Whose science? Whose knowledge? : thinking from women's lives/ Sandra Harding; Ithaca: Cornell University Press, 1991. (77-103 p.)

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Why "Physics" Is a Bad Model for Physics

Both natural and social sciences can benefit from feminism in the variety of ways preceding chapters have described. Even most feminist critiques, however, have not gone far enough in identifying the fortifications that have been erected—intentionally or not—around the natural sciences and that protect them from the very kind of critical, causal scientific explanation that the natural sciences insist on for all other social phenomena. This chapter focuses on popular but false beliefs that block our ability to understand the natural sciences as a social phenomenon and, consequently, to appreciate the relevance of feminism to the content and logic of research and explanation.

Science without the Elephants

Are feminist criticisms of Western thought relevant to the natural sciences? "Of course, there should be more women in science, mathematics, and engineering—and the good ones will rise to the top," the conventional argument says. "Moreover, it is not at all good that some technologies and applications of natural science have been dangerous to women; policymakers should take steps to eliminate these misuses and abuses of the sciences. But the logic of research design and the logic of explanation in the physical sciences are fundamentally untouched by the feminist criticisms and will necessarily remain so. This is because the logic of research and of explanation and the cognitive, intel-

lectual content of natural science's claims—'pure science'—cannot be influenced by gender."

This argument will not stand up to scrutiny. It is grounded not only in an underestimation of the pervasiveness of gender relations—relations that appear not only between individuals but also as properties of institutional structures and of symbolic systems[1]—but also in false beliefs about the natural sciences. Because of these beliefs, it is difficult to make sense of many aspects of science and society. One can think of these false beliefs as extraneous elements in metatheories of science: if we remove them, we can begin to understand aspects of science that appear inconsistent or inexplicable as long as we hold them.

By "physics"—in quotation marks—I mean a certain image of science that is full of these mystifying beliefs. "Physics" is magical; it is like the ancient image of a column of elephants holding up the earth. The logic of the column of elephants—"You can't fool me, young man: it's elephants all the way down," as the punch line to the old joke goes—prevents the observer from asking questions that would quickly come to mind were the elephants not so solidly in view. Physics is to "physics" as a satellite photo of the earth is to a picture of the earth balanced on top of a column of elephants. We can understand physics without "physics."

The reader should be reassured again that I do not intend to throw out the baby of science along with the bath water of false views about science.[2] My concern is to separate the false beliefs from those that are conducive to empirically, theoretically, and politically more adequate sciences—to identify more carefully where the baby ends and the bathwater begins. There are some *causes* of scientific beliefs and practices that are to be found outside the consciousnesses of individual scientists; that is, they are not *reasons* for the acceptance or rejection of these beliefs and practices. Our society is permeated by forms of scientific rationality; and it is in just such a society that there is a deep resistance to understanding how the institutional practices of science shape the activities and consciousnesses of scientists as well as of the rest of us. From the perspective of the democratic tendencies within

1. See Sandra Harding, *The Science Question in Feminism* (Ithaca: Cornell University Press, 1986), 52–56, for discussion of these three sometimes conflicting manifestations of gender relations.

2. Contrary to the apparent recommendation of such critics as, e.g., Sal Restivo, "Modern Science as a Social Problem," *Social Problems* 35:3 (1988).

science, that resistance is irrational, but it frames discussions in such a way that it is difficult for people to understand their own activities and why some of the choices they confront are so limited and narrow. The false beliefs examined below serve to hide the irrationality from critical scrutiny.

Some readers will think I am criticizing a straw figure. They will find it convenient to see only positivist tendencies that are no longer fashionable as the reasonable target of these criticisms. I cannot here detour to define positivism and debate its influence. But it is widely recognized in the social studies of science that although fewer scientists, philosophers, and social scientists who model their work on the natural sciences are as openly enthusiastic about positivism than was the case forty and more years ago, most of these people still happily embrace fundamental assumptions of positivism. As philosopher Roy Bhaskar has astutely observed, positivism still represents the unreflective "consciousness of science."[3]

Six False Beliefs

(1) "Feminism is about people and society: the natural sciences are about neither; hence, feminism can have no relevance to the logic or content of the natural sciences." One line of thinking behind this argument is that researchers are far more likely to import their social values into studies of other humans than into the study of stars, rocks, rats, or trees. And it is absurd, the conventionalist will argue, to imagine that social values could remain undetected in studies of the abstract laws that govern the movements of the physical universe. Scientific method has been constructed exactly to permit the identification and elimination of social values in the natural sciences. Practicing scientists and engineers often think the discussions of objectivity and method by philosophers and other nonscientists are simply beside the point. If bridges stand and the television set works, then the sciences that produced them must be objective and value-free—that's all there is to the matter.

One could begin to respond by pointing out that evolutionary theo-

3. Roy Bhaskar, "Philosophies as Ideologies of Science: A Contribution to the Critique of Positivism," in his *Reclaiming Reality* (New York: Verso, 1989).

ry, a theory that is about all biological species and not just about humans, clearly "discovered" secular values in nature, as the creationists have argued. It also "discovered" bourgeois, Western, and androcentric values, as many critics have pointed out.[4] Moreover, the physics and astronomy of Newton and Galileo, no less than those of Aristotle and Ptolemy, were permeated with social values. Many writers have identified the distinctively Western and bourgeois character of the modern scientific world view.[5] Some critics have detected social values in contemporary studies of slime mold and even in the abstractions of relativity theory and formal semantics.[6] Conventionalists respond by digging in their heels. They insist on a sharp divide between premodern and modern sciences, claiming that while medieval astronomy and physics were deeply permeated with the political and social values of the day, the new astronomy and physics were (and are) not; this is exactly what distinguishes modern science from its forerunners. As historian of science Thomas Kuhn said, back when he was such a conventionalist, the world view characteristic of medieval Europe was much like that of "primitive societies" and children, which "tends to be animistic. That is, children and many primitive peoples do not draw the same hard and fast distinction that we do between organic and inorganic nature, between living and lifeless things. The organic realm

4. Stephen Jay Gould, *The Mismeasure of Man* (New York: Norton, 1981); Ruth Hubbard, "Have Only Men Evolved?" in *Discovering Reality: Feminist Perspectives on Epistemology, Metaphysics, Methodology, and Philosophy of Science*, ed. Sandra Harding and Merrill Hintikka (Dordrecht: Reidel, 1983).

