1. Referat: Wissenschaftstheorie

RACE, GENDER, AND SCIENCE

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Is Science Multicultural?

POSTCOLONIALISMS, FEMINISMS, AND EPISTEMOLOGIES

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course we then must justify why it is *there* that we want to go. Borderlands have emerged as expanding and crowded territories of contemporary social life. Standpoint epistemologies articulate how important forms of knowledge can be produced from such "territories."

What has happened to the universality ideal in these accounts? If we have only local knowledge systems, how can different cultures communicate with each other and work together in useful ways? And how does standpoint theory account for itself? Standpoint theories, too, must be located in their local histories and social relations. How do they deal with the issue of reflexivity that has troubled late-twentieth-century studies of the production of knowledge? We turn to these issues next.

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Dysfunctional Universality Claims? Scientific, Epistemological, and Political Issues

1. *Universality and modernity.* The ability to produce a uniquely universal science is commonly thought to be a distinctive mark of modernity. Such a science should have uniquely valid standards of rationality, objectivity, method, and what counts as nature's order and as knowers. Such purported features of modern science have been called on to legitimate as uniquely socially progressive European models of government, law, education, social policy, and even ethics. From this perspective, modern Europe and its diasporas in the Americas, Australia, and elsewhere provide a uniquely desirable model of human achievements, social relations, and standards of living.

Other cultures' accounts of themselves and the world around them, like those of premodern Europe, cannot really be considered in the same category as modern sciences, this account holds. They should not even be called science traditions since there is one and only one possible true account of nature, and that is the one modern science has been struggling to piece together.[1] As noted in earlier chapters, such other accounts are to be regarded only as "ethnosciences," "folk thought," "precursors of modern science," belief systems "with scientific elements," or—worse—savage and barbaric thought, witchcraft, superstitions, magic, and products of pre-logical mentalities.

Moreover, models of objectivity, rationality, scientific method, and their ability to advance modernity have also invariably been defined in terms of idealizations not only of Europeans, but also of masculinity, as the feminist critiques reviewed in earlier chapters have shown. The desirable virility of European civilization is often signified by the progressiveness of its modern sciences, and the desirability of dominant models of manliness by their links to modernity, its rationality and social progressiveness. The thinking and behavior of women of European descent, too, are to be assigned to the premodern, according to this kind of conventional thinking.[2] Thus, the meanings of claims to modern science's universality are constructed in opposition to meanings of womanliness and cultural otherness.

The power of these meanings is indicated by their immunity to empirical evidence to the contrary, as feminist and postcolonial science and technology theorists have pointed out. No matter how effective other cultures' (including "women's cultures'") knowledge traditions are, were, or might have been for enabling effective interaction with natural worlds, they are not counted as real sciences. No matter how much modern sciences might have incorporated elements of other cultures' concepts and theories about nature, their mathematical and empirical techniques, and even whole bodies of their accumulated navigational, medical, pharmacological, climatological, agricultural, manufacturing, or other effective knowledge enabling prediction, and control of nature, these other bodies of knowledge are not counted as "real science" until incorporated into European knowledge systems. And no matter how poor at explanation, prediction, and control European sciences are—for example, with respect to social causes of environmental destruction, or the causes of patterns of carcinogens or contagious diseases—these inadequacies do not count against European sciences' purportedly unique universal validity. Such issues were explored in earlier chapters.[3] How is this pattern of prevailing thought to be explained in light of the fact that success at prediction and control of nature are always claimed to be the most reliable hallmarks of a real science?

When assumptions are used to define the unique identity and value of a people, its civilization, and its history in the way the universal science ideal and its supporting internalist epistemology tradition apparently do, critical examination of them obviously is going to draw forth deep psychic anxieties and resistances. When assumptions carry this much moral and political weight, exposing them to contrary evidence is not going to be a comfortable process.

Four unity-of-science claims. In the early twentieth century, the unity of science thesis became an important form in which the universality claim was widely defended. This thesis overtly makes three claims: there exists just one world, one and only one possible true account of it ("one truth"), and one unique science that can piece together the one account that will accurately reflect the truth about that one world. What this thesis means—what methodological, metaphysical, or other features could constitute the unity of physics, chemistry, biology, psychology, economics, and so on—are issues about which philosophers and scientists have been concerned to make sense.[4] However, as political theorists are aware, a fourth claim is also assumed in these universality/unity arguments: that there is a distinctive universal human "class"—some distinctive group of humans—who should be taken as exemplars of the uniquely or admirably human to whom the truth about the world could become evident. For early modern scientists and philosophers, such a group was those members of the new educated classes whose minds were trained to reflect the order of nature that God's mind had created, as God's mind had also created human minds "in his own image." God's mind, human minds, and nature's order were assumed to be congruent or homologous. Scientists and the educated classes that could see the truth and importance of scientific accounts represented the universal class that could learn to detect the one possible true account of nature's order. For nineteenth- and twentieth-century Marxists, the proletariat represented this universal class. This class alone, since its labor transformed nature into provisions for everyday human life to exist, had the potential to become the unique representative of distinctively human knowers. This class alone had the potential to detect the real relations of nature and social life beneath the distorted appearances produced by class society. Some forms of feminism have flirted with a similar kind of transvaluation of gender that considers the possibility that women are the uniquely human gender: if it made sense in sexist society to imagine men as the model of the uniquely human, then perhaps it is reasonable to consider how in many respects women's characteristics—their claimed altruism, pacifism, sensitivity to others' needs, or some other putative virtue—are more reasonably regarded as uniquely valuable models of the human, capable of producing less distorted understandings of natural and social orders. And some African Americans have claimed that the suffering, compassion, or some other characteristic of African Americans under the horrible conditions of slavery uniquely equips them to understand natural and social orders in ways unavailable to those who have not had such experiences.

There are important insights behind such claims.[5] In the contemporary world of multicultural, postcolonial, and (more complex and diverse) feminist politics and social theories, however, faith has declined in the possibility and desirability of such a universal class—Enlightenment, proletarian, feminine, or culturally distinctive in any other way. In these worlds in which we all live (whether or not we acknowledge the effects post–World War II emancipatory social movements have had), who could such a distinctively human, universal class be? What group could democratically gain assent to their own abilities uniquely to represent accurately universal human interests and the one true natural and social order such interests supposedly could reveal in the face of other groups' different but also valuable cultural conditions for the production of knowledge for them and their survival? In contemporary life, many kinds of important differences between humans—biological and, more importantly, social, economic, political, psychic, and otherwise cultural—are recognized as resources for producing effective knowledge and advancing democratic social relations.[6]

The universality/unity ideal is no mere philosopher's notion; in one form or another it has been one of the most central and enduring values of otherwise conflicting conceptual and political tendencies in modernity's social theories. However, it is now attracting critical attention from many groups around the globe which claim that for them it has had primarily bad scientific, epistemological, and political effects.

2. *Science and democracy: Allies or enemies?* Does the ideal of a single, universally valid science decrease global democracy? Does the goal of global democracy advance or obstruct the plausibility of such an ideal? In the late nineteenth and early twentieth centuries, defenders of the universality ideal hoped that it could serve as a powerful antidote to the tides of racialist and nationalist partisan conflict that again and again had resulted in violence and even genocide. For them, appreciation of the universality of science and its standards of rationality and objectivity could only support and advance democratic social relations. Today the universality ideal's defenders see in the unique standards of scientific rationality and objectivity the main hope for restoring what they think of as the fair and orderly social relations now being disrupted by the claims and demands of multiculturalism, feminism and "relativism" in the post-Kuhnian social studies of science. In effect, these defenders of the universality ideal fear and do not find plausible the analyses produced by the three distinctive schools of science and technology studies that have emerged since World War II, and whose arguments have been examined in earlier chapters.

For many feminist, multiculturalist, and post-Kuhnian science studies theorists, however, the universality ideal increasingly appears as a force for maintaining inequality and obstructing democratic tendencies, and for obstructing the growth of knowledge. For these groups, claims to the transcultural truth of modern sciences' representations of nature, and of only those of modern science, function to mask the ways that modern sciences and their representations of nature's order tend to distribute the cognitive and social benefits of scientific and technological changes disproportionately to those already positioned to take advantage of them, and the costs primarily to those least able to resist them. Moreover, universality claims legitimate the devaluation and even destruction of knowledge traditions that have enabled women, the poor, and less powerful cultures to interact effectively with their environments. The unique universality claims also have bad epistemological and scientific effects, in addition to their political consequences. In a variety of ways, they function to increase the production of systematic

ignorance. From this perspective the universality claims are epistemologically, scientifically, and politically dysfunctional.

Of course the familiar "universalist" response to such claims is to insist that the "anti-universalists" are confused. Lamentable as the worsening situation of women and racially and culturally disadvantaged groups may be ("if this *is* the situation," they demur), such arguments only address the applications and technologies of science, and nobody denies that these often are shaped by anti- as well as pro-democratic politics. Of course politics can misuse and abuse applications of sciences and technologies—"Think of Lysenkoism! Think of Nazi science!" they argue. Real sciences could not possibly have any political consequences. "Real sciences" simply provide pure information about nature's order, according to this older view. One can note that such a position also blocks the argument that science, its rationality and objectivity, support or advance democratic social relations, or have any other good social effects, however. If science were culturally neutral, then it could not have any social effects at all. Of course this recognition motivated the invention of "positivism" in Auguste Compte's proposal that the pure information that sciences produce is politically neutral, and the only *positive* social effects of science are to be found in its distinctive method.

However, this attempt to disassociate modern sciences from their effects has become increasingly difficult to defend. Earlier chapters reviewed the evidence against this "pure science" claim when they focussed on the explicit mission-directed character of so much valuable scientific research, from Galileo's work in the Venice armory and Pasteur's concerns with public health, to contemporary medical, economic, and military-directed scientific and technological projects.[7] Such histories clarify that mission-directed research should not always be conceptualized as an obstacle to the growth of scientific knowledge; obviously, it can produce valuable information about and explanations of nature's regularities, whether or not one approves of the "missions." Sometimes the cultural interests and values that constitute a scientific project, its conceptual framework, methods, and purpose are politically relatively uncontroversial; sometimes not. After all, medical research to discover the causes of cancer or of AIDS, and research to establish space satellites for military surveillance have all produced reliable and valuable information about nature's regularities regardless of how one evaluates the social desirability of such projects. How are the technologies and applications of a science to be regarded as completely separate from that science's information when the information is produced specifically *for* such technologies and applications? Obviously, to start with, the patterns of knowledge and ignorance that a science or collection of sciences generates bear a close relation to the culturally local overt purposes and unarticulated interests in such information. If such science is conceptualized at its cognitive core in ways suitable to culturally local medical or military purposes—whether or not individual scientists are aware of such a match—in what sense is it "pure"?

Another kind of evidence against the purity-of-science thesis, however, showed that technologies of scientific research themselves contribute to constituting what can count as legitimate scientific knowledge, and that those research technologies themselves have always been constituted through social, economic, and political processes that have social, economic, and political consequences. Such research technologies are part of scientific methods, yet modern science's methods were long cited as value neutral and thus responsible for science's unique universality. Consequently, philosophers of science have been forced to reexamine what it is about scientific methods that makes modern science so effective if it is not their social and political neutrality.[8]

Thus, the assumption that the universality ideal can only advance both the growth of knowledge and a democratic social order has come under increased suspicion from a variety of sources.

3. *The epistemological status of universality/unity claims.* The universality/unity claims express ideals, not the results of empirical observation. The question of this chapter is, therefore, whether they should retain their status as ideals. However, many of their defenders seem to think they are scientific claims; that the history and present achievements of science somehow prove that it is uniquely universally valid and unified.

One stream of common sense captured by the older histories and philosophies of science seems to conjoin everyday experience and historical evidence to make the universality thesis appear obviously supported by empirical evidence. In this way of thinking, our observing, perceiving bodies-with-rational-minds and their environments seem to fit together in ways that enable modern sciences to gain greater and greater accuracy in their predictions and control of nature. How else could we account for the many magnificent achievements of modern medicine, the ability of humans to walk on the moon, or the possibility of composing these sentences on this computer? Modern sciences must be providing more and more pieces of the one coherent account that reflects or uniquely corresponds to how the world is for these technological achievements to be possible. Doesn't the history of such successes constitute incontrovertible evidence that there is one nature, one truth about it, and one science that captures that truth? How could scientific predictions increasingly achieve such accuracy were this not the case?

On the other hand, before the pull of this way of thinking becomes too irresistible, we can recollect that common sense and the history of science also tell us that there is something wrong with it. We all know

that scientific claims can never be regarded as once and for all proved (or disproved). They always must be left only tentatively confirmed by observation and reasoning since new evidence continually shows how familiar scientific ways of thinking have limitations that were not earlier visible. Every scientific project makes "background assumptions" about properties of the instruments, theories of vision, what the relevant variable local conditions are, the cultural neutrality of the relevant conceptual framework, and much more that can at another time be thrown into doubt. Perhaps even more importantly, any given scientific framework eventually outlives its usefulness in advancing the growth of knowledge. At moments of revolutionary scientific change, when a new framework promises to replace the older one, old data is repositioned within a different conceptual scheme. Most of the observations made in Ptolemaic astronomy were repositioned within Copernican astronomy. Do they provide "the same information" within these conflicting conceptual frameworks? Well, yes and no. Of course many observations of the moon, the sun, and the planets made prior to Copernicus and Galileo were retained in the heliocentric account. In one sense we see "the same heavens" that cultures did a millennium and more ago. On the other hand, what patterns such observations form, how such patterns are to be explained, and what such observations, patterns, and explanations mean to different groups of scientists and their diverse audiences (intended and unintended)—these differ immensely between the two theories. In important respects, the pre-Galilean observations do not provide "the same information" for heliocentric theories.[9]

In recognizing the importance of this kind of understanding of the history of science, one need not hold that new conceptual frameworks are fully incommensurable with the older ones, or that ones from different disciplines leave their practitioners unable to communicate with each other or to work together on scientific projects, as both "incommensurabilists" such as Thomas Kuhn and also his critics claimed must be the case when one gives up these kinds of universalist assumptions. Temporary, local *universalizing* strategies are devised in the face of the de facto unavailability of reliable universality claims. Historical and sociological evidence shows how scientists continually make effective, "good-enough" translations—pidgin languages—and technical equivalences to get from one conceptual terrain to another and to enable them to work together effectively. Thus, their joint scientific projects can draw on otherwise disunified, heterogeneous, local scientific practices and cultures. For example, Peter Galison examines the "trading zones" scientists create between their otherwise disunified work. When H-bomb designers, logicians, aerodynamical engineers, and statisticians sat down together in the 1940s and 1950s to construct computer-simulated realities, they brought to such interences to which it gives an appearance of unity, is a motley collection of principles and practices, as he and other historians of mathematics point out.[20] And numerous other such unifiers are to be found among scientific instruments, techniques, attitudes . . . all those inventive strategies that occur in the "trading zones" within which scientists in the modern West, like other indigenous knowers, work to communicate across the diverse cultural and natural conditions that separate them.

Thus, common sense, the history of science, and observation of contemporary scientific practice do not support either the inherent singleness or "integrated harmony" of modern science. Moreover, earlier chapters explored the scientific, epistemological, and political advantages of understanding science as necessarily and desirably plural. Let us briefly review those findings and then turn to consider some techniques pointed out in the postcolonial and feminist accounts through which the illusion of the unity and universality of modern sciences has been historically established.

4. *Producing illusions of unity and of universality.* Some of the most important cognitive, technical resources of modern sciences are to be found in their distinctively local features, as post-Kuhnian, postcolonial and feminist science studies showed in earlier chapters. Of course nature's order—"reality"—has a great deal to do with what sciences—modern or other—come up with as the best results of research. "Nature" is a major player in producing sciences' most reliable and widely accepted claims, as is the case also with much of the belief of everyday life. People who do not pay attention to known regularities of nature, or who are disinterested in charting what turn out to be important regularities of nature, are among those who tend to live shorter lives as they are felled by avoidable "accidents" and other threats to life and limb. But nature does not have *everything* to do with even the best representations of such regularities. Scientific claims are not mere reflections of nature's order such that no traces of social values, interests, and inquiry processes are visible in such claims—let alone in the patterns of such claims that the sciences of different eras and different cultures tend to produce. As earlier chapters explored, it turns out that nothing in science can be protected from cultural influence—not its methods, its research technologies, its conceptions of nature's fundamental ordering principles, its other concepts, metaphors, models, narrative structures, or even formal languages that all play crucial roles in advancing the growth of knowledge—that is, its research questions and the consequent distinctive patterns of systematic knowledge and systematic ignorance that it generates. Many socially constituted theories about nature can be *consistent* with nature's order, but none are uniquely *congruent* with it; none uniquely correspond to it. Indeed, we should not want to protect sciences from all cultural influences, for many of these are precisely responsible for their great successes and are necessary for their continued successes in the future.[21] This is where the universality ideal turns out to be costly to the growth of scientific knowledge.

Indeed, it was precisely the use of local resources that enabled modern sciences to emerge in Europe according to postcolonial accounts. European expansion and the growth of modern sciences in Europe were causally linked in that each contributed important resources to the success of the other. Without the knowledge of those daunting aspects of nature's order that Europeans encountered in their "voyages of discovery," knowledge provided by the emerging modern sciences, Europe could not have successfully developed the imperial and colonial relations that permitted it to achieve global leadership. Modern sciences helped Europe shift from being just one of a number of cultures around the globe that were living through the beginning of the end of feudalism in the late Middle Ages to becoming the single most important center of the early or proto-capitalist global economic and political relations that it would spread around the globe. Moreover, without the diverse resources provided by European expansion, modern sciences would have had a far more difficult time emerging—perhaps they would not have emerged in Europe.[22]

Through this process, modern sciences developed distinctive patterns of systematic knowledge and systematic ignorance, traces of which remain visible in contemporary modern science. Early modern science produced information about those aspects of nature's order that European societies needed in order successfully to expand into the Americas, around the Cape of Good Hope, into Asia and eventually Australia, New Zealand, and Africa (and, now, out into space stations and onto other planets in our solar system). As some of the development theorists have argued, the "science and technology transfer" involved in post–World War II so-called development projects that overtly were intended to bring the "underdeveloped countries" up to the standard of living of the "developed countries" in fact have continued the colonial process begun five centuries earlier. These expansionist projects shaped what modern sciences would and would not know about nature's order.[23]

Chapter 4 identified four respects in which this kind of postcolonial account as well as the post-Kuhnian and feminist accounts argue for the advantages as well as the limitations that local resources provide for the growth of scientific and technological knowledge for every culture's knowledge projects. There it was pointed out that different cultures are located in different parts of heterogeneous nature's order; their environments are always local ones whether restricted to a Pacific isle or the trajectory between Spain and the Caribbean, or Cape Canaveral and the moon. Cultures are interested in whatever they count as their own environments, but even in "the same" environment, they will tend to have different interests generating different questions about the world around them. For example, on the shores of the Atlantic, one culture will be interested in fishing, another in coastal trading, a third in oil and minerals lying beneath the ocean's floor, a fourth in possibilities for transporting slaves, sugar, and rum back and forth across it, a fifth in using the ocean as a toxic dumping site, and so forth. Such culturally local interests lead to different patterns of knowledge and ignorance about local environments.

Moreover these patterns are organized and produced through culturally distinctive discursive resources. Both advancing and limiting a culture's patterns of knowledge are metaphors, models, and narratives about, for example, the Garden of Eden, peaceable kingdoms, wild and unruly nature, nature as a machine, or as a product of God's mind, as a computer, a spaceship, and a lifeboat; about noble, innocent, childlike, animal-like, primitive, or evil natives; about manly, heroic explorers, conquistadors, and natural philosophers, or ones that purportedly represented the admirable national temperaments of Spain, England, France, or other European nations. These kinds of discursive resources represent a distinctive European legacy rather than, for instance, one that could be found in an Islamic or Native American culture. Finally, the production of knowledge is organized in the distinctive ways that different cultures tend to organize social activities more generally. The characteristic ways that work, travel, conquest, and other social relations were organized in fifteenth- through twentieth-century societies of Europe and its diasporas shaped how the work of science and of European expansion were organized. The "voyages of discovery" were distinctively European ways of organizing the production of these parts of modern sciences' knowledge. Though these four kinds of local resources have been described here as if they were completely separate, in daily practice they are partly interlocked and shape each other.

Similarly, as earlier chapters explored, post-Kuhnian and feminist histories, sociologies, ethnographies, and cultural studies of modern sciences produced in the last thirty years have charted precisely the ways that scientists have used local resources to generate such new theories and interpretations. Thus, the postcolonial studies converge with northern science and technology studies, and with feminist components of both, in highlighting the strengths as well as the limitations of sciences' uses of local resources. Modern sciences are "local knowledge systems" no less than are the science and technology knowledge systems of other cultures. Of course modern sciences in many respects are much more powerful than other cultures' knowledge systems, though other cultures' knowledge systems also have their relative strengths over modern sciences, for their locations in nature, interests, discursive resources, and ways of organizing the production of knowledge

enable them to learn patterns in nature's order that are not visible from modern science's perspective. But no matter how global the successes of modern science's predictions of nature's order, they can never achieve a unique universality in the sense of being culture free, or destined to persist through history with their meanings and conceptual contexts unchanged. Further, significant parts of the knowledge systems of other cultures also have been able to achieve effective prediction far from the original cultural location of their production.

If it is not useful to think of modern sciences as single or harmoniously integrated in the various senses reviewed above, how is it that we have all been fooled about this? Noted above were various strategies of translation, "trading zones," mathematical and other unifiers that have permitted modern scientists to think and communicate across their disparate projects. Postcolonial histories of science and technology enable us to identify several practices of European expansion that have also contributed to this effect. First, as such expansion turned the world into a laboratory for emerging European sciences, Europeans could test the hypotheses they developed over vastly larger and more diverse natural terrains than could other cultures. European expansion gained access for European sciences to a far greater diversity in nature's order than was available to cultures not so engaged in expansion and, in some cases, whose trade routes and other travels Europeans curtailed. Not all the sciences benefitted equally from this aspect of European expansion, of course. Astronomy, physics, and chemistry benefitted less than did cartography, geology, geography, climatology, and many kinds of biology, though they still did benefit as they addressed the challenges of expansion and its effects on European economies, and, more indirectly, as they became funded through riches gained from the Americas.[24] Agricultural, pharmacological, and medical sciences immensely benefitted from expansion, as did such social sciences as linguistics and anthropology. Of course any culture engaged in such expansionist projects could also have developed their systematic knowledge about natural and social worlds. Indeed, they would have to have done so in order to succeed at travelling through or settling in unfamiliar environments and climates, and cohabiting with the indigenes they encountered. The internalist epistemology of modern science has provided no resources for understanding the effects on European sciences of these expansionist projects.

Second, European sciences could forage in other cultures for elements of those cultures' "ethnosciences" to incorporate into European sciences. It was not just "hypotheses" about nature's order that Europeans came up with all by themselves that were tested in the course of expansionist projects. Native informants taught Europeans about the local flora and fauna and how to use them, minerals and ores and how to extract them, climates and how to survive them, diseases and other threats to health and how to avoid them, pharmacological remedies, agricultural, fishing and engineering practices, land and sea routes, and much of the rest of the knowledge traditions developed and stored in local cultures. Incorporated into the European sciences were those parts of this local knowledge that fit into the prevailing European conceptual frameworks. Those parts that did not fit were ignored or rejected. As the historians point out, not all the resources for modern sciences that the Europeans encountered in other cultures' knowledge traditions were initially perceived to be such, however. Europeans encountered mathematical notions they could not use till decades and even centuries later, and pharmacological knowledge that only now are the northern pharmaceutical companies systematically interested in gathering.[25] A history of "unborrowed knowledge" can provide an illuminating accompaniment to the histories of borrowed knowledge.

Moreover, the Europeans could combine knowledge gathered through observation or foraging from one part of the globe with knowledge so gained elsewhere to create kinds of knowledge that could not emerge from fewer sites in nature and in culture. This, too, is a unifying strategy. For example, Linnaeus's categories were designed to accommodate species from many different parts of the world; Darwin's hypotheses came to him as a result of thinking back and forth between what he had learned at different sites in his travels. Conceptual frameworks designed to explain the relation between observations made at different sites around the globe contributed to the idea that universal sciences were in the making.

Third, at the same time, European expansion suppressed or destroyed—both intentionally and unintentionally—competitive local knowledge systems. Some cultures were wiped out by diseases inadvertently carried by the Europeans; they were infected before there was a chance for them to be conquered, as one historian puts the point.[26] Others were destroyed by conquest. In both cases, the cultures took to the grave their repositories of knowledge about nature and social relations.

Even when the indigenes survived their first encounters with Europeans, their local knowledge traditions were often destroyed nevertheless, both intentionally and unintentionally. For example, the British set out to destroy the Indian textile industry, and succeeded in doing so, in order to sell their British-made textiles in the Indian market. In the United States, Native Americans were neither permitted to speak their native languages in the government schools nor to develop their traditional repositories of knowledge there. Again, the British did not permit Indians to learn the mathematics that had been created by Indian mathematicians.[27] Land upon which local knowledge traditions depended was appropriated by Europeans, turned to "scientific" agriculture, forestry, or other profit production for Europeans, and often environmentally impoverished. In such ways the basis for local knowledge traditions was removed from local access and often destroyed.[28] So the suppression of other cultures' knowledge traditions also contributed to producing the illusion that only European sciences were and could be universal ones.

A fourth way the illusion of unique success was created has been through the dissemination of a predatory conceptual framework for and by European sciences. This conceptual framework spread through the societies Europeans encountered as a central feature of the imposition or adoption of European culture. What is meant by a "predatory conceptual framework"? One way this occurred was through the persistent substitution of abstract, transcultural and ahistorical concepts of nature and processes of gaining knowledge for concrete, locally situated, and historical ones. The former were claimed unique to modern sciences and responsible for their successes, and the latter devalued as merely characteristic of "folk science." For example, features of local environments become aspects of omnipresent "nature" to be explained adequately only by universally valid laws of nature.[29]

There is nothing wrong with abstractions and generalizations in themselves. The point is rather that such abstract concepts always must in fact be accompanied by local knowledge about how to apply such concepts—when and where they are relevant, how to revise and extend them. Yet such an abstract, universalizing conceptual framework devalues this very local knowledge that it needs in order to complete our understanding of it as empirical knowledge—how it relates to the world around us. One could say that the abstract and universal perpetually depend upon and reproduce the "premodern" forms of local knowledge required for the "universal" to be regarded as empirically relevant. It is not that modern science actually replaces its premodern predecessor; rather, it insists on its continual production as a devalued form of knowledge.[30] Moreover, such "foreign" concepts consistently have been used to legitimate the authority of powerful groups over economically and politically vulnerable ones.

Most effective in establishing the impression of universality is simply insisting upon it as an empirical fact: there is one and only one kind of "right" or "real" science, and that is the kind practiced in modern Europe. This replication in modern science of the monologic voice of the Judeo-Christian God is buttressed with various supporting theses—scientific accounts are value free, nature is value free, no kinds of interventions in or uses of nature are forbidden either by nature or by science, and so on. However, as reviewed above and in earlier chapters, such claims are not themselves the results of scientific or historical investigations, nor is there anything logically necessary about them. They are, instead, articles of faith, as is the insistence in modern science on its own "solo performances," that are so well suited to the belief in nature's "monovocality."

Thus, the appearance of universality is created not by any internal epistemic features of modern sciences, as the universality ideal assumes. Instead, it is produced by the kind of hard scientific work reported in the post-Kuhnian accounts and by contingencies of history and political strategies, obscured by, or fit into, a dogmatic conceptual framework that is persistently rhetorically elaborated. This will sound like a harsh judgment. Yet it is important to state as clearly as possible these findings of postcolonial science studies that are strongly supported also by the other two schools of science studies examined here. We need better ways to conceptualize the successes and limitations of modern sciences than are provided by the universality ideal of the internalist scientific epistemology. The ideal neither fits the facts of state-of-the-art history, sociology, and philosophy of science, nor does it make sense in light of what is now understood about how human knowledge of the nature's order must be gathered, preserved, and expanded.

5. *The local-global continuum: An alternative conceptual frame.* If the successes of sciences—modern or other—cannot be attributed to their internal epistemic features—such as a uniquely universally valid metaphysics, methodology, language, or standards of objectivity and rationality—what does account for them? Apparently there is no distinguishing feature of a science, as we saw earlier, but we still might usefully ask about causes of, or influences on, variations in the powers of different science traditions.

One strategy of many science and technology observers has been to try to bring into visibility the set of practices through which different modern scientific projects have maintained valuable tensions between the local and the global. Knowledge systems, any knowledge systems, always are constituted initially through a set of local conditions. However, the most widely successful ones, such as many parts of modern sciences, manage to travel effectively to become useful in other sets of local conditions—parts of nature, interests, discursive resources, ways of organizing the production of knowledge—that are different in significant respects from those that initially produced them. Without claiming a universality for them that we now can see is historically and conceptually misleading, how could we usefully think about valuable tensions between the local and this movability, or ability to travel, that has characterized parts of modern sciences in particular, but also parts of other knowledge systems (e.g., the concept zero and acupuncture)?

"Technoscience," proposed by Bruno Latour, is one term that has proved useful for drawing attention to the value of maintaining certain kinds of tensions between the local and the global in modern scientific practices.[31] Other science observers have focussed on different sets of components of such complexes that enable them to maintain the local/global tensions. As Helen Watson-Verran and David Turnbull point out, this is an area of study still emerging since no single analysis so far proposed quite captures all of the heterogeneous practices modern technosciences have developed.

> Though scientific culture is now being more frequently recognized as deeply heterogeneous (see, e.g., Law, 1991c; Pickering, 1992b), there is, at present, no term in general usage that adequately captures the amalgam of places, bodies, voices, skills, practices, technical devices, theories, social strategies, and collective work that together constitute technoscientific knowledge/practices. Foucault's epistemes; Kuhn's paradigms; Callon, Law, and Latour's actor networks; Hacking's self-vindicating constellations; Fujimura and Star's standardized packages and boundary objects, and Knorr Cetina's reconfigurations—each embraces some of the range of possible components but none seems sufficiently all-encompassing.[32]

Watson-Verran and Turnbull's work is especially interesting because of the way it links European and other cultures' scientific practices in these respects. They are concerned to show how other scientific and technology traditions besides those of modern science have achieved similar kinds of balances between the local and the global in their most successful projects. They develop Deleuze and Guattari's term "assemblage" as a more satisfactory way to capture the set of technoscientific "power practices" that enable cultures in different ways to maintain that crucial tension between the local and the global.[33] Watson-Verran and Turnbull show how medieval European cathedral builders, the Anasazi, the Inca, Australian aborigines, and Pacific navigators, like modern scientists, develop "social strategies and technical devices" that enable them to create "equivalences and connections whereby otherwise heterogeneous and isolated knowledges are enabled to move in space and time from the local site and moment of their production and application to other places and times."[34] This is not the place to explore their interesting account in greater detail. Rather, they provide a good example of the postcolonial arguments showing that it is not internal epistemological features but diverse combinations of technical and social strategies that enable both some modern and "indigenous" technoscientific traditions to become more successful than others. We do not need the notion of universal validity under consideration in this chapter, for other frameworks are becoming available that can preserve what was valuable in the universal science framework without the severe costs of the latter's historical and conceptual inadequacies.

It is time to summarize those costs for the sciences, for epistemologies, and for democratic social relations.

6. Dysfunctional universality claims: Scientific, epistemological, and political costs. To conclude, whatever the remaining benefits of supporting the universality ideal, the sources and arguments reviewed here show that its costs are significant. Let us look first at scientific and epistemological and then political costs of maintaining this ideal.

For one, the unique universality thesis supports the legitimacy of appeals to the authority of a single, monolithic "science" to support individual scientific claims, rather than each having to stand on its own—to "face the tribunal of observation" without the crutch of the general authority of modern science. Feminist and postcolonial critics have pointed this out again and again. Hypotheses about women's psychologies, reproductive systems, or physical abilities have achieved legitimacy when they can claim to be scientific ones, whether or not rigorous testing of such hypotheses has occurred.[35] The empirical reliability of agriculture and forestry principles developed for European environments has been presumed superior to local practices in African, Indian, and other environments when the former can claim the status of modern scientific principles rather than only the ones local farmers and peasants have developed and improved for generations.[36] In such cases individual scientific claims have not had to face the empirical tests that are demanded of claims that cannot appeal to modern science for their legitimacy.

This argument has been voiced far more widely. As philosopher John Dupre puts the point, "The political power of science rests in considerable part on the assumption that it is a unified whole." If science is disunified, then "particular appeals to the authority of science must stand on their own merits."[37] The unity-of-science thesis and its unique universality claim encourage what Dupre refers to as the "unity of scientism."[38] Without the crutch of such dogmas as the universality claim, many purportedly viable scientific claims would have to face much more rigorous tests of empirical and theoretical adequacy.

Secondly, the universality claim legitimates resistance to the most valuable criticisms of contemporary science. Feminist theorists frequently are challenged either to show the ideological bias in physics, or admit the irrelevance of any other kind of evidence to support their claims of androcentric assumptions in the constitution of scientific claims.[39] Criticisms of modern sciences that cannot be recognized as coming from within the sciences can be devalued or ignored without the kind of consideration that criticisms from within the sciences would receive by those who hold the unique universality ideal. Yet it is precisely the fact that they come from what is perceived to be outside the sciences that makes such critiques especially valuable. It is only by starting from outside the dominant conceptual frameworks that such frameworks can themselves come into sharp focus, as the arguments in earlier chapters for standpoint epistemologies and their standards for "strong objectivity" pointed out.

This issue has been central in the postcolonial accounts also. The global authority of a claimed uniquely unitary science, especially one associated with increasingly widespread eurocentric ideals of modernity, progress, unique human potential, and manliness defined in eurocentric terms, conspires to silence what are potentially the most viable alternatives to modern sciences' claims and concerns. The universality claim makes it difficult to see the limitations to modern sciences' institutions, cultures, and practices that accompany their strengths. Moreover, the universality claim works against the overt, valuable claim of modern sciences and their philosophies that it is vigorous criticism that most advances the growth of knowledge. Instead of encouraging such criticism, the universality thesis suppresses it. The way the universality ideal tends to immunize sciences against their most telling criticisms points to the problematic assumption of a single, unified "class" of knowers to whom responsibility for discovering nature's order should be assigned. Women, non-Europeans, and activists/scientists among such groups, who "bring their special-interest politics into science," have never been considered appropriate members of such a class of knowers by those who have benefitted most from scientific and technological change.

Third, the universality thesis is dysfunctional for the growth of scientific knowledge in another related respect. It has the effect of decreasing valuable forms of cognitive diversity, as the postcolonial critics in particular have argued. There is no evidence that the kinds of sciences favored in the modern North today will remain the most useful ones in the future either for other cultures or for the heirs of modern European cultures. Indeed, the arguments here, and many others explored earlier in this book, point to ways in which the ontologies and methodologies of modern sciences, and the interests and discursive resources that shape them, are not the most useful ones for many scientific research projects today. The universality ideal functions to delegitimate any but the scientific problems found interesting in the modern West.

Fourth, the strongest form of the universality ideal has raised distinctive obstacles to our understanding of certain kinds of ways the world is arranged and changes over time. It does this by promoting only narrow conceptions of both nature and science. As long as physics is assigned the status of the model for all sciences, whether on historical, ontological, methodological, logical, or other grounds, modern sciences will unnecessarily generate a certain kind of distinctive pattern of ignorance about the world around and in us. When physics, especially the narrowest conceptions of it, is permitted to set the standards for what counts as nature and what counts as scientific accounts, our knowledge will tend to focus disproportionately on discrete, isolated, short-term, and "purely physical" aspects of the world around us. (Here, the phrase "nature's order" starts to look suspiciously narrow.) It blocks our ability to get into focus the social elements—institutions, practices, languages, meanings—in what are often presented as purportedly merely natural, scientific, and technological changes. It makes it especially hard to see those that are distant, broadscale, and long-term.

Moreover, it blocks our ability to grasp systematic patterns of ignorance that any preferred pattern of knowledge will also generate. The universality ideal encourages the unfortunate tendency to internalize the benefits of scientific and technological change and externalize their costs. The benefits tend to be seen as the consequence of internal features of the epistemology of modern sciences, and the costs as the consequence only of misapplications of scientific knowledge or of their technologies, but not of scientific processes themselves.

Finally, such a model in the natural sciences also promotes the production of systematic ignorance in the social sciences. There are the social sciences that overtly model themselves on the natural sciences: physicalist psychologies, rational choice theorists in economics and international relations, and positivistic sociologies, for example. But there are also the social sciences that conceptualize their projects in such single-minded opposition to the naturalistic models prevailing in their research areas that they cannot get at the ways that more global forces shape or are the consequences of the social phenomena that they study. They get stuck in the local as a reaction to naturalistic social sciences' devaluations of the local. In such cases universalism's conceptual world is advanced in unarticulated forms.

Last but not least, there are the political costs. Feminist and postcolonial theorists especially have argued that the bad political effects of modern sciences' universality ideal are in part a consequence of the scientific and epistemological costs of this ideal. We have seen in this chapter and earlier ones how the universality thesis supports the devaluation of forms of knowledge-seeking that have proved valuable in non-western and premodern cultures, and in devalued subcultures in the West (and elsewhere), such as women's cultures. Indeed, modern sciences have ended up, unintentionally usually, partners with the worst genocidal social projects when they lend legitimation to the destruction of other peoples and the cultures that sustain them, not just their knowledge systems, as the inevitable costs of "human" progress. The

centrality of European sciences and technologies to the further de-development of the world's least advantaged peoples in the name of human "development" is one place where such bad effects of the universality ideal can be seen. Here the universality thesis legitimates continuing to move access to nature's resources from those who are already the most economically and politically vulnerable to those who are already the best positioned to take advantage of such access. The universality thesis elevates to a desirable ideal models of the distinctively rational, progressive, civilized, and human that are constructed in opposition to, in terms of their distance from, the non-European, the economically frugal, and the feminine. Indeed, the universality thesis elevates authoritarianism—the necessity and desirability of acknowledging the legitimacy of just one true account of the world—to a necessity for the distinctively rational, progressive, civilized, and human.

The philosophies of modern sciences have always claimed that such modern knowledge-seeking contributes to democratic social relations. One can find such assessments throughout the evaluations of modern sciences from the Baconian New Science Movement in the seventeenth century through the advent of Comte's positivism in the nineteenth century, the logical positivist philosophies of the 1930s and 1940s, to today's debates about the appropriate projects for sciences and technologies after the Cold War. However, the explorations of the scientific and epistemological dysfunctionality of the universality thesis support long-voiced arguments that there is another, conflicting story to be told about the relationship between modern sciences and democratic social relations. Other conceptual frameworks can do the historical, empirical, and theoretical work that was provided by the universality ideal without invoking the latter's scientific and epistemological dysfunctionality or its ethnocentric, antidemocratic politics.[40]

24. Patricia Hill Collins has discussed this in *Black Feminist.*

25. "Outsider within" is Patricia Hill Collins's phrase; see her *Black Feminist Thought.* As indicated above, *Borderlands* is Gloria Anzaldua's term.

26. See my "Why Has the Sex/Gender System Emerged into Visibility Only Now?" in *Discovering Reality: Feminist Perspectives on Epistemology, Metaphysics, Methodology, and Philosophy of Science,* ed. Sandra Harding and Merrill Hintikka (Dordrecht: Reidel, 1983).

27. Blaut, *Colonizer's Model.*

28. See, for example, Donna Haraway, *Primate Visions: Gender, Race, and Nature in the World of Modern Science* (New York: Routledge, 1989); Edward Said, *Orientalism.*

29. Feminist standpoint ambiguities and ambivalences about the role to be assigned to women's experiences have been the topic of innumerable discussions. See, for example, Rosemary Hennessy, *Feminist Materialism and the Politics of Discourse* (New York: Routledge, 1993); and many discussions in sociology journals of Smith's work in particular. However, one strain throughout standpoint theory's history within feminism, more strongly emphasized in some writings than in others, has been that women's experiences are themselves generated from within discourses—prevailing, or subjugated, or newly constructed through feminisms. Neither women's experiences nor their subjectivities are constituted prior to "the social." Accessible discussions of this topic more generally can be found in Chris Weedon, *Feminist Practice and Poststructuralist Theory* (Cambridge, Mass.: Blackwell, 1987).

30. Some of these accounts will be more complex than others. For example, while class origins do stick to one, class identity is more crossable than race or gender—at least in the contemporary United States.

31. Dorothy Smith made this claim in her "Comment on Harding," *American Philosophical Association Newsletter on Feminism and Philosophy* 88:3 (1989).

32. Quine, "Two Dogmas."

10. Dysfunctional Universality Claims?

1. As noted in earlier chapters, there are also postcolonial reasons to resist subsuming all cultures' traditions of systematic knowledge about themselves and the world around them under what the West has in the last century or so referred to as "science." (Even in the West, the term is a recent one, since Galileo, Newton, and Boyle's work was referred to as "natural philosophy.") After all, why should other cultures' projects have to be named in European terms in order to be taken seriously by Europeans?

2. Compare, e.g., Susan Bordo, *The Flight to Objectivity: Essays on Cartesianism and Culture* (Albany: State University of New York Press, 1987); Alison Jaggar, "Love and Knowledge: Emotions in Feminist Epistemology," in *Gender/Body/Knowledge,* ed. Susan Bordo and Alison Jaggar (New Brunswick: Rutgers University Press, 1989); Evelyn Fox Keller, *Reflections on Gender and Science* (New Haven: Yale University Press, 1984); Genevieve Lloyd, *The Man of Reason: "Male" and "Female" in Western Philosophy* (Minneapolis: University of Minnesota Press, 1984); Phyllis Rooney, "Recent Work in Feminist Discussions of Reason," *American Philosophical Quarterly* 31:1, 1–21.

3. Compare, e.g., Susantha Goonatilake, "The Voyages of Discovery and the Loss and Rediscovery of the 'Other's' Knowledge," *Impact of Science on Society* no. 167 (1992), 241–64; R. K. Kochhar, "Science in British India," parts I and II, *Current Science* 63:11 (1992–93), 689–94; and 64:1 (1992–93) 55–62 (India); Joseph Needham, *The Grand Titration: Science and Society in East and West* (Toronto: University of Toronto Press, 1969); Patrick Petitjean et al., eds., *Science and Empires: Historical Studies about Scientific Development and European Expansion* (Dordrecht: Kluwer, 1992); Ziauddin Sardar, ed., *The Revenge of Athena: Science, Exploitation, and the Third World* (London: Mansell, 1988).

4. For illuminating recent accounts of the history and current scientific support for these unity of science claims, see John Dupre, *The Disorder of Things: Metaphysical Foundations for the Disunity of Science* (Cambridge: Harvard University Press, 1993); and *The Disunity of Science,* ed. Peter Galison and David Stump (Stanford: Stanford University Press, 1996). For one exploration of problems with the unity of science claims from a postcolonial perspective, see David J. Hess, *Science and Technology in a Multicultural World* (New York: Columbia University Press, 1995). For an older harbinger of these arguments, see Patrick Suppes, "The Plurality of Science," *Philosophy of Science Association 1978,* vol. 2, ed. P. Asquith and I. Hacking (East Lansing: Philosophy of Science Association, 1978). Chapter 4 above, "Cultures as Toolboxes for Sciences and Technologies," examined what it is about nature and social relations that insures that science and technology inevitably and desirably must be plural. Note that the universality claim in its unity of science form, as well as in other forms, asserts the uniquely maximal reliability of scientific claims (often expressed in terms of their truth, or in terms of the "fact that science works") and the unique validity of sciences' logic of research and explanation that produced them. The focus here will be primarily on the validity claim since it is sciences' logic of research and explanation that is thought responsible for its production of empirically reliable claims.

5. Such insights are the beginning of the development of standpoint epistemologies—only the beginning, not the end, since these insights express "identity epistemologies" while standpoint epistemologies center not socially unmediated experience but distinctive kinds of critically and dialogically achieved discourses as generators of knowledge. See chapters 8 and 9, and, e.g., Patricia Hill Collins, *Black Feminist Thought: Knowledge, Consciousness, and the Politics of Empowerment* (New York: Routledge, 1991).

6. Thanks to Val Plumwood for pointing out to me this fourth assumption in the unity of science thesis.

7. Mario Biagioli, *Galileo Courtier* (Cambridge: Harvard University Press, 1993); Bruno Latour, *The Pasteurization of France* (Cambridge: Harvard University Press, 1988); Robert Proctor, *Cancer Wars: How Politics Shapes What We Know and Don't Know about Cancer* (Boston: Basic, 1995).

8. Compare, e.g., John A. Schuster and Richard R. Yeo, eds., *The Politics and Rhetoric of Scientific Method: Historical Studies* (Dordrecht: Reidel, 1986); Steven Shapin and Simon Schaffer, *Leviathan and the Air Pump* (Princeton: Princeton University Press, 1985).

9. This was a major point of Thomas Kuhn's *The Structure of Scientific Revolutions,* 2d ed. (Chicago: University of Chicago Press, 1970) and the outpouring of subsequent histories, sociologies, ethnographies, and philosophies of science and technology that followed it. For the demise of the idea of "crucial experiments," see also Sandra Harding, ed., *Can Theories Be Refuted? Essays on the Duhem-Quine Thesis* (Dordrecht: Kluwer/Reidel, 1976).

10. Galison, "Introduction," in *Disunity,* ed. Galison and Stump, 14–15.

11. Compare, e.g., Helen Watson-Verran and David Turnbull, "Science and Other Indigenous Knowledge Systems," in *Handbook of Science and Technology Studies,* ed. S. Jasanoff, G. Markle, T. Pinch, and J. Petersen (Thousand Oaks, Calif.: Sage, 1995), 115–39.

12. Compare David Bloor, *Knowledge and Social Imagery* (London: Routledge

and Kegan Paul, 1977); George Gheverghese Joseph, *The Crest of the Peacock: Non-European Roots of Mathematics* (New York: I. B. Tauris, 1991); Sal Restivo, *Mathematics in Society and History: Sociological Inquiries* (Dordrecht: Kluwer, 1992). Arthur B. Powell and Marilyn Frankenstein, eds., *Ethnomathematics: Challenging Eurocentrism in Mathematics Education* (Albany: State University of New York Press, 1997).

13. Compare Ted J. Kaptchuk, *The Web That Has No Weaver: Understanding Chinese Medicine* (New York: Congdon and Weed, 1983).

14. Galison, *Disunity*, 5.

15. Ibid., 3–8.

16. Weinberg's original argument is in *Dreams of a Final Theory* (New York: Pantheon, 1993). A later, more measured, statement can be found in his discussion of Maxwell's equations in "Sokal's Hoax," *New York Review of Books* (8 Aug. 1996), 13.

17. Ian Hacking, "The Disunities of the Sciences," in *Disunity*, ed. Galison and Stump, 52.

18. A. C. Crombie, *Styles of Scientific Thinking in the European Tradition* (London: Duckworth, 1994); Hacking, in *Disunity*, ed. Galison and Stump.

19. Hacking, in *Disunity*, ed. Galison and Stump, 68.

20. Bloor, *Knowledge;* Morris Kline, *Mathematics: The Loss of Certainty* (New York: Oxford, 1980); Restivo, *Mathematics.*

21. These issues were discussed in earlier chapters. In addition to the citations against the unique universality of modern science provided above, see, e.g., N. Katherine Hayles, "Constrained Constructivism: Locating Scientific Inquiry in the Theater of Representation," in *Realism and Representation*, ed. George Levine (Madison: University of Wisconsin Press, 1993); Bas Van Fraassen and Jill Sigman, "Interpretation in Science and in the Arts," in *Realism*, ed. Levine.

22. See the notes to earlier chapters, e.g., J. M. Blaut, *1492: The Debate on Colonialism, Eurocentrism, and History* (Trenton, N.J.: Africa World Press, 1992); Lucille Brockway, *Science and Colonial Expansion: The Role of the British Royal Botanical Gardens* (New York: Academic, 1979); Goonatilake, "Voyage"; James E. McClellan *Colonialism and Science: Saint Domingue in the Old Regime* (Baltimore: Johns Hopkins University Press, 1992); Petitjean, *Empires;* Nathan Reingold and Marc Rothenberg, eds., *Scientific Colonialism* (Washington, D.C.: Smithsonian Institution Press, 1987); *Revenge*, ed. Sardar.

23. See Wolfgang Sachs, ed., *The Development Dictionary: A Guide to Knowledge as Power* (Atlantic Highlands, N.J.: Zed, 1992; and many of the essays in *Revenge*, ed. Sardar. See Third World Network, "Modern Science in Crisis: A Third World Response," in *Revenge*, ed. Sardar, as a separate monograph published by the Third World Network (Penang, Malaysia, 1988), and reprinted in Sandra Harding, ed., *The "Racial" Economy of Science: Toward a Democratic Future* (Bloomington: Indiana University Press, 1993).

24. See Blaut, *Debate;* Boris Hessen, *The Economic Roots of Newton's Principia* (New York: Howard Fertig, 1970).

25. Joseph, *Crest.*

26. J. M. Blaut, *The Colonizer's Model of the World: Geographical Diffusionism and Eurocentric History* (New York: Guilford Press, 1993).

27. Michael Adas, *Machines as the Measure of Man* (Ithaca: Cornell University Press, 1989).

28. Susantha Goonatilake, *Aborted Discovery: Science and Creativity in the Third World* (London: Zed, 1984); Ashis Nandy, ed., *Science, Hegemony, and Violence: A Requiem for Modernity* (Delhi: Oxford University Press, 1990); Sachs, *Development;* Vandana Shiva, *Staying Alive: Women, Ecology, and Development* (London: Zed, 1989); *Revenge*, ed. Sardar.

29. Compare Tom Patterson's arguments that the concept "nature" has a class history. It was persistently introduced by protocapitalist "outside experts" (often groups in their own society) in their struggles with peasants and/or farmers over who would have the power to decide how land was to be used. Tom Patterson, "Nature: The Shadow of Civilization," (forthcoming), and his *Inventing Western Civilization* (New York: Monthly Review Press, 1997). See also the issues about "nature" raised in chapters 5 and 6.

30. See chapter 7 for related discussion of the dependency of modern, masculinized forms of knowledge on purportedly premodern women's forms. Maria Mies makes similar arguments in *Patriarchy and Accumulation on a World Scale: Women in the International Division of Labor* (Atlantic Highlands, N.J.: Zed, 1986).

31. Bruno Latour, *Science in Action* (Cambridge: Harvard University Press, 1987).

32. Watson-Verran and Turnbull, "Science," 117.

33. Gilles Deleuze and Felix Guattari, *A Thousand Plateaus: Capitalism and Schizophrenia* (Minneapolis: University of Minnesota Press, 1987).

34. David Turnbull, "Local Knowledge and Comparative Scientific Traditions," *Knowledge and Policy* 6:3/4 (1993), 29.

35. See, e.g., Carolyn Wood Sherif, "Bias in Psychology," in *Feminism and Methodology*, ed. Sandra Harding (Bloomington: Indiana University Press, 1987); Ruth Hubbard, *The Politics of Women's Biology* (New Brunswick: Rutgers University Press, 1990); Anne Fausto-Sterling, *Myths of Gender: Biological Theories about Women and Men*, 2d ed. (New York: Basic, 1994).

36. See, e.g., Thomas A. Bass, *Camping with the Prince, and Other Tales of Science in Africa* (Boston: Houghton Mifflin, 1990), and Vandana Shiva, *Staying Alive: Women, Ecology, and Development* (London: Zed, 1989).

37. John Dupre, "Metaphysical Disorder and Scientific Disunity," in *Disunity*, ed. Galison and Stump, 115. See also Dupre, *Disorder.*

38. Dupre, "Metaphysical," 115.

39. Dupre, "Metaphysical," also makes this point about resistance to feminist criticisms (116). Cf. Sandra Harding, *The Science Question in Feminism* (Ithaca: Cornell University Press, 1986).

40. Similar criticisms have been made of the idea that the sciences do and should make truth claims. For one review of the issues, see "Are Truth Claims Dysfunctional?" by Sandra Harding, in *Philosophy of Language: The Big Questions*, ed. Andrea Nye (New York: Blackwell, 1998).

11. Robust Reflexivity

1. I suggested a stance of "robust reflexivity" in *Whose Science? Whose Knowledge?* (Ithaca: Cornell University Press, 1991), 149–50, 161–63.

2. See, e.g., Joseph Rouse, "Feminism and the Social Construction of Scientific Knowledge," in *Feminism, Science, and the Philosophy of Science*, ed. Lynn Hankinson Nelson and Jack Nelson (Dordrecht: Kluwer, 1996).

Feminist Inquiry

From Political Conviction to Methodological Innovation

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Chapter 1 Sources of Error, Strategies of Redress

How do feminists know? What is involved in contestation over long-established beliefs? How do feminists produce knowledge to displace misogynist or androcentric claims? How do feminists prove knowledge claims? These epistemological questions lie at the heart of feminist inquiry. Yet outside the field of philosophy, few feminist scholars receive formal training about "problems" of knowledge or how to begin to address them. This chapter introduces debates about the nature of knowledge, discussions of multiple sources of error that can confound efforts to investigate the world, and strategies to overcome error and distortion. Drawing upon philosophical arguments developed in the Western tradition over the past two millennia, the chapter introduces and defines basic epistemological concepts, such as skepticism, rationalism, empiricism, foundationalism, antifoundationalism, positivism, and post-positivism. Because these concepts have been, and continue to be, subjects of contestation, the chapter traces the emergence of multiple versions of these concepts in both antiquity and modernity and tries to illuminate the epistemological issues that have fueled their articulation, repudiation, reconceptualization, and refinement over centuries.

Trying to synthesize more than two thousand years of philosophical argument in one chapter is not an easy feat. Nor is it a simple matter to translate technical philosophical terminology into accessible prose for an interdisciplinary feminist audience. Despite the hazards of such an undertaking, there are strong reasons to make the attempt. Feminist knowledge production is frequently challenged by antifeminist scholars, conservative pundits, and confused citizens whose understandings of the world are under constant siege from misogynist talk-radio hosts, fundamentalist religious leaders, and social Darwinists masquerading as policy scientists. A nuanced and sophisticated understanding of epistemological issues affords feminist scholars a vital resource with which to counter scurrilous attacks. Awareness of important continuities between feminist understandings of knowledge and post-positivist theories of knowledge advanced by contemporary epistemologists and philosophers of science can assist feminists in developing a strong justification of their transformative intellectual project. Moreover, the arguments supporting antifoundationalism offer interdisciplinary feminist scholars an account of knowledge that vindicates feminist knowledge production in all its richness and complexity. This chapter, then, provides the philosophical background necessary for a feminist theory of knowledge sufficiently capacious to accommodate feminist intellectual interventions in the humanities, social sciences, and natural sciences. Subsequent chapters address feminist engagements with the epistemological issues traced here.

From Trust to Skepticism

As children, we engorge a world. From the moment of birth, people speak to us, tell us things, teach us a language, and thereby moor us in a culture and a tradition. Knowledge is conveyed to us on the basis of testimony from others (Alcoff 2000, 236). "The weight of a civilization" (Fanon 1967, 18) is bestowed on us through the tales of others. Absorbing vast amounts tacitly as well as explicitly, we seldom question the validity of what we learn. Our intuitions, our horizons of understanding, and our most basic perceptions are shaped long before we are capable of raising any questions concerning the credibility of our sources or the reliability of their claims. Our earliest accounts of the world are taken on trust.

Philosophical investigations of the world are often rooted in skepticism. The unrelenting distrust of our mental faculties, senses, language, and beliefs can make philosophy seem quite alien. But the constant probing of our assumptions and intuitions has a point. Critical examination of what is most taken for granted can free us from "the myth of the given" (Sellars 1963, 164) and empower us to change oppressive practices. Given the tendency of feminists to challenge existing social relations and traditional conceptions of the world, it could be argued that feminists have an affinity for philosophical investigation. The theories of knowledge developed within the Western philosophical tradition provide rich resources for feminists who seek to interrogate the conditions of our existence. For they identify problems for knowledge production caused by the senses, processes of reasoning, language, beliefs, social relations, and dynamics linked to particular objects of study.

Epistemology is the branch of philosophy that investigates the nature of knowledge. As developed over the past two thousand five hundred years in the Western tradition, epistemology has been concerned with complex questions: What is knowledge? What is the source of knowledge? Do the senses supply, or does reason provide reliable knowledge of the world? What is the relation between knowledge and belief? How much of what we ordinarily think we know is really knowledge? The answers philosophers have provided to such questions have varied markedly, but familiarity with some of the central issues and arguments in these debates can help feminists gain sophistication and critical acuity in our own knowledge production.

Feminist epistemologist Lorraine Code (1991, 224) has defined knowledge as an "intersubjective product constructed within communal practices of acknowledgment, correction, and critique." This definition has the virtue of emphasizing that knowledge is a human product, generated by fallible inquirers through processes of interrogation and contestation that involve many people over long periods of time. Her reference to "practices of acknowledgment" suggests plurality: the multiple forms of knowledge (for example, perception, memory, intuition, introspection, recollection, recognition, conceptualization, contemplation) cannot be reduced to a singular kind. As human conventions, practices have histories; they change over time. Practices also have standards internal to them that provide criteria for assessing quality. Thus Code's definition makes it possible to understand that the criteria for judging recognition (of a person, a place, an object, a pattern) might be different from the criteria for assessing introspection (an examination of one's innermost thoughts, beliefs, motives). Assessing the validity of knowledge claims, then, requires attention to specific ways of knowing that are situated within particular social, cultural, and historical practices, which afford determinate standards of evaluation.

Skepticism: Challenge and Response in the Ancient World

One of the most intensive debates within Western epistemology focuses on questions concerning the sources of knowledge and the standards for assessing the validity of knowledge claims linked to a particular source. This debate was initiated by the Sophists, a group of Greek philosophers in fifth century B.C.E.; these skeptics challenged the possibility of objective knowledge of the natural world. The Sophists asked fundamental questions: How much of what we think we know about nature is really objective, and how much is contributed by the human mind? Do we have any knowledge of nature as it really is, or are appearances all that we can know? The Sophists were the first to suggest that all humans can know are their perceptions of reality. Because individual perceptions vary, the very notion of an objective reality is called into question. Protagorus, for example, asserted the doctrine of *homo mensura*, which insisted that the individual is "the measure of all things." This doctrine quickly devolves into a form of relativism known as "subjectivism." For if each individual's perception is "the measure" of what exists, and individuals differ in their perceptions, then there is no objective measure. Assertions about the world are merely the subjective perceptions of particular individuals and there is no way to adjudicate competing perceptual claims. Following this argument to its logical conclusion, Gorgias insisted that there is no such thing as reality; if there were, then we could not know it, and even if we could know it, then we could not communicate our knowledge to another person. Many versions of subjectivism have surfaced since the time of the Sophists, and potent versions continue to circulate in the twenty-first century. Recognition of human fallibility combined with individualist assumptions and the overwhelming evidence of diversity in and disagreement about perceptions lead many of our contemporaries to conclude that subjectivism is an accurate account of the limited possibilities for human knowing. The earliest epistemological debates, however, challenged the Sophists' claim that individual perceptions exhaust human's access to knowledge about the world.

A RATIONALIST RESPONSE

Plato, the first philosopher to develop a systematic response to the Sophists, argued that they went astray because they confused "appearance" with "reality"; they mistook what "seems to be" for "what is." The Sophists made this error, according to Plato, because they were "empiricists" who relied on the senses as the source of knowledge. They failed to understand that a carefully trained mind exercising the powers of reason could correct the faulty observations of the senses. As the founder of the "rationalist" tradition, which holds that the faculties of reason provide more reliable knowledge than the senses, Plato suggested that there are multiple dimensions of existence to be known. He distinguished between the realm of appearances, which could be apprehended by the senses, and the realm of being, which could be grasped only by the a well-honed intellect, trained to pierce the illusions and distortions of the realm of appearances.

For Plato, the world of appearances was a complex domain, encompassing the physical or natural world, the "made" world of human artifacts and conventions, as well as the "shadow" world of human beliefs, opinions, myths, and representations of nature and convention through visual art and literature. Beliefs about reality based on perception of appearances could be mistaken for a variety of reasons, according to Plato. Some of these sources of error are rooted in the character of the realm of appearances, and some are due to the limitations of the human senses. The physical world and the world of human convention are unstable, subject to change, continually in flux. Physical objects such as rocks, plants, trees, stars, come into and pass out of existence. Similarly, human beings are born, grow, transform themselves in innumerable ways, then die. The artifacts created by humans are also subject to decay, dissolution, and destruction.

To capture on-going processes of emergence and disappearance that characterize the world of appearances, Plato called this domain, a realm of "becoming." The constant fluidity of the realm of becoming provided one source of error for human observers. A claim made about an object could be true one day and false the next because the object had changed. A claim could also be wrong because it imposed fixity on an on-going process, whose stages varied diametrically. Indeed, Plato suggested that within the realm of becoming, it is not uncommon for opposites to embrace. A massive mountain that seems solid and unalterable may be volcanic; erupting lava flows in liquid form transform every aspect of the stone façade. A beautiful face may convulse in anger or hatred, manifesting profound ugliness.

In addition to errors in perception that arise from changes in the world of appearances, Plato suggested that human senses themselves can also contribute to misperception. Eyes, ears, and noses, for example, are not perfect conduits of information. They play tricks on us. Anticipation may structure perception so that we "see" what we want to see. Settled convictions may influence our perception so that we only see or hear views that confirm our beliefs. Although Plato developed these arguments millennia ago, a good deal of work in social psychology and opinion research supports Plato's claims about "selective perception" and "selective attention." Our senses may also be deceived. Consider optical illusions. Plato used the example of a stick, perfectly straight when observed in the air, which appears bent when submerged in water. Figure-ground relations can produce similar illusions as the famous examples of the duck-rabbit and the chalice-face make clear.

Beyond sources of error in observation linked to the nature of things that exist in the realm of appearances and to the nature of perception, Plato identified several other causes of mistakes in claims about the world derived from the senses. Changing standards of comparison can cause variance in perception. A person who is six feet in height may seem very tall when measured against someone who is four feet, yet seem very short when compared with a person who is seven feet six inches tall. Thus different standards of comparison may generate very different characterizations of the same phenomenon. Perception is further complicated when one observes representations of objects. Whether the representation is a visual artist's rendering, a writer's graphic depiction, or another person's verbal characterization, some features of the object will be emphasized, others downplayed, and some omitted entirely. Plato noted that any inferences drawn from representations were peculiarly vulnerable because of their distance from the original.

Inconstancy, change, fluidity, selective perception, optical illusion, multiple standards of comparison, and mediated representations are all included in Plato's account of the ways that the senses can be led astray. The sources of human error are multiple and various. Plato did not think, however, that humans had to resign themselves to wallow in perceptual distortion. He argued that with sufficient education and recourse to rigorous analytic techniques, individuals could transcend the realm of appearances and gain knowledge of the "realm of being." They could succeed in grasping "things as they are," free from the distortions introduced by the senses and by appearances. Much of Plato's confidence about the power of human reason was derived from his ontology, an account of reality at great remove from contemporary beliefs. Plato argued that the ultimate reality transcended the realm of appearances and all its defects. In contrast to the inconstancy and imperfection of the realm of becoming, the realm of being is a domain of perfect and eternal "Forms" or "Ideas" that provide a template, which the various appearances in the realm of becoming merely approximate. The "Forms" then constituted the essence of existence, which could be grasped by human beings because prior to assuming bodily form, humans existed as immaterial beings in the realm of the Forms. Although the trauma of birth caused people to forget the truth of being and to mistake appearance in the material world for reality, systematic education in mathematics, music, and philosophy could enable them to "recollect" the truth.

There are many good reasons to challenge Plato's ontology as we will see below, but even if one rejects Plato's theory of the Forms, there is much to learn from his account of how to avoid being misled by the many sources of error in the realm of appearances, the domain in which most feminist contestations take place. Plato suggests that inquiry must begin with careful consideration of the nature of the object under investigation, for the kinds of knowledge possible vary, depending upon the objects of study. Images and representations generate inferences that never go beyond conjecture. Appearances of living things, natural phenomena, and human artifacts require close attention to processes of production, growth, change, and decay. Even the most scrupulous observations of such processes are fallible, however; and justified beliefs, or opinions backed by evidence, are the best one can attain about objects in this domain. Abstract ideas, such as those developed in geometry, establish tautological truths amenable to proof by logical deduction and also support applications in the realm of appearances via hypothetical (if-then) reasoning.

The mode of inquiry that Plato endorsed drew upon a form of crossexamination of competing accounts developed by his teacher, Socrates, who routinely began his investigations by gathering together what others said about a topic. Socrates sought to collect as diverse a range of opinions as possible so he could compare them against one another, by drawing insights from the comparison and developing arguments that enabled him to refute faulty views. In this process of reasoning, he paid particular attention to inconsistencies and contradictions that might illuminate errors in perception or reasoning. After purging as many

mistakes as possible through this comparative analysis of varying opinions, Socrates probed the competing views for any underlying commonalities to provide clues to a central idea shared by all the conflicting opinions. The common factor or "essential property" underlying all the variations, according to Socrates, provided a definition for the concept under investigation. Although it often differed from the particular claims examined, the concept was "universal" in that it captured the feature that all the differing accounts shared. Once identified, the concept could also provide a standard against which the particular claims could be measured, assessing them according to how closely they approximated the "ideal" or "essential" concept. Plato, appending his ontology to Socratic concepts, suggested that the "essence" underlying all appearances of a particular object was precisely the ideal Form that existed in the realm of being.

AN EMPIRICIST RESPONSE

Aristotle, who had been Plato's student for fourteen years, amended Plato's theory of knowledge, preserving certain insights while jettisoning the ontological assumptions in order to develop an empiricist epistemology—that is, a theory of knowledge that privileges the senses as the source of reliable evidence about the world. Aristotle rejected Plato's theory of the Forms and the notion that a transcendent realm of ideas is the true reality. Like Socrates, he argued that "universals" or "essences" are inherent in the "particulars"—that is, the universal is that which all particulars share in common. But he suggested that there were more mechanisms for gaining information about particulars than Socrates had acknowledged. Inquiry need not be restricted to comparative analysis of conflicting opinions because the senses allowed access to the physical world. Systematic observation aided by reason could generate reliable knowledge about the world, including sophisticated understanding of processes of change and development that characterized the realm of becoming.

The Aristotelian account of inquiry begins with induction, repeated observation of particular cases in order to arrive at a generalization, but Aristotle noted from the outset that individuals must be trained to observe the world so as not to be misled by transitory appearances. By asking the right questions and making careful distinctions, empirical observation could generate accurate knowledge of the physical world. Aristotle agreed with Plato that the physical world is constantly changing, but he suggested that the processes of becoming are themselves characterized by a particular order. Transformations observable in nature, including human nature, are linked to the realization of potentialities inherent in living organisms. Aristotle was a teleologist; he insisted that all processes of development are goal (*telos*) directed. The telos of all life forms is the full realization of potential. The "essence" of any life form is nothing other than the actualization of all potentiality. Appearances depict the amount of potential developed at any particular stage of development, and appearances change as increasing amounts of potential are actualized. A tadpole assumes many different appearances as it progresses toward its development into a frog. An acorn is totally transformed as it grows into an oak tree: its size, shape, complexity, functioning, and uses change dramatically over its developmental process. According to Aristotle, these transformations are governed by an inherent striving to achieve full realization. Given the appropriate soil and moisture and absent intervention by catastrophic forces (natural or humanly created), the acorn will become an oak. At the moment when full actualization occurs, when all potentiality has been realized, actuality and essence coincide. Thus, systematic observation of the developmental process enables a viewer to see the oak's essence, for, at the moment of full flourishing, the oak's essence is manifest in its appearance.

Aristotle noted that a trained observer can provide very different kinds of explanation of developmental processes. A genetic explanation is oriented toward the past, tracing the origin of a phenomenon, identifying its "genesis." A teleological explanation is future-oriented, for it seeks to explain the telos or goal toward which someone is striving or something is developing. A material explanation provides an account of the "matter" or "substances" of which something is made. A material analysis of a human being, for example, would be cast in terms of DNA, RNA, genes, and cells differentiating into specific organs of the body. A formal explanation provides an account of the various stages of actualization over the course of the developmental process by attending to particular forms assumed by the developing organism. An "efficient" explanation provides an account of the mechanisms that cause the transformations from one stage to the next, locating the "engine" of change. According to Aristotle, empirical investigation can generate accurate accounts of all these dimensions of existence. Because each of these forms of explanation focuses on a different level of analysis, the accounts they generate are markedly different. The differences in these accounts do not imply, however, subjectivity in perception. On the contrary, each form of explanation generates objective information about a different aspect of the living organism. A comprehensive account encompassing all these modes of explanation is required to fully understand a particular organism.

Over the course of his life, Aristotle attempted to develop such comprehensive accounts of complex dimensions of existence. His investigations led him to conclude that different kinds of phenomena admit of different kinds of knowledge. Theoretical knowledge, which involves the contemplation of things as they are without attempt to change them, is possible in the domains of physics, mathematics, and metaphysics. In contrast to theoretical knowledge's recognition and acceptance of things as they are, practical knowledge involves the use of reason to guide choices in order to live well. Practical knowledge used to enable individuals to attain happiness is, according to Aristotle, the science of ethics. Practical knowledge of what is necessary to foster the good of communities is the science of politics. Aristotle also identified a third kind of knowledge, productive knowledge, a kind of "know how" essential to making things. The spheres of making and the kinds of "things" that could be made in Aristotle's view are far more expansive than are typically associated with technical knowledge in contemporary understandings of production and construction. *Techne*, the term that refers to "making" in classical Greek, is the etymological root for contemporary conceptions of technology, but in the ancient context techne referred to the knowledge that artisans used to produce goods essential to survival, that poets and playwrights used to produce pathos, bathos, and catharsis in their audiences, and that rhetoricians used to persuade listeners to accept their arguments. Thus, Aristotle's conception of productive knowledge is not only relevant to forms of knowledge that support industrial production and information technology, but it also informs feminist accounts of the manifold practices through which categories of difference are produced and maintained, such as Teresa de Lauretis's discussion of "technologies of gender" and the creative and symbolic production of cultural meanings that structure raced, sexed, and gendered identities, imaginings, and sentiments. On Aristotle's view, the criteria for truth in the realm of practical and productive knowledge is efficacy. The proof of the truth of practical reason's ethical arguments is that they do indeed produce individual happiness. Similarly political knowledge succeeds in promoting the well-being of communities and states. The proof of techne's "know how" is that it succeeds in producing precisely the products, emotions, and convictions that it sets out to produce in particular instances. Practical and productive knowledge succeed because they get the world right; inaccurate or mistaken views fail because they do not.

Skepticism in the Modern World

The version of skepticism that arose in Europe in the late sixteenth and early seventeenth centuries sought to dethrone medieval scholasticism, a system of thought in which Christian theology and Aristotelian philosophy were deeply entwined. Accredited by religious authorities, academics, and rulers of states, Scholasticism governed political life and scientific inquiry, as well as religious convictions. In a world in which "science" had not yet been demarcated from "natural philosophy," scholars like Francis Bacon (1561–1626), Galileo Galilei (1564–1642), René Descartes (1596–1650), and Thomas Hobbes (1588–1659) sought to carve out a space for scientific inquiry free from the heavy hand of church-ruled states and principalities. Skepticism provided a critical tool in these efforts to emancipate knowledge from religious dogmatism. Deploying skepticism to attack religious authorities as guardians of state-sanctioned knowledge, these skeptics also laid the groundwork for drastically curtailing the types of knowledge believed possible.

A MODERN VERSION OF EMPIRICISM

Bacon, often depicted as the "father of modern science," declared all knowledge his province as he set out to accredit certain modes of inductive inquiry. In *The Proficience and Advancement of Learning* (1605) and in *Nine Books of the Dignity and Advancement of Learning* (1623), he championed a utilitarian conception of practical knowledge "for the use and benefit of men" and "relief of the human condition." Where Aristotle had carefully distinguished theoretical knowledge, practical knowledge, and productive knowledge by identifying the kinds of objects in the external world appropriate to each, Bacon reclassified knowledge into three primary categories corresponding to three fundamental faculties of the human mind: history, the form of knowledge associated with memory; poesy, the mode of knowledge corresponding to the imagination; and philosophy, the domain of knowledge tied to reason. Identifying inductive reason as the key to progress in knowledge production, Bacon's reclassification defined philosophy as the domain of "realistic possibility," of everything that can theoretically or actually occur. As the domain of "fact," everything that has happened, history is craftily reconfigured as a subfield of philosophy, for what has happened falls within the larger category of realistic possibility. Poesy is construed by Bacon as "feigned history," the domain of everything that is imaginable. Typically manifested in literature and the arts, empirically oriented Bacon marginalized poesy as far less central to the progress of knowledge, affording merely a means to illustrate scientific discoveries.

Bacon envisioned empirical inquiry as a way to overcome the undue reverence for the past. Yet he acknowledged that for individuals to be able to "open their eyes and minds to the world around them," significant obstacles would have to be overcome. He identified these obstacles in need of clearing as "diseases or distempers of learning." Chief among these distempers, he included "vain imaginations" or pseudosciences such as alchemy, astrology, and magic; "vain altercations," the endless debates and metaphysical quibbling of medieval Scholasticism; and "vain affectations" or "literary vices," preoccupations with words more than matter, and style over substance, which he associated with the revival of Ciceronian rhetoric and classical prose.

In *New Organon or True Directions Concerning the Interpretation of Nature* (1620) Bacon enumerated multiple sources of error that impeded the acquisition and progress of empirical knowledge. The Greek term, *organon*, means "instrument" or "tool," and Bacon constructed this tool as a means to identify, eliminate, or control sources of potential deception and misunderstanding. With lovely literary flair, Bacon called these various sources of error, "idols" from the Greek,

eidolon—"images" or "phantoms" that cloud the mind and impair an objective apprehension of external reality. He identified four distinct idols, which must be purged to prepare the way for empirical inquiry.

"Idols of the Tribe" refer to basic operations of the human mind, which Bacon understood as fundamental "weaknesses of human nature." As such, they cannot be eliminated, but they can be controlled by adherence to "scientific method." A chief human weakness, according to Bacon, is that the human senses themselves are dull and easily deceived. They can be corrected, however, by use of scientific instruments. Consider how glasses, telescopes, and microscopes assist the naked eye and how hearing aids, microphones, and amplifiers can assist hearing. In addition to sensory dullness, Bacon suggested that we tend to rely too heavily on immediate perceptions, rushing to conclusions and making premature judgments that are more likely to be wrong that right. Human observers also tend to impose more order on observed phenomena that actually exists. We think we "see" similitude when there is singularity or "perceive" regularity when there is randomness. Humans also have a profound tendency to "wishful thinking" in Bacon's view. We tend to accept, believe, and seek conclusive "proof" for what we prefer to be true. These troubling tendencies can be counteracted by rigorous adherence to "the scientific method," inductive techniques, which require careful and painstaking accumulation of evidence by multiple observers who subject one another's claims to strict scrutiny.

"Idols of the Cave" involve peculiar distortions, prejudices, and erroneous beliefs that arise from an individual's upbringing within a particular family within a specific tradition and culture. Whereas the idols of the tribe pertain to all human beings, idols of the cave are social in nature yet vary from one person to another. Tied to an individual's position within a society, education, and personal history, idols of the cave could include biases linked to particular disciplinary training or theoretical orientation, a tendency to rely upon a few select "authorities" to justify one's stance, or to interpret phenomena in terms of one's own narrow specialization. To "dislodge" the idols of the cave, Bacon recommended the use of skepticism as a resource for the individual inquirer. Whatever one's mind "seizes and dwells upon with peculiar satisfaction is to be held in suspicion" (lviii) and interrogated at length. Distortions of this sort can also be corrected by the practice of science as a public enterprise, involving many people, who test one another's claims and subject them to rigorous empirical tests.

Bacon's third and "most troublesome" type of obstruction to the clear apprehension of the world is related to language. Bacon refers to misunderstandings and confusions that creep into the mind through "alliances of words and names" as the "idols of the market place" because the market is a social space in which people associate with one another, engaging in "commerce and consort." Bacon suggests that language has the power to distort perception because it is not the neutral tool that many believe it to be. On the contrary language can shape understanding in a variety of ways. Everyday meanings of words may exact a powerful hold on people that interferes with new scientific understandings. Consider, for example, how the vernacular meaning of "race" as a biological phenomenon precludes popular acceptance of demonstrative scientific evidence that there is no biological basis for "race." Words also lend substance to imagined phenomena so that many people believe that "fairies," "leprechauns," "Fortune," or "the Prime Mover" (Aristotle's term for the originator of the cosmos) exist because there are words that name such "phantoms." Some terms can also be markedly misleading because they have so many different referents that their meaning in a particular instance is always ambiguous. Consider, for example, the multiple referents for "sex" (chromosomal configurations, forms of embodiment, erotic practices, sexual identifications, gendered configurations) and how they can complicate understanding of any particular usage of the term. Bacon also pointed out that when technical meanings of terms proliferate, scholars can devote all their time and attention to fights over the meanings of words and lose all sight of larger questions about processes in the world.

The final source of error identified by Bacon suggested that philosophical systems themselves can distort individual's perceptions of the world. In a caustic critique of their pretense to knowledge, Bacon referred to these distorting theoretical frames as "idols of the theater." He identified three distinctive kinds of mistake that generate these flawed worldviews. Casual observation and anecdotal evidence, made the ground for abstract argument and speculation, generated a particular form of philosophical corruption: fashioning the world out of theoretical concepts and categories absent any kind of experimental testing. Bacon suggested that Scholasticism was one example of the errors introduced by such arm-chair philosophizing. In the contemporary world, one might argue that neo-liberalism is another prime example. Bacon's second example refers to philosophical systems based on a single key insight, which itself rests upon very limited empirical research, but which is generalized to explain phenomena of all kinds, thereby producing a pattern of distortion. Sociobiology is an apt example of this kind of distortion. The potent mixture of philosophy and theology, characteristic of many contemporary fundamentalisms, is the third "parent stock of errors" that impedes objective perception of the external world, according to Bacon.

In delineating these idols of the tribe, cave, marketplace, and theater, Bacon anticipated twentieth-century discussions of the theoretical constitution of facticity, the argument that theoretical presuppositions structure every step of the research process, from the most elementary perceptions through the accreditation of particular forms of evidence and explanation. In contrast to these more recent debates, however, Bacon argued that these idols could be purged. Induction, the systematic observation of particulars as a means to arrive at defensible

generalizations, coupled with experimental methods designed to test the validity of inductive generalizations, could generate accurate knowledge of the world. Refutations of mistaken generalizations or axioms could also serve as a "ladder to the intellect," for they indicated wrong directions that should not be pursued any further. Moreover, the use of scientific knowledge to develop instruments to help humans solve problems and improve their condition also generated an important means to demarcate truth from falsity. Bacon anticipated the "pragmatic theory of truth," which links the assessment of knowledge claims to outcomes. On this view, both theories and technological innovations are true if "they work," if they enable people to achieve the objectives that they set for themselves.

Bacon argued that skepticism could be deployed to hone observational powers and liberate people from superstition and error. Convinced that progress was possible through scientific investigation and innovation, Bacon laid the foundation for modern science as a mode of empirical inquiry that relied on induction and experimentation. During the same time period, Descartes also sought to deploy skepticism as a means to achieve truth, but where Bacon vindicated empiricist strategies of knowledge production, Descartes developed a defense of rationalism.

A MODERN VERSION OF RATIONALISM

Like Bacon, Descartes sought to create a new foundation for knowledge to supplant medieval Scholasticism but he did not believe the path to reliable knowledge was through the senses. Tracing a range of errors that typically befall our senses, such as optical illusions, dream images, and misperceptions that stem from physical illnesses or bodily malfunctions, Descartes argued that only reason can save us from falling prey to such distortions. Best known to nonphilosophers for his famous quip, "*Cogito ergo sum*" (I think, therefore I am), Descartes argued that our powers of reasoning provide both the foundation for truth and the requisite guidance to attain it.

In his *Discourse on Method* (1637) and his *Meditations on First Philosophy* (1640) Descartes developed a method of investigation that relied on radical doubt as a primary tool. Conceiving "exaggerated" or "hyperbolic" doubt as a form of philosophical experiment, Descartes suggested that we should push doubt to its absolute limits; we should doubt everything until we arrive at that which cannot be doubted. Such a deployment of doubt is a rational process that enables us to question all existents. During the process of doubting all that exists, we cannot doubt our own existence, however, for the doubting process presupposes the existence of the doubter. We cannot call into question our rational capacity to question. Thus this reasoning process itself becomes the ground for certainty; doubt leads us to the indubitable.

Descartes developed basic guidelines for the production of reliable knowledge that capitalized on the powers of reason. Doubt figures in these as a starting point and as a tool that helps us challenge preconceptions and avoid precipitate conclusions. Descartes suggests that we should apportion belief to evidence. We should never accept anything as true unless we have "evident knowledge" of its truth. Evident knowledge appears in the mind as "clear" and "distinct" ideas, that which remains after the doubting process has eliminated problematic elements. Using a visual analogy of viewing an object up close and in brilliant light, Descartes suggests that "clarity" allows us to understand all the properties and qualities of the object. "Distinctness" enables us to grasp how an idea relates to an object, the dimensions of the object itself, and the scope of its relationships to other phenomena. To apprehend clear and distinct ideas, Descartes recommends a form of philosophical analysis through which we break ideas down to their simplest component parts and scrutinize all the constitutive elements. From the examination of the most simple components, we then proceed in an orderly manner to build more complex ideas and arguments by testing each step of the process so that we understand clearly how the ideas go together. In thereby building knowledge from the ground up, we should seek comprehensiveness, providing an account so complete that nothing escapes scrutiny. The knowledge that is produced by this method, then, will be certain and indubitable.

FOUNDATIONