda choices on what would maximize the growth of systematic empirical knowledge of the natural universe, and we might choose principles for allocating credit for scientific achievements in terms of which ones, when followed, are most conducive to this end. If we answered all value questions within science in terms of what would maximize the growth of systematic empirical knowledge of the natural universe, the result would be "autonomous science" in the strongest possible sense. But it would be morally intolerable, for example, to base the treatment of human and animal experimental subjects on this criterion, since it would treat them and their lives as mere means to the advancement of scientific knowledge. This is one area--and there probably are many--where science should not be autonomous. In this area the appropriate values must be chosen and justified on other grounds, and they have the potential to conflict with and limit criteria, norms and values justified instrumentally by reference to constitutive values.

Another lesson to be learned from this is that "V is uncontroversial" does not follow from "V is instrumentally justified by reference to the constitutive values of science." Controversy can arise in spite of such justification just in case there is a weighty external value that contradicts V.

In sum, there are two conclusions to be reached about values and objectivity. One is that insofar as epistemic criteria can be justified instrumentally by reference to the constitutive values of science, the objectivity or reliability of scientific results can be assured in spite of the role of values in scientific work. The other conclusion is that major practical and theoretical difficulties can arise because (1) the constitutive values of science have several potentially conflicting dimensions (e.g., systematicity and empirical adequacy) but are not ranked or weighted and hence provide little or no guidance in resolving conflicts between epistemic criteria; and (2) important external values sometimes should prevail over considerations based on the constitutive values of science.

ENDNOTES

1Richard Rudner, "The Scientist Qua Scientist Makes Value Judgements," Philosophy of Science 20 (1953), p. 6.

2Ernan McMullin, "Values in Science," PSA 1982, Volume 2, pp. 3-28. For an earlier and slightly shorter list of this sort see Rudner, note 1 above, p. 1

3Nicholas Rescher, "The Ethical Dimensions of Scientific Research," in R. Colodny, ed., Beyond the Edge of Certainty (Englewood Cliffs, N.J.: Prentice Hall, 1965), 261-276. See also Rescher, "The Role of Values in Social Science Research," in Charles Frankel, ed., Controversies and Decisions: The Social Sciences and Public Policy (New York: Russell Sage Foundation, 19), pp. 31-53.

4Rudner, note 1 above. See also the critique of Rudner's view by Richard Jeffrey, "Valuation and Acceptance of Scientific Hypotheses," Philosophy of Science 23 (1956), pp. 237-246.

5See Thomas S. Kuhn, The Structure of Scientific Revol ons, Second Edition (Chicago: University of Chicago Press, 1970), especially 111-135.

6For an extended argument about ethics for university teachers that suffers from these sorts of weaknesses, see "The Obligations of University Teachers," Minerva 20 (1982), pp. 105-208.

7See note 4 above.

8See note 1 above, p. 2.

9Jeffrey, note 5 above.

10Jeffrey, note 5 above, p. 242.

11This is far from a new idea; it is found in W. K. Clifford, "The Ethics of Belief," Lectures and Essays, vol. II (London, 1979). It is also developed in Roderick Chisholm, Perceiving: A Philosophical Study (Ithaca, NY: Cornell University Press, 1957), pp. 9-11, 100. See also Alvin Goldman, Epistemology and Cognition Cambridge, MA: Harvard University Press, 1986), particularly chapters 4 and 5.

12See Thomas Kuhn, "Objectivity, Value Judgement, and Theory Choice," in The Essential Tension (Chicago: University of Chicago Press, 1977), pp. 320-339.

13Kuhn makes this argument in "Objectivity, Value Judgement, and Theory Choice," The Essential Tension (Chicago: University of Chicago Press, 1977), pp. 321-5).

[14] McMullin, pp. 14-20.

[15] This point is made in somewhat different terms by W. V. Quine in "On the Nature of Moral Values," Critical Inquiry 5 (1979), 471-80, reprinted in W. V. Quine, Theories and Things (Cambridge, MA: Harvard University Press, 1981), pp. 55-60.

[16] Rudner, note 1 above, suggests this strategy on p. 2.