

## Introduction: Good Science, Bad Science

How do we judge the claims of science? The news media regularly report the latest hot item from the scientific journals. Scientific ideas and their proponents seem to command belief simply through the newsworthiness accorded them. Others, however, with less access to “the public mind,” caution against any temptation to accept uncritically the pronouncements from the lab (or its public relations office). While these critics do not speak as one, recent academic commentary from various vantage points has highlighted the role of social and political interests in the making of scientific knowledge. Historians and social scientists have increasingly directed attention to so-called external factors in the development of knowledge. Their investigations include historical studies of the relation between theory and ideology—for example, Darwinian evolutionary theory and nineteenth-century capitalism, nineteenth-century craniometry and racism and sexism, and sociological studies detailing the connections between research and the interests of those conducting or supporting the research and of the role of science in policy making. Activists charge that political bias has shaped certain contemporary research programs—from studies affirming a genetic basis for group differences in intelligence to the prevalence of various forms of reductionism in the life sciences. How should these demonstrations and allegations of the interaction of science and social values affect our conception of scientific knowledge?

The links that historians, social scientists, and scientists themselves have demonstrated between the study of nature on the one hand and social values and ideology on the other raise pressing questions about such traditional philosophical topics as rationality, objectivity, and the nature of knowledge. The new awareness, however, of the relations between science and society has not yet had much impact in the philosophy of science. This book is an attempt to rectify this neglect by developing an account of scientific reasoning and knowledge that enables us to make sense of scientific debates that involve social ideology and values as well as the more stereotypically scientific issues of evidence and logic. My aim is to show *how* social values play a role in scientific research by analyzing aspects of scientific reasoning. I propose to do this by engaging in a philosophical analysis of certain fea-

tures of evidential relations and by applying that analysis to certain areas of contemporary scientific research. In this chapter I shall map some of the debates within which this project is located.

#### CONSTITUTIVE AND CONTEXTUAL VALUES

It is, of course, nonsense to assert the value-freedom of natural science. Scientific practice is governed by norms and values generated from an understanding of the goals of scientific inquiry. If we take the goal of scientific activity to be the production of explanations of the natural world, then these governing values and constraints are generated from an understanding of what counts as a good explanation, for example, the satisfaction of such criteria as truth, accuracy, simplicity, predictability, and breadth. These criteria are not always equally satisfiable and, as I shall suggest, are appropriate to different conceptions of what counts as a good explanation. Nevertheless, they clearly constitute values by which to judge competing explanations and from which norms and constraints governing scientific practice in particular fields (for example, the requirement for repeatability of experiments) can be generated.

Independence from these sorts of values, of course, is not what is meant by those debating the value freedom of science. The question is, rather, the extent to which science is free of personal, social, and cultural values, that is, independent of group or individual subjective preferences regarding what ought to be (or regarding what, among the things that are, is best). For the sake of clarity I will call the values generated from an understanding of the goals of science *constitutive* values to indicate that they are the source of the rules determining what constitutes acceptable scientific practice or scientific method. The personal, social, and cultural values, those group or individual preferences about what ought to be, I will call *contextual* values to indicate that they belong to the social and cultural environment in which science is done.<sup>1</sup> The traditional interpretation of the value freedom of modern natural science amounts to a claim that its constitutive and contextual features are clearly distinct from and independent of one another. Can this distinction, as commonly conceived, be maintained?

The issue of the independence of science and values (or constitutive and contextual values) can be reformulated as two questions. One question concerns the relevance of scientific theories (and methods) to contextual values: To what extent do or should scientific theories

<sup>1</sup> I introduce this distinction in Longino (1983).

shape moral and social values? The other concerns the impact of contextual values upon scientific theories and methods: To what extent do social and moral values shape scientific theories? The first, then, has to do with the autonomy of questions of personal, social, and cultural values from the revelations, discoveries, and inventions of scientific inquiry. Does, for instance, the assertion that a certain form of behavior (for example, aggressive war) is an adaptation, sculpted into human nature by the chisel of natural selection, have any relevance to ethical judgments? This question and its cognates have been much discussed in the contemporary uproar about sociobiology. I shall pursue the question of the relevance of scientific theory to moral and political values as a consequence, instead, of the second question. This question concerns the autonomy of the content and practices of the sciences from personal, social, and cultural preferences regarding what ought to be and what, among the things that are, is best. I will argue not only that scientific practices and content on the one hand and social needs and values on the other are in dynamic interaction but that the logical and cognitive structures of scientific inquiry require such interaction.

When we ask whether the content of science is free from contextual values we are asking about the integrity and autonomy of scientific inquiry. These concepts can be understood both morally and logically or epistemologically. Thus scientists sometimes become defensive when asked to comment on the relation between science and values because they think their moral integrity is being challenged. Or they dismiss cases of value influence as “bad” science, practiced only by the corrupt or inept. But what does the attribution of epistemological integrity and autonomy to scientific inquiry mean in the first place?

Autonomy and integrity are separable attributes, and I shall consider them in sequence. In its most extreme form the attribution of *autonomy* is a claim that scientific inquiry proceeds undisturbed and unaffected by the values and interests of its social and cultural context, that it is propelled instead by its own internally generated momentum. In one sense this seems clearly false.

The dependence of most current science on corporate and/or government funding makes the conduct of science highly vulnerable to its funding sources. The questions to which the methods of scientific inquiry will be applied are at least partly a function of the values of its supporting context. That the questions also bear a logical relationship to prior research does not rule out their social determination. Consider, for instance, the commercialization of genetic engineering. The techniques of isolating and recombining selected bits of DNA molecules to effect the production of desired substances depend critically

on the discovery of the structure of the DNA molecule in the 1950s and on the work that has been done since correlating segments of that molecule with phenotypic expressions of genetic information. There is a great deal of concern now that the commercial possibilities involved in the bacterial production of antibodies, growth and other hormones, et cetera, will incline biomedical research even further toward the search for cures of disease and away from the search for understanding of the causes of disease. This provides a simple and clear example of the interaction of internal and external factors in the development of inquiry. Studies of funding patterns and research pursued in other areas of inquiry reveal similar interactions.

This kind of palpable influence exerted by the social and cultural context on the directions of scientific development has led many observer-critics of science to reject the value freedom of science. Defenders of the idea that science is value-free can argue, however, that cases such as these show that science is not autonomous in the extreme sense but can also point out that the alleged science/value interactions are superficial ones. These sorts of considerations, the defender might continue, go nowhere towards showing that the internal, real practice of science is affected by contextual values. The thesis that the internal practices of science—observation and experiment, theory construction, inference—are not influenced by contextual values is what I call the thesis of the *integrity* of science. Contemporary criticisms of research in the biology of behavior and cognition pose a more severe challenge to the thesis of integrity, for they address not just how the context influences the questions thought worth asking but the answers given to those questions.

Societies in which one race or sex (or one race-sex combination, for example, white males) is dominant generally distribute their resources disproportionately, the greater share of benefits going to the dominant group. This distribution is usually justified on the basis of presumed inherent differences between the dominant and subordinated groups. Aristotle told us how women and slaves were inferior to free-born Athenian males. George Gilder and Michael Levin tell us how women are unsuited to the rigors of public life. Theories about the genetic basis of racial differences in I.Q. test performance and theories about the hormonal basis of gender differences are not propounded and contested in a vacuum. They are debated in a context informed about social inequality but divided about its nature and legitimacy.

To the extent that research on the biological basis of various socially significant differences is taken seriously as science, it is presumed to offer accurate and “unbiased” descriptions of what is the case—de-

scriptions or theories that are not themselves in any part a product of cultural values or assumptions. This is what the thesis of the integrity of science claims and what the critics of this research deny. An account of evidence and reasoning in science ought, among other things, to give us a standard by which we can ascertain the degree to which these currently contested theories of cognition and behavior are or could be developed and supported independently of cultural values. This demand, it seems to me, encompasses two of the most pressing questions a contemporary methodologist of science must address—the questions of whether and to what extent a value-free or autonomous science is methodologically possible. These questions challenge traditional conceptions of rationality and objectivity. Answers to these questions would help us to assess the real relevance to cultural ideals and social policy of research with apparent social consequences. They would also prompt us to reexamine the ideas of “good science” and “bad science” and the assumption that value-laden or ideologically informed science is always bad science.

#### DEBATES ABOUT SCIENCE AND SOCIAL VALUES

While most philosophers of science have ignored these questions, other theorists have either explicitly or by implication filled the void left by our silence. Several positions on the relation between science and values can be distinguished. One approach argues that to the extent that contextual values can be shown to influence reasoning, they are shown to have produced bad reasoning. This is the approach most scientists seem, by implication, to favor and to which many philosophers are committed in virtue of their analyses of reasoning and validation in the sciences. Another approach, the social constructionist tendency in sociology and history of science, argues that the processes by which scientific knowledge is built are social and hence ideological and interest-laden. A third, characteristic of many scientists who oppose some particular theory such as human sociobiology because of its social implications, tries to have it both ways. These critics state that science is value-laden and inevitably reflects the values of scientists and their society. Simultaneously they wish to claim that some specific (objectionable) scientific claim is also incorrect. To set my own inquiry in perspective, I shall briefly sketch out these approaches.

A recent article by Robert Richardson exemplifies the first form of response.<sup>2</sup> Richardson is sympathetic to the criticisms of science as

<sup>2</sup> Richardson (1984).

value-laden and attempts, in his article, to articulate the proper role of “ideology critique” in the sciences. He is one of the very few philosophers of science to have addressed these questions and to have brought them to the attention of the professional philosophical community. While his attention is a welcome exception to the rule, ironically the particular analysis he develops ultimately supports the view that social values are associated with bad science.<sup>3</sup>

The specific target of Richardson’s argument is the supposition that demonstrating the ideological bias of a scientific explanation is sufficient reason to reject it. Some of the early rejections of human sociology as racist and sexist are examples of this supposition in practice. Richardson argues instead that to reject a theory or hypothesis one must show that it is false or not warranted. Showing that it is ideologically incorrect is not sufficient. To make his point he reviews a number of cases—some notorious, others less so—in which racist, individualist, or sexist ideology plays a role. In each instance he elegantly demonstrates that the offending hypotheses are inadequately warranted. The role of ideology in these cases is to blind the proponents of the hypotheses to the fact that their warrants are inadequate. The role of ideology critique is to explain why their proponents cling to inadequately warranted hypotheses. Thus, Richardson seems to be saying that, properly followed, the methods of inquiry sanctioned by the constitutive values of science weed out the influence of subjective preferences. This thesis can be called the thesis of the integrity of science.

One striking feature of Richardson’s examples is that the hypotheses in question are unwarranted with respect to the field or discipline or theory within which they are propounded: they violate or ignore methodological constraints accepted by workers in the field, including the individuals whose work he is criticizing. For instance, claims by the sociobiologists Richard Dawkins and John Maynard Smith that phenomena such as certain forms of sexual or parental behavior or the apparent self-limitations on animal violence represent adaptations or “evolutionarily stable strategies” fail to demonstrate that there was variation from which the alleged adaptation could have been selected. But a trait is an adaptation or “evolutionarily stable strategy” only if there was such variation. The analyses of the particular cases are compelling for each case, but Richardson seems to assume that all cases will be like the ones he discusses. His analysis will not, however, apply

<sup>3</sup> Richardson does distinguish between value-laden and value-loaded science and states that all science is value-laden. He does not, however, explain what value-laden science might be in distinction from value-loaded science. Thus, his analysis invites being indiscriminately applied to all cases of contextual values in the sciences.

to those cases where the warrants themselves—that is, the methodological procedures or framing assumptions accepted within a field—are ideologically driven or value-laden. Moreover, the implication of Richardson's essay is that "ideology critique" has no role to play in discussions of "good science." But the scientist who is trying to do different science and to escape the ideology perceived in her or his field wishes to dissect its role in theories, not in order to show them wrong but to find the places where an alternative set of values might yield a different set of hypotheses. Richardson is persuasive about the particular examples he analyzes but does not support the claim that all cases of ideologically laden science are analogous to those.

The social constructionist approach urges us to abandon our obsession with truth and representation. The phrase "social constructionist" is used to refer to analytic programs in history and sociology of science that take scientific theories and hypotheses to be products of their political, economic, and cultural milieu. These programs employ a wide range of epistemological views, but their proponents are unanimous in rejecting the idea that science is objective or that it gives us an unbiased view of the real world. Social constructionism comes in two forms. The more modest form of the social constructionist thesis holds only that social interests influence the choice of research areas and problems. This is consistent with Richardson's view of the relation of science and values. Thus, defenders of the value neutrality of science can respond to the modest form of the thesis by pointing out that while such examples as the influence of governmental funding and commercial applicability on research show that science is not autonomous they do not have a bearing on the thesis of the integrity of science. Such defenders can invoke the distinction between discovery and justification and argue that as long as values are shown only to influence the discovery process, they have not been shown to undermine claims to objectivity in the justification process. And if values have influenced individuals' justification procedures, then so much the worse for those individuals. The objectivity of science, conceived as a set of rules and procedures for distinguishing true from false accounts of nature, is not undermined by arguments establishing modest forms of social constructionism.

The so-called "strong program in sociology of science" associated with the University of Edinburgh scholars Barry Barnes and David Bloor holds that social interests are more deeply involved in scientific practice.<sup>4</sup> The strong program questions not merely the autonomy but

<sup>4</sup> See, for example, the essays in Hubbard and Lowe, eds. (1979); Hubbard, Henifin, and Fried, eds. (1979); Ann Arbor Science for the People Collective (1977).

the epistemological integrity of science. Barnes and Bloor have argued that social interests determine the *acceptance* of hypotheses in the sciences. They argue (1) that there is no transcendent or context independent criterion of rational justification that renders some beliefs (hypotheses) more credible than others and (2) that the explanation why a given set of beliefs is found in a given context depends on features of the context and not on intrinsic properties of the beliefs. Bloor extends Durkheim's thesis that "the classification of things reproduces the classification of men" to the sciences. Other social constructionists argue similarly that all outcomes in the sciences are negotiated and that social interests are involved in the negotiation of technical outcomes, such as the description of experimental results, as much as of political outcomes, such as who will head a research group.<sup>5</sup>

Feminist scholars, too, have rejected the idea of the value neutrality of the sciences. Donna Haraway, in a series of studies of twentieth-century primatology, has concentrated on the ways socio-political-economic ideology constructs the subject matter of that discipline. She shows how the basic concepts and forms of knowledge are subtly transformed in response to changing political agenda. For Haraway science is a series of political discourses and must be read as such. Scientist turned historian Evelyn Fox Keller has argued that the language of mainstream science is permeated by an ideology of domination created in the very processes of personal psychological development and individuation characteristic of modern European and North American societies.<sup>6</sup>

Proponents of the integrity of science thesis can respond to the strong form of the social constructionist program in either of two ways, depending on what kind of argument is used. To the extent that the argument rests on case histories, they can respond (1) that it fails to show that all science is interest-shaped or value-laden and (2) that the cases on which it rests are instances of "bad science," just the sort of thing that scientific methods, properly followed, are designed to eliminate. To the extent that the argument rests on philosophical arguments, it is only as strong as those arguments. For example, many social constructionists cite Kuhn's *Structure of Scientific Revolutions* as the philosophical basis of their work.<sup>7</sup> Kuhn's views, however, have been subjected to searching philosophical criticism. In neither case does the demonstration of social influence require the proponents of value-free science to alter their views.

<sup>5</sup> Haraway (1981).

<sup>6</sup> Barnes and Bloor (1982); Bloor (1982); and Barnes and Edge, eds. (1982).

<sup>7</sup> See, for example, Knorr-Cetina and Mulkay, eds. (1983), pp. 1-18.



Finally, some critiques of research programs with racist or sexist implications seem to combine the assumptions of a Richardsonian and a social constructionist approach.<sup>8</sup> They argue that racist or sexist research is the inevitable product of a scientific community that excludes women of any background and members, male and female, of certain ethnic or racial groups. Citing Kuhn, they argue that all observation is theory-laden and that, hence, the observations of a racist or sexist scientific community will be laden with racism and sexism. At the same time these critics tackle particular research programs, such as the I.Q. research or human sociobiology, and show that these programs are methodologically flawed. Politically and polemically this approach can seem attractive as it suggests that if we want good—that is, methodologically respectable—research, we should put an end to exclusionary practices in science education and hiring. To eliminate the bad science more quickly, we should even engage in affirmative action to change the racial and sexual composition of the scientific work force.

Philosophically, however, this attempt to have it both ways is unsatisfactory. As Donna Haraway observed in a review of several collections of essays on sociobiology and hereditarianism, to simultaneously adopt an analysis of observation in science as theory- or paradigm-determined while asserting the incontrovertible existence of any fact is to embrace paradox.<sup>9</sup> Underlying her critique is the idea that if observation is theory-determined, then we can have no confidence that what appears to be a fact in the context of one theory will remain so in the next. Indeed, if sexist and racist science is bad science that ignores the facts or fails to treat them properly, this implies that there is a good or better methodology that will steer us away from biased conclusions. On the other hand, if sexist science is science as usual, then the best methodology in the world will not prevent us from attaining those conclusions unless we change paradigms. Is the scientific critic faced with a choice between critiquing methodologically incompetent science (but saying nothing more general about the relation between science and society) and critiquing science in general (but saying nothing in particular about politically pernicious science)? I will argue that this is a false dilemma. To see that this is so, however, requires a certain amount of philosophical groundwork.

The view that science is a social product is at least as old as Marxism. Marxists argued that the knowledge and culture of a society were ultimately determined by the relations of production. Part of what is at issue here is how to make good on that claim. According to Marx-

<sup>8</sup> The work of both Haraway and Keller is discussed in Chapter Nine.

<sup>9</sup> See the introduction to Barnes and Edge, eds. (1982), pp. 1–12.

ists, the knowledge and culture of a class society reflect the interests of its ruling class. A more objective and transformative knowledge can only be found or produced through another perspective—for Marxists, the perspective of wage laborers, or the proletariat. Feminist theorists have given this view a new form.<sup>10</sup> Knowledge in a male dominant society reflects the experience and interests of men. A more objective and transformative knowledge is therefore to be found in the perspective of women. Both forms of standpoint theory share the same weakness. Since neither wage laborers nor women share a common perspective, it becomes necessary to identify a subclass within each of those classes whose perspective does form an appropriate standpoint. However, the theory one is attempting to vindicate by a standpoint methodology is required to identify this subclass, thus making the procedure circular.

Are there criteria or standards of truth and rationality that can be articulated independently of social and political interests? I will argue that there are standards of rational acceptability that are independent of particular interests and values but that satisfaction of these standards by a theory or hypothesis does not guarantee that the theory or hypothesis in question is value- or interest-free. This argument involves a point similar to a different sort of feminist (and Marxist) claim. Feminist theorists have drawn our attention to the pervasiveness of interdependence in human societies—at its most obvious this claim is simply the observation that the public activities of production, commerce, and governance require the material support provided in the domestic realm to those carrying out those public activities. Individuals do not act alone but require others both for the execution and for the significance of their actions. Similarly, I will argue, the development of knowledge is a necessarily social rather than individual activity, and it is the social character of scientific knowledge that both protects it from and renders it vulnerable to social and political interests and values. The argument that develops this thesis is, therefore, simultaneously an account of what it means to say that science is socially constructed.

### THE ARGUMENT AHEAD

This book is not an attempt to mediate between conflicting views about the relation between science and values but to explore some of the philosophical questions about scientific inquiry that such views

<sup>10</sup> See Hartsock (1983) and Jagger (1985) for two different ways of developing feminist standpoint theory.

provoke. The investigation of scientific knowledge that forms the first section of the book aims to clarify the notion of the value freedom of scientific inquiry and to show that the ideal of value neutrality places unrealistic constraints on science as we know it. While my study is based on logical analysis of reasoning and of scientific inquiry, and so escapes the contingency of empirical studies, it is actual reasoning and actual inquiry that is analyzed. Philosophers are notorious for developing rigorous elaborations and analyses of formal models that are never realized in practice. My study does not rely on logical formalism, staying closer, therefore, to the texture of inference in both scientific and nonscientific reasoning.

In Chapter Two I explore some of the consequences of understanding scientific reasoning as a practice rather than as the disembodied application of a set of rules. I also set out my dissatisfactions with the views of scientific reasoning and knowledge that underpin current accounts of the relation between science and contextual values. In the following chapter I argue that evidential reasoning—both everyday and scientific—is context dependent. I resolve some of the resulting puzzles about objectivity in Chapter Four, where I develop an understanding of scientific inquiry as a set of necessarily social rather than individual practices. The result is a picture of scientific inquiry as a group endeavor in which models and theories are adopted/legitimated through critical processes involving the dynamic interplay of observational and experimental data and background assumptions. Since contextually located background assumptions play a role in confirmation as well as in discovery, scientific inquiry is, thus, at least in principle, permeable by values and interests superficially external to it.

Chapters Five through Eight illustrate the ways in which social and cultural values can and do influence the development of scientific knowledge. One significant test of philosophical analyses is the degree of illumination they afford of the (relatively) more concrete phenomena to which they are ultimately referred. The analyses of the first section enable us to understand a variety of the interactions between scientific inquiry and sociocultural values occurring in contemporary science.

Chapter Five develops a typology of ways in which values and interests perceived as external to or different from scientific ones can nevertheless play a significant part in shaping scientific knowledge and practice. I also use some recent scholarship on the development of early modern physics to demonstrate the possibility of convergence of contextual and constitutive values. This is followed by two sets of in-depth comparative studies of research on the biological bases of al-

leged sex differences in temperament, behavior, and cognition. Because of the potential social effects of research supporting claims that there is such a biological basis, whether genetic or physiological, this is a notoriously charged area. As noted above, it has drawn criticism of a variety of kinds—from dismissal either as prejudiced, or as “bad science,” or analysis as the expression of ideology in paradigm-governed science.

While a case for the value ladenness of scientific inquiry might better be made by investigating an area much further removed from political controversy, this study was initially motivated by the desire to make a contribution to understanding this very area. The philosophical analysis of evidence, background assumptions, objectivity, et cetera, enables me to pull this work apart enough to distinguish the different levels at which ideology operates and to distinguish the different kinds of interest that interact with and in the research. One chapter in this series (Chapter Six) focusses on the logical structure and evidential base of several research programs on sex differences. In this chapter I compare the different roles gender ideologies play in structuring evidential relations. A second chapter (Seven) brings out the background assumptions informing much research on the role of fetal hormones in the development of sex-differentiated adult behaviors by a detailed comparison of this work with an alternative research program in neurophysiology. This comparison focusses on the different roles assigned to the brain in behavior. Both of these chapters distinguish different kinds of values and interests that operate in the description and interpretation of data as well as the different levels at which they operate. A third chapter (Eight) explores the relation of this biological research to assumptions underlying certain of our culture’s ideals and values. These include not only the gender ideology underlying ideals of personhood but concepts of human agency and responsibility. It concludes by comparing how the different theories of scientific knowledge discussed in earlier chapters of the book would analyze these relations.

The final two chapters return to the consideration of general questions stimulated by the logical analysis and its application in the case studies. In his book *Between Science and Values* historian of science Loren Graham addressed the relevance of twentieth-century scientific theory to human cultural and personal values.<sup>11</sup> He was studying both the ways in which key ideas from relativity theory, quantum theory, ethology, and other fields had shaped thinking in the larger social and cultural contexts of science and the degree to which ideas from those

<sup>11</sup> Loren Graham (1981).

theories really do have consequences for traditional values. My study has approached these questions from a different direction, asking how those contexts shape the theories developed within them. The demonstration that general methodological constraints are inadequate to the task of ruling values out of scientific inquiry and that in specific and quite disparate areas of inquiry their role in shaping scientific knowledge can be clearly delineated suggests several questions. To what degree is scientific research an impartial arbiter of questions about human nature and about our relation to the rest of the natural world? What, if any, is the proper role of values in research programs? In Chapter Nine, I suggest an interpretation of feminist science as an example of any politically sensitive science and discuss the views of four other thinkers concerned with the relations between science and politics. Why has the idea of a value-free science persisted? And have any of the values and ideologies shaping scientific knowledge become encoded in the metascientific epistemological debates? The concluding chapter draws out the implications of the preceding analyses for these issues.

The prospect of a value-laden science is, for many, the prospect of a science whose results are continually in contestation. For others it is the more frightening prospect of a science continually at the mercy of dominant interests, a science that, under the guise of neutrality, helps create a world to serve those interests. The specters of Lysenkoism in the first half of the century and of creationism today are powerful incentives to support the goal of value-free science. They cannot be ignored in any responsible argument that science is not value-neutral. My argument does not require us to give Lamarckism or creationism equal time in the classroom. As I indicated, I will pursue general implications of understanding science as value-laden in the last section of this book. In the next several chapters I lay the philosophical groundwork for that discussion by examining concepts of evidence, reasoning, and objectivity. In this examination I will show what a value-free science might be, why it cannot be, and how we can avoid the paradoxes inherent in more traditional accounts by treating scientific knowledge as social knowledge.