5. See Leszek Kolakowski, *The Alienation of Reason: A History of Positivist Thought* (New York: Doubleday, 1968); Carolyn Merchant, *The Death of Nature: Women, Ecology, and the Scientific Revolution* (New York: Harper & Row, 1980); Alfred Sohn-Rethel, *Intellectual and Manual Labor* (London: Macmillan, 1978); Margaret C. Jacob, *The Cultural Meaning of the Scientific Revolution* (New York: Knopf, 1988); Wolfgang Van den Daele, "The Social Construction of Science," in *The Social Production of Scientific Knowledge*, ed. Everett Mendelsohn, Peter Weingart, and Richard Whitley (Dordrecht: Reidel, 1977); Morris Berman, *The Reenchantment of the World* (Ithaca: Cornell University Press, 1981).

6. Evelyn Fox Keller, "The Force of the Pacemaker Concept in Theories of Aggregation in Cellular Slime Mold," and "Cognitive Repression in Contemporary Physics," both in Keller, *Reflections on Gender and Science* (New Haven, Conn.: Yale University Press, 1985); Paul Forman, "Weimar Culture, Causality, and Quantum Theory, 1918–1927: Adaptation by German Physicists and Mathematicians to a Hostile Intellectual Environment," *Historical Studies in the Physical Sciences* 3 (1971); Merrill B. Hintikka and Jaakko Hintikka, "How Can Language Be Sexist?" in Harding and Hintikka, *Discovering Reality*.

has a conceptual priority, and the behavior of clouds, fire, and stones tends to be explained in terms of the internal drives and desires that move men and, presumably, animals."[7]

The conventionalist fails to grasp that modern science has been constructed by and within power relations in society, not apart from them.[8] The issue is not how one scientist or another used or abused social power in doing his science but rather where the sciences and their agendas, concepts, and consequences have been located within particular currents of politics. How have their ideas and practices advanced some groups at the expense of others? Can sciences that avoid such issues understand the causes of their present practices, of the changing character of the tendencies they seem to "discover in nature" in different historical settings?

Even though there are no complete, whole humans visible as overt objects of study in astronomy, physics, and chemistry, one cannot assume that no social values, no human hopes and aspirations, are present in human thought about nature. Consequently, feminism can have important points to make about how gender relations have shaped the origins, the problematics, the decisions about what to count as evidence, social meanings of nature and inquiry, and consequences of scientific activity. In short, we could begin to understand better how social projects can shape the results of research in the natural sciences if we gave up the false belief that because of their nonhuman subject matter the natural sciences can produce impartial, disinterested, value-neutral accounts of a nature completely separate from human history.

(2) "Feminist critics claim that a social movement can be responsible for generating empirically more adequate beliefs about the natural world. But only false beliefs have social causes. Whatever relevance such critics have to pointing out the social causes of false beliefs, feminism can not generate 'true beliefs.'" This claim assumes that no social science findings could be relevant to our explanations of how the best, the empirically most supported (or least refuted) hypotheses arise and gain scientific legitimacy. Some conventionalists will agree that the

7. Thomas Kuhn, *The Copernican Revolution* (Cambridge, Mass.: Harvard University Press, 1957), 96.

8. See Joseph Rouse, *Knowledge as Power: Toward a Political Philosophy of Science* (Ithaca: Cornell University Press, 1987); Merchant, *Death of Nature;* Van den Daele, "Social Construction of Science"; Harding, *The Science Question in Feminism*, chaps. 8–9.

social sciences can tell us about the intrusion of social interests and values into research processes that have produced false beliefs: when we want to know why phlogiston theory, phrenology, Nazi science, Lysenkoism, and creationism were able to gain a legitimacy and respect that they should not have had, the causes are to be found in social life. Funding them is a worthy task for sociologists and historians. But the content of "good science" has no social causes, only natural ones, according to the conventionalist. It is a result of the way the world is, of the way our powers of observation and reason are, and of bringing our powers of observation and reason to bear on the way the world is. Consequently, the most widely accepted natural science claims require no causal accounts beyond the reason scientists could give for their own cognitive choices.

Supporting this view of the asymmetry of causal explanations of belief is a long tradition in epistemology but one that has been criticized in recent decades by sociologists of knowledge.[9] They argue that it is simply a prejudice of philosophers to hold that the beliefs a culture regards as legitimate should uniquely be excepted from causal social explanations. To hold such a position is to engage in mysticism; it is to hold that the production of scientific belief, alone of all distinctively human social activities, has no social causes. Instead, they argue, a fully scientific account of belief will seek causal symmetry; it will try to identify the social causes (as well as the natural ones) of the best as well as the worst beliefs.

This sociological account is flawed in a variety of ways. For one thing, these writers appear to exempt their own claims from the causal accounts they call for elsewhere, in this and other ways adopting still excessively positivist conceptions of scientific inquiry.[10] Moreover, their account appears to reduce scientific claims to beliefs that happen to be socially acceptable. It offers no way to talk about the natural constraints within which historically distinctive scientific accounts are

9. David Bloor, *Knowledge and Social Imagery* (London: Routledge & Kegan Paul, 1977); Barry Barnes, *Interests and the Growth of Knowledge* (Boston: Routledge & Kegan Paul, 1977); Karin Knorr-Cetina, *The Manufacture of Knowledge* (Oxford: Pergamon Press, 1981); Karin Knorr-Cetina and Michael Mulkay, eds., *Science Observed: Perspectives on the Social Study of Science* (Beverly Hills, Calif.: Sage, 1983).

10. See, e.g., Bloor, *Knowledge and Social Imagery*, 142–44. Attempts to remedy this situation by pursuing to its amusing though disastrous end the embrace of relativism required by the logic of the "strong programme" in the sociology of knowledge can be seen in Steve Woolgar, ed., *Knowledge and Reflexivity* (Beverly Hills, Calif.: Sage, 1988).

produced.[11] But we do not have to replicate the limitations of these sociological accounts, the functionalism and relativism that plagues these otherwise illuminating analyses. We can hold that our own (true! or, at least, less false) account also has social causes—that, for example, changes in social relations have made possible the emergence of the distinctive intellectual and political trajectory of modern science as well as of feminism. These histories leave their fingerprints on the cognitive content of science no less than of feminism.[12] Moreover, we can insist that the identification of social causes for the acceptance of a belief does not exclude the possibility that that belief *does* match the world in better ways than its competitors. That is, we can hold that certain social conditions make it possible for humans to produce reliable explanations of patterns in nature, just as other social conditions make it very difficult to do so.

If the objection to feminist accounts of the social causes of "true belief" were reasonable, one would have to criticize on identical grounds the new histories, sociologies, psychologies, anthropologies, and political economies of science. A wide array of studies have shown the politics within which modern scientific knowledge has been constructed. Eliminating the idea that only false beliefs can have social causes—this "elephant"—makes possible more coherent accounts of what actually has contributed to the growth of knowledge in the history of the sciences. It makes possible an understanding of feminism as able to advance knowledge not only by debunking false beliefs but also by helping to create social conditions conducive to the recognition of less partial and distorting beliefs, and by generating such scientifically preferable beliefs.

(3) "Science fundamentally consists only of the formal and quantitative statements that express the results of research, and/or science is a unique method. If feminists do not have alternatives to logic and mathematics or to science's unique method, then their criticisms may be relevant to sociological issues but not to science itself." Galileo

11. Hilary Rose, "Hyper-reflexivity: A New Danger for the Counter Movements," in *Counter-Movements in the Sciences: The Sociology of the Alternatives to Big Science*, ed. Helga Nowotny and Hilary Rose (Dordrecht: Reidel, 1979).

12. See, e.g., Harding, "Why Has the Sex/Gender System Become Visible Only Now?" in Harding and Hintikka, *Discovering Reality*; Van den Daele, "Social Construction of Science"; and Edgar Zilsel, "The Sociological Roots of Science," *American Journal of Sociology* 47 (1942).

argued that nature speaks in the language of mathematics, so if we want to understand nature, we must learn to speak "her" language. Some conventionalists have understood this to mean that "real science" consists only of the formal statements that express such laws of nature as those discovered by Isaac Newton, Robert Boyle, and Albert Einstein.

There can appear to be no social values in results of research that are expressed in formal symbols; however, formalization does not guarantee the absence of social values.[13] For one thing, historians have argued that the history of mathematics and logic is not merely an external history about who discovered what when. They claim that the general social interests and preoccupations of a culture can appear in the forms of quantification and logic that its mathematics uses. Distinguished mathematicians have concluded that the ultimate test of the adequacy of mathematics is a pragmatic one: does it work to do what it was intended to do?[14]

Moreover, formal statements require interpretation in order to be meaningful. The results of scientific inquiry can count as results only if scientists can understand what they refer to and mean. Without decisions about their referents and meanings, they cannot be used to make predictions, for example, or to stimulate future research. And as is the case with social laws, the referents and meanings of the laws of science are continually extended and contracted through decisions about the circumstances in which they should be considered to apply.

There is also the fact that metaphors have played an important role in modeling nature and specifying the appropriate domain of a theory.[15] To take a classic example, "nature is a machine" was not just a useful heuristic for explaining the new Newtonian physics but an inseparable part of that theory, one that created the metaphysics of the theory and showed scientists how to extend and develop it. Thus, social metaphors provided part of the evidence for the claims of the new sciences; some of their more formal properties still appear as the kinds of relations model-

13. This section repeats some of the arguments made in Harding, *The Science Question in Feminism*, chap. 2.

14. Bloor, *Knowledge and Social Imagery;* Morris Kline, *Mathematics: The Loss of Certainty* (New York: Oxford University Press, 1980).

15. Mary Hesse, *Models and Analogies in Science* (Notre Dame, Ind.: University of Notre Dame Press, 1966); Merchant, *Death of Nature*. See also my discussion of Hesse's conclusions in Harding, *The Science Question in Feminism*, 233–39.

ed by the mathematical expressions of the natural sciences. They were not only "outside" the process of testing hypotheses; they were also "inside" it. The social relations of the period, which both made possible and were in turn supported by the machines on which Newton's mechanistic laws were modeled, functioned as—*were*—part of the evidence for Newtonian physics. Giving up the belief that science is really or fundamentally only a collection of mathematical statements is necessary if we are to begin to explain the history and practices of science. Insistence on this belief is a way of irrationally restricting thought.

If science is not reducible to its formal statements, is it reducible to its method? This is an equally problematic claim. Contemporary physicists, ethologists, and geologists collect evidence for or against hypotheses in ways different from those that medieval priests used to collect evidence for or against theological claims, yet it is difficult to identify or state in any formal way just what it is that is unique about the scientific methods. For one thing, different sciences develop different ways of producing evidence, and there is no clear way to specify what is common to the methods of high-energy physics, ethology, and plate techtonics. "Observing nature" is certainly far too general to specify uniquely scientific modes of collecting evidence; gatherers and hunters, premodern farmers, ancient seafarers, and mothers all must "observe nature" carefully and continuously in order to do their work. These examples also show that linking prediction and control to the observation of nature are certainly not unique to science, since they are also crucial to gathering and hunting, farming, navigation, and child care. Scientific practices are common to every culture. Moreover, many phenomena of interest to science, though they can be predicted and explained, cannot be controlled—for example, the orbit of the sun and the location of fossils. And prediction alone is possible on the basis of correlations that in themselves have little or no explanatory value.

Philosophers and other observers of science have argued for centuries over whether deduction or induction should be regarded as primarily responsible for the great moments in the history of science,[16] but it is obvious that neither is unique to modern science: infants and dogs regularly use both. It may be futile to try to identify distinctive features of knowledge-seeking that will exclude mothers, cooks, or

16. See Sandra Harding, ed., *Can Theories Be Refuted? Essays on the Duhem-Quine Thesis* (Dordrecht: Reidel, 1976).

farmers from the ranks of people who should be counted as scientists but will include highly trained but junior members of, say, biochemical research teams. This is even more true in a society such as ours where scientific rationality has permeated child care, cooking, and farming.

One might try to defend the idea that the important feature of scientific method is science's critical attitude.[17] That is, scientific method is fundamentally a psychological stance. In all other kinds of knowledge-seeking, this line of argument goes, we can identify assumptions that are regarded as sacred or immune from refutation; only modern science holds all its beliefs open to refutation. But this proposal is not supported by the history, present practices, or leading contemporary metatheories of science. On the one hand, assumptions that are held immune from criticism—either on principle or inadvertently—are never absent from the sciences. The history of science shows that scientists and science communities again and again make unjustified assumptions and that they are loath to examine critically the hypotheses in whose plausibility they have invested considerable time, energy, and reputation. Moreover, we could call some beliefs constitutive of science in the sense that they can be questioned only at the risk of creating skepticism about the whole scientific enterprise. One example is the idea that all physical events and processes have causes even if we can't always know what they are; another is that it is a good thing to know more about nature. Furthermore, everyone understands that there must be many scientific assumptions that are questionable in principle, but that they cannot all be questioned simultaneously if research is to occur at all. Thomas Kuhn proposed that a field of inquiry really becomes a science only when it decides to accept some set of beliefs as "not to be contested" and makes these the assumptions that define the field (this line of thought led Kuhn to dubious claims about how to create true sciences, as we shall see).[18] Others point to the necessarily unquestioned "background assumptions" or "auxiliary hypotheses" that inevitably hover behind every hypothesis being tested. These include optical theories, beliefs about how the testing and recording instruments work, assumptions about which variables are significant and about what can count as a repeated observation or experiment.

17. Robin Horton, "African Traditional Thought and Western Science," pts. 1–2, *Africa* 37 (1967); Karl Popper, *Conjectures and Refutations: The Growth of Scientific Knowledge*, 4th ed. (London: Routledge & Kegan Paul, 1972).

18. Thomas Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1970).

Nor is Western science the only domain of critical thought. All of us must have a critical attitude toward a good number of beliefs if we are to survive the vicissitudes of nature and social life. It is part of the ethnocentrism of the West to assume that only practitioners of Western scientific rationality exercise critical reason. Feminists and the working class have also questioned the assumption that critical reason is the talent only of the dominant groups.[19]

The idea that science really or fundamentally comprises formal statements or is a distinctive method is an extraneous belief that blocks our ability to describe and explain the workings of modern Western science. Science has many interlocking practices, products, referents, and meanings. It is a cumulative tradition of knowledge. It is an "origins story," a fundamental part of the way certain groups in the modern West identify themselves and distinguish themselves from others. It is a metaphysics, an epistemology, and an ethics. It is a politics that has been compatible with the agendas of modern liberal states, capitalism, and Protestantism. Some have pointed out not only that science has become a religion for many but that although it attempts to hide its religious character by distancing itself from religion, it intends to hold the place of a religion. What else, they ask, could one conclude about its insistence on its own absolute authority, on its "monologue" form, on its inherent moral good; about its intolerance of criticisms from "outside"; about its intended use to define the borders of "civilization"? It is a social institution with complex rituals and practices that both reflect and shape social relations in the cultures in which it exists. It is both the producer and the beneficiary of technological invention. It is a major factor in the maintenance and control of production and, increasingly, reproduction.

There is a striking contrast between this array of descriptions of "what science is" and the restricted range upon which conventionalists

19. See, e.g., Mary G. Belenky, B. M. Clinchy, N. R. Goldberger, and J. M. Tarule, *Women's Ways of Knowing: The Development of Self, Voice, and Mind* (New York: Basic Books, 1986); Carol Gilligan, *In a Different Voice: Psychological Theory and Women's Development* (Cambridge, Mass.: Harvard University Press, 1982); Sandra Harding, "Is Gender a Variable in Conceptions of Rationality? A Survey of Issues," in *Beyond Domination: New Perspectives on Women and Philosophy*, ed. Carol C. Gould (Totowa, N.J.: Littlefield, Adams, 1983); Genevieve Lloyd, *The Man of Reason: "Male" and "Female" in Western Philosophy* (Minneapolis: University of Minnesota Press, 1984); J. E. Wiredu, "How Not to Compare African Thought with Western Thought," in *African Philosophy: An Introduction*, 2d ed., ed. Richard A. Wright (Washington, D.C.: University Press of America, 1979).

insist. False beliefs block our ability to explain how science works.

(4) "Applications of science are not part of science proper. So feminist criticisms of the misuses and abuses of the sciences (such as of the proliferation of dangerous reproductive technologies) challenge only public policy about science, not science itself." Preceding discussions indicate why this statement is a distorted representation of science and technology and the relations between them. Whatever was true in the past, it is difficult now to identify anything at all that can count as *pure* science. Is this too strong a claim? Let us see. Science makes use of technological ideas and artifacts at least as much as the reverse. Moreover, even when scientific ideas do not result in any immediate application, they may very well still be permeated with values. After rethinking the complex relationship between sciences and technologies, many observers have concluded that science is "politics by other means." It is more than that, but it is that.

Everyone is willing to acknowledge that scientific research makes possible new technologies and applications of science. Science produces information that can be applied in the social world and used to design new technologies. This is not thought to threaten the purported purity of science, because it is not scientists but policymakers who actually decide to construct the technologies and carry out the new applications of scientific information. "You can't infer an 'ought' from an 'is,'" as philosophers like to say. Deciding what we ought to do with the information that science provides is supposed to be a separate process from producing the information in the first place. According to this way of thinking, it is policymakers who should be held responsible for the misuses and abuses of the sciences and their technologies—not scientists or the sciences themselves.

Because two distinct groups of people have responsibility for the two kinds of decisions, it is easier to think that technologies and sciences must be conceptually and politically separate. Scientists in universities and research laboratories produce the information; scientists in industry, the military, and the government make the decisions about what information is to be disseminated and how it is to be used.[20] But this division of labor does not have the consequences its defenders suppose.

20. See, e.g., Paul Forman, "Behind Quantum Electronics: National Security as Bases for Physical Research in the U.S., 1940–1960," *Historical Studies in Physical and Biological Sciences* 18 (1987).

It simply makes it difficult for scientists in universities to explain their own activities in a plausible way: that is, to give the kind of causal account of science that scientists recommend we give about everything else. Their explanations of their activities do not maximize coherence, generality, simplicity, do not fit with empirical evidence, and so on.

In the first place, some "is's" in practice ensure "oughts." For example, in a racist society, "pure descriptions" of racial difference have little chance of functioning as pure information. One can be confident that racist assumptions will markedly narrow the range of "reasonable" applications of such "information." Moreover, the very concern with racial difference in such a culture cannot be free of race value.[21] The scientific reports can be as value-neutral as possible in the sense that they describe only difference, not inferiority and superiority, and make no recommendations for social policy. But it is exactly this kind of research that one can reasonably predict will be used for racist ends (intentionally and not) in a race-stratified society. (This is an argument not against doing such research but against the refusal to state and discuss publicly the political interests in and possible consequences of the research.)

Does it make sense to refer to this kind of research as objective inquiry when everyone has a stake in its outcome? Moreover, as some social scientists have pointed out, it cannot be value-free to describe such social events as poverty, misery, torture, or cruelty in a value-free way. In the face of those phenomena, every statement counts as either for or against; there is no possible third stance that is value-free. The use of objective language to describe such events results in a kind of pornography; the reader, the observer, consumes for his or her own intellectual satisfaction someone else's pain and misfortune. It is not irrelevant, some critics argue, that scientific method does not appear to provide any criterion for distinguishing whether certain procedures on humans should subsequently be referred to as scientific experiments or as torture.[22]

Defenders of pure science frequently appear to be arguing that a scientist's ignorance of the consequences of his scientific behaviors should be counted as evidence for his objectivity. But if the law finds

21. Gould, *Mismeasure of Man*.

22. See the discussion of this problem in "Commentary by Naomi Scheman" (on Sandra Harding's "The Method Question"), *American Philosophical Association Newsletter on Feminism and Philosophy* 88:3 (1989), 40–44.

avoidable ignorance culpable, why shouldn't science? Of course, no one can guarantee the good consequences of all or perhaps any of one's decisions. But why should it not be regarded as culpable to refuse to consider the consequences of one's acts, as this insistence on the possibility of a separation between pure and applied science directs scientists to do? The "innocence" of science communities—our "innocence"—is extremely dangerous to us all. Perhaps people who have exhibited tendencies toward such innocence should not be permitted to practice science or construct metatheories of science; they are a danger to the already disadvantaged and perhaps even to the species! Why shouldn't we regard ignorance of the reasonably predictable consequences of one's scientific behaviors as evidence not of the objectivity of that research but of incompetence to conduct it? Although I am putting this issue in terms of moral responsibility, it is fundamentally a political issue: how is modern Western science constructed by class, race, and gender struggles? But claiming individual moral responsibility can be a powerful motive for political change.

It is less widely recognized that the technologies science uses in its research processes themselves have political consequences. The use of the telescope moved authority about the heavens from the medieval church to anyone who could look through a telescope. The introduction of complex diagnostic technologies in medical research moves authority about the condition of our bodies from us to medical specialists; in practice, it even tends to move this authority from physicians to lab technicians. These are not trivial involvements of science in political interests and values. Not all technologies can be used in a given society, for the political and social values that a technology expresses or enacts may conflict with the dominant social values. In fact, historians and sociologists of science have pointed out that the technologies of experimental method could not gain widespread acceptability in a slave culture: experimental method requires a trained intellect as well as the willingness to "get one's hands dirty," but slave cultures forbid education to slaves and manual labor to aristocrats.[23]

There is a third important relation between science and technology: scientific problematics are often (some would say always) responses to social needs that have been defined as technological ones. For example, scientists were funded to produce information about the reproductive

23. Zilsel, "Sociological Roots."

system which would permit the development of cheap and efficient contraceptives. The development of contraceptives was a technological solution to what was defined by Western elites as the problem of overpopulation among ethnic and racial minorities in the First World and indigenous Third World peoples. From the perspectives of those peoples lives, however, there are at least equally reasonable ways to define what "the problem" is. Instead of overpopulation, why not talk about the First World appropriation of Third World resources which makes it impossible for the Third World to support its own populations? Why not say that the problem is the lack of education for Third World women—the variable said to be most highly related to high fertility?[24] After all, just one member of a wealthy North American family uses far more of the world's natural resources in his or her daily life than do whole communities of Ethiopians. Would it not be more objective to say that First World overpopulation and greed are primarily responsible for what Westerners choose to call Third World overpopulation?

To take another example, research to develop higher-yield varieties of grains is said to make the Third World better able to feed its peoples. But given the political and economic relations between the First and Third Worlds, what it actually does is to increase the supply of crops for export to the First World, leaving Third World peoples even hungrier than they were before they were the beneficiaries of technological "development." The problem could have been defined as why the First World should profit even further at Third World expense, or who benefits most when the First World so squanders its resources that it needs to import food from far poorer societies.

This argument distinguishes scientists' intentions from the functions of their work. The point is not that scientists *intend* to conduct technology-driven inquiry, or to promote the politics that the production of their information requires or makes possible; most do not. Instead, the point is how scientific research functions within the contemporary social order. This kind of argument is difficult for many people to appreciate because elites—and especially scientists—are taught to think of the results of science as the consequence of individual and

24. See Maria Mies, *Patriarchy and Accumulation on a World Scale: Women in the International Division of Labor* (Atlantic Highlands, N.J.: Zed Books, 1986), for a discussion of why a capitalist imperialist patriarchy paradoxically cannot permit Third World women to reproduce themselves but insists that First World women do so.

team effort to find descriptions of the regularities of nature and their underlying causal tendencies which are less false than the prevailing ones. In such a view, the behaviors of women and members of marginalized races and classes may be regarded as a function of their biological or social characteristics, but not the behavior of elites. Elite behavior is considered the consequence of individual choices and the exercise of will. The contrary argument here depends upon recognition that elite behavior, too, is distinctively shaped by social agendas.

Is there any "pure science" left after we see all these ways in which science and technology are interrelated? Some would say yes—that at least in such projects as the search for the basic constituents of the universe, one can see scientific research that is not technology-driven. Yet this research too uses technologies that themselves have social implications: who is being educated to use them? what kinds of social status accrue to people who get to use these technologies? Moreover, is not apparently pure research often justified on the grounds that it is *likely* to produce technologically useful information? In any case, the cost of producing apparently "useless" information is justifiable to science policymakers on the additional grounds of its halo effect on the rest of science: this 5 percent of "pure research" provides a camouflage for the 95 percent that is so obviously technology-driven. But if that is its function, how is it pure?[25]

Finally, the insistence on the argument for "pure science" may express a deep irrationality about our culture. In a world where so many go hungry, where cities are in decay and countrysides have been devastated, where many need medical assistance they cannot afford, where the literacy gap increases between the haves and the have-nots—where, in short, access to just a few more resources could have such large effects on the lives of so many—in such a world, why should we support scientific activity defined as "pure" precisely *because* it promises no socially usable results? The support of "pure science" might more reasonably be seen as a make-work welfare program for the middle classes in the service of elites. Science is not responsible for all the bad characteristics of contemporary social life, but if it does not

25. See Forman's analysis (in "Behind Quantum Electronics") of loss of purity in twentieth-century physics, and Restivo's argument (in "Modern Science") claiming that the purity of science blocks our ability to understand modern science as a social problem.

develop effective means for identifying the causes and consequences of its own beliefs and practices, it remains complicitous in the production of these social ills. In the insistence that the technologies and applications of the sciences are no part of "science proper," one can locate another false belief that we should give up once and for all. It is no accident that sciences adopting this belief end up disproportionately disadvantaging those, such as women, whom elites define as "other."

(5) "Scientists can provide the most knowledgeable and authoritative explanations of their own activities, so sociologists and philosophers (including feminists) should refrain from making comments about fields in which they are not experts." To many people, it seems obvious that only physicists can really understand the history and practice of physics; only biologists, the reasons why some hypotheses were preferred to others in the history of biology. To hold this view, however, is to hold not the obvious truth that physics should be done by people trained in physics but the quite different belief that the "science of the natural sciences" is best created by natural scientists—of physics by physicists, of chemistry by chemists, and so on. Yet if this were so, the sciences would be the only human activity for which science recommends that the "indigenous peoples" should be given the final word about what constitutes a maximally adequate causal explanation of their lives and works. It would amount to the same thing to say that there cannot be a science of science; that science alone must be exempted from the claim that all human activity and its products—including the content and form of beliefs—can be explained causally. Should we accept this view, then the sciences alone could not be explained in ways that go beyond, or contradict, the understandings its practitioners can produce.

There are at least five reasons why natural scientists are not the best people to provide causal explanations of their own activities (and most of these claims could be adjusted to apply to practitioners in any discipline). In the first place, a science of science will try to locate origins of everyday scientific activity and belief that are not visible from the location of that activity. In some premodern societies, social relations are simple enough to be seen in virtually their entirety from the perspective of everyday life. But in modern societies, social relations are so much more complex that it is impossible to understand how the government, the economy, or the family actually works on the basis of

our everyday interactions with and in those institutions.[26] For example, many causes of everyday family life are located far away—in the economy, government policy, Supreme Court decisions, child-rearing practices, religious beliefs, and other aspects of social relations. Similarly, important causes of scientists' everyday activities and experiences are to be found far distant from the laboratory or field site—in the economy, government policy, Supreme Court decisions, child-rearing practices, religious beliefs, and other social relations. A science of science must generate descriptions and explanations of scientific phenomena which start off not in the labs but far away from where scientists and their expertise are located.[27]

In the second place, that "far away" where science begins is temporal as well as spatial. Many patterns in the behaviors of individuals and social institutions are not visible from the single local historical perspective of any individual or any group such as scientists. They are detectable only if one looks systematically over large sweeps of history. At any present moment there appear only confusing and small tendencies in various directions. Patterns in these tendencies appear and accumulate power only over decades or even centuries. Distinctive ways of explaining history will be useful in understanding the causes of everyday life in science. Of course, explaining individual events or processes as parts of larger patterns is one way of describing exactly what natural scientists do. The point is that the history and practices of science themselves can be usefully subjected to such scientific explanations.

But, third, the problem goes still deeper. Scientists' activity as scientists is exactly the wrong kind of activity from which to be able to detect many interesting causal features of science. For one thing, simply by virtue of choosing to continue to carry out the routine practices of this institution, they undermine the probability of their achieving the kind of critical perspective on those practices that "outsiders" could provide (I do not say that they *cannot* provide such a perspective; a few practicing scientists in every field have done so). The same is true of every human activity (including doing philosophy or writing a book). A more important reason, however, is that at least since World War II,

26. Dorothy Smith has made this point repeatedly; see *The Everyday World as Problematic: A Feminist Sociology* (Boston: Northeastern University Press, 1987).

27. This problem is neither resolved nor even acknowledged in the work of the "strong programme" theorists; see citations in note 9 above.

doing science has been part of the apparatus of ruling.[28] Science generates capital in the form of information, ideas, and technologies that are used to administer, manage, and control the physical world and social relations. When human activity is divided in hierarchical ways, those who engage in "ruling class" activity can have only a partial and distorted understanding of nature and social relations.[29] For this reason, laboratory life especially is the wrong activity from which to try to describe and explain the causal relations of administering, managing, and controlling the physical world and social relations. Even Kuhn hints at this truth when he points to the false stories about Nobel Prizes and glorious careers in science that scientists generate in order to recruit young people into the arduous training and routine work necessary to careers in science.[30]

In the fourth place, in modern Western cultures, middle-class white men tend more than other groups to believe in the ability of their individual minds to mirror nature, their faculties of judgment to make rational choices, and the power of their wills to bring about their choices. Hence, given the qualities that make them "good scientists," natural scientists are the last people to suppose it desirable to examine the limits of their minds to mirror nature or make rational scientific choices, and of their wills to bring about their choices. They are psychologically the wrong people to provide causal accounts of science. To ask them to try to provide fully causal accounts of their own activity is to ask them to identify the kinds of irrationalities in their own behaviors on which Freud and Marx focused—not to mention the gender and race "irrationalities" identified by later critics.

Finally, natural scientists have the wrong set of professional skills for the project of providing causal accounts of science. What is needed are people trained in critical social theory: that is, in locating the social contexts—psychological, historical, sociological, political, economic—that give meaning and power to historical actors, their ideas, and their audiences. Natural scientists are trained in context-stripping; the

28. See Forman, "Behind Quantum Electronics"; Hilary Rose and Steven Rose, "The Incorporation of Science," in *Ideology of/in the Natural Sciences*, ed. Hilary and Steven Rose (Cambridge, Mass.: Schenkman, 1979).

29. These are the claims of the standpoint theorists, discussed at length in the following chapters.

30. Kuhn, *Structure of Scientific Revolutions*, chap. 11.

science of science, like other social sciences, requires training in context-seeking.

Our ability to understand and explain science would be enhanced if we eliminated the extraneous belief that scientists in general are the best people to describe and explain scientists' activities. This is not to say that they should not be permitted in the group who can provide illuminating accounts of how science works. Scientists, like anyone else, can use causal accounts of science to generate valuable explanations. But they, like anyone else, must learn how to think about and observe sciences and their technologies in ways for which present-day scientific training does not prepare them. They must become critical social scientists to learn how to reflect critically on intuitive, everyday beliefs about methods and nature which further reflection shows are false. For this reason it can be illuminating to think of the natural sciences as inside, part of, social science.

The sciences incorporate both liberatory and oppressive tendencies. They have done so since their origins. The new sciences of the seventeenth century decentered our species from its unique location in a universe described by Christian and feudal thought. They said instead that humans are located on an otherwise ordinary planet circling around an unremarkable sun in an insignificant galaxy and, further, that the earth and the heavens are made up of the same kinds of materials and moved by the same kinds of forces. Thus those new sciences gave antiaristocratic messages. They implied that nature does not specify any essential higher or lower stations in life or human "natures." They undermined belief in the natural legitimacy of royalty and aristocracy. And they were epistemologically antiauthoritarian and participatory. "Anyone can see through my telescope," said Galileo, and can then reason to the conclusions of the new sciences. We are used to thinking in contradictory ways about this particular set of social values carried by modern science. On the one hand, these are thought not to be social values at all, since even though science incorporates them, it can still attain value-neutrality. On the other hand, these values are thought to be so constitutive of science that someone who criticizes science is thought to be against reason, progress, and democracy.

However, the new sciences carried other kinds of social values also. They provided resources for a new social class to assert its legitimacy over others. This class had interests in owning land and developing

resources (ores, plants, animals, and the peasants who also belonged to the land) for its own benefit, in using warfare to obtain access to land and resources, and in legitimating only its own activities and achievements as what everyone should recognize as civilization. These interests found a ready companion in the focus of the new sciences on the materiality of the world, on developing more efficient ways to dominate nature, on the value of technological "progress," and on the legitimacy and usefulness of universal laws.

Thus, modern Western science was constructed within and by political agendas that contained both liberatory and oppressive possibilities. Present-day science, too, contains these conflicting impulses. The antidemocratic impulses are not only morally and politically problematic; they also deteriorate the ability of the sciences to provide objective, empirically defensible descriptions and explanations of the regularities and underlying causal tendencies in nature and social relations. One way to focus on this problem is to discover that we have no conception of objectivity that enables us to distinguish the scientifically "best descriptions and explanations" from those that fit most closely (intentionally or not) with the assumptions that elites in the West do not want critically examined. It is only part of the problem that scientists are part of this elite. Without such a strong criterion of objectivity, science can easily become complicitous with the principle that "might makes right," whether or not anyone intends this complicity. The ethics and rationality of science are intimately connected.

(6) "Physics is the best model for the natural sciences, so feminist social science analyses can have nothing to offer the natural sciences." Now we can consider the false belief that produces the title for this chapter. It is still common to regard the natural sciences, and especially physics, as the ideal model for all inquiry. Of course, there is a long history of dispute over whether models of research and explanation originating in the study of inanimate nature are the most useful for studying social beings, but I intend to challenge an assumption made by both sides to that dispute: namely, that the way physics has been taught and practiced—the accepted "logic" of its research processes and forms of explanation—is the best it could be: that "physics" is a good model for physics. Both the "naturalists" and the "intentionalists," as the two parties have been named in the debate over the philosophy of social science, assume that physics provides a perfectly fine model of inquiry and explanation for the natural sciences. That is not

controversial to either group, even though (my point here) it should be. So my argument is not that physics provides a poor model for social inquiry; it is the stronger argument that the paradigm of physics research and explanation, as it is understood by scientists and most other people, is a poor model for physics itself.

We can appreciate the historical reasons why the physics of the seventeenth and subsequent centuries was so highly valued as a model for all scientific inquiry. In the twentieth century the unity-of-science thesis of the Vienna Circle provided the modern justification for prescribing a hierarchy of the sciences with physics at the top. Ironically, my analysis here can be understood to agree that the sciences should be unified—but I propose that the hierarchy should be "stood on its head." On scientific grounds, as well as for moral and political reasons, those social sciences that are most deeply critical and most comprehensively context-seeking can provide the best models for all scientific inquiry, including physics.[31]

It is not helpful from a scientific perspective to take as a model those research projects in which controversy about basic principles is absent—the criterion Thomas Kuhn used to identify research that had reached the truly scientific stage. The problem with Kuhn's criterion is that in sciences that are important to dominant groups in socially stratified societies, lack of controversy about fundamentals is not a reliable or even plausible indicator of the absence of social, economic, and political values. This is such a society, and physics is such a science. Perfect agreement about basic principles and methods of inquiry can be and has often been reached by scientific "guns for hire" employed by the most egregious sexists, imperialists, and profiteers. Even more distressing is the history of well-intentioned research by the most distinguished of scientists which was inadvertently highly constrained by the sexist, racist, imperialist, and bourgeois ethos of its period.[32]

Instead, the model for good science should be research programs explicitly directed by liberatory political goals—by interests in identifying and eliminating from our understanding of nature and social relations the partialities and distortions that have been created by socially coercive projects. It does not *ensure* good empirical results to

31. I discussed this point in a preliminary way in *The Science Question in Feminism*.

32. E.g., the kinds of cases analyzed by Forman, "Behind Quantum Electronics"; and Gould, *Mismeasure of Man*.

select scientific problematics, concepts, hypotheses, and research designs with these goals in mind; democratic sciences must be able to distinguish between how people want the world to be and how it is. But better science is likely to result if *all the causes* of scientific conclusions are thought to be equally reasonable objects of scientific analysis. Since sexism, racism, imperialism, and bourgeois beliefs have been among the most powerful influences on the production of false scientific belief, critical examination of these causes, too, of the "results of research" should be considered to be *inside* the natural sciences. We could say that the natural sciences should be considered to be embedded in the social sciences because everything scientists do or think is part of the social world.

Objections and Responses

The foregoing proposal will seem bizarre to thinkers who are comfortable with the scientific and epistemological authoritarianism embedded in the models of "value-neutral" research that dominate in the natural sciences. Let me respond to some predictable criticisms, even at the risk of repeating in different terms the arguments above.

Here is one: "Who is to decide what is liberatory? What's liberatory for you may not be so for me." It is true that people will have to negotiate through social and political processes about whose lives most deserve improvement at any particular time and, therefore, from the perspective of whose lives sciences should be developed. If those processes are not now sufficiently democratic, then we must take (democratic) steps to make them better. But the problem of "whose perspective?" is not solved by hiding the decision process behind claims of value-neutrality. Many scientists do not really believe—and some actively protest—the dominant scientific ideology. Nevertheless, the myth of experts and their authority is the one used to recruit students into science education and to keep the sciences linked as firmly as possible to the goals of the dominant groups in the West. Thus many people who are most comfortable with hierarchical decision-making and who have little experience in negotiating social arrangements except among white, Western, economically privileged, men like themselves will find it difficult to participate effectively in such negotiations (but it is never too late to learn new skills).

Another objection: "Discussions of the appropriate goals of science should indeed occur, and of course the needs of minorities, women, and the poor should be considered. But there is no good reason to think of these discussions as part of science itself. These are discussions more appropriately conducted in political arenas than in the laboratories and other locations where scientific research is done." Moral and political loyalties, however, have counted as part of the evidence for the best as well as the worst hypotheses in the natural sciences.[33] The problem is not primarily differences between the commitments of individual scientists, for those differences are relatively easy to identify and eliminate from research processes through existing norms of inquiry. The problem, instead, is those values, interests, and commitments that are close to culturewide within scientific cultures or cultural elites, for these cannot even be identified by the methods of the natural sciences. If all the evidence for scientific belief is to be critically examined, so must these social commitments that function as evidence.

Objection: "But I thought it was exactly widespread social beliefs that the individual critical observation and reasoning of the sciences was supposed to correct. It is individuals in the history of the sciences who have formulated hypotheses, observed nature, and interpreted the results of research. The Great Man history of science may not the whole history, but it is a distinguished and central part of it. You are simply proposing that science be entirely subjected to mass thought and thus to the irrationality of politics." But Western scientific thought, no less than the thought of other cultures, has distinctive cultural patterns. I always see through my community's eyes and begin thought with its assumptions. Or, in other words, my society can "observe" the world only through my eyes (and others'), and can begin to think only with my assumptions (and others'). In an important sense, my eyes are not my own, nor are even my most private thoughts entirely private; they belong to my historical period—and to particular class, race, gender, and cultural commitments *that I do not question.* (Questioning, too, belongs to my historical period, but to critical and reflective

33. This is another way to put the kind of argument made by Forman, "Behind Quantum Electronics"; Gould, *Mismeasure of Man;* Keller, *Reflections;* Merchant, *Death of Nature;* Van den Daele, "Social Construction of Science," and others.

parts of that history rather than to the "custom and superstition" of the day.) It takes a reorganization of the scientific community and a rethinking of its goals and methods to make visible the social characteristics of the purportedly invisible authors of claims in the natural and social sciences. We need to be able to see how gender, race, and class interests shape laboratory life and the manufacture of scientific knowledge. This, too, is a scientific project, and one that can usefully be regarded as part of the natural sciences.

Objection: "Aren't you arguing that we should substitute subjectivist and relativist stances for objectivity in the sciences?" On the contrary, any research that is conceptualized as maximally value-free on the grounds that—among other things—it does not critically examine the social causes and dimensions of "good" as well as "bad" scientific belief is, I have been arguing, disabled in its attempts to produce objective understandings of nature and social life. It is unable to scrutinize critically one of the significant causes of widespread acceptance of scientific hypotheses without the notion of "strong objectivity" (defined in Chapter 6). Nature causes scientific hypotheses to gain good empirical confirmation, but so, too, does the "fit" of problematics, concepts, and interpretations with prevailing cultural interests and values. A maximally objective understanding of science's location in the contemporary international social order is the goal here. This is far from a call for relativism. Instead it is a call for the maximization of criticism of superstition, custom, and received belief—criticism for which the critical, skeptical attitude of science is supposed to be an important instrument. Ironically, we can have a science of morals and politics not by imitating the natural sciences in designing research in these fields but only by putting critical discussions of morals and politics at the heart of our sciences.

Objection: "Isn't this argument really against science? Aren't you 'down on physics'?" No doubt many will think so. But this argument has a different target. It is against a certain kind of narrow and no longer useful explanation of why it is that physics has contributed so greatly to the growth of scientific knowledge in the West. Only "sciences for the people" (in Galileo's phrase), not for elites, can be justifiably supported in a society committed to democracy. There are plenty of useful projects for such sciences, but they do not include research that provides resources for militarism or for ecological disaster, or con-

tinues to move resources away from the underprivileged and toward the already overprivileged.

There is plenty of science still to be done once physics is considered just one human social activity among many others. What kinds of knowledge about the empirical world do we need in order to live at all, and to live more reasonably with one another on this planet from this moment on? Should improving the lives of the few or of the many take priority in answering this question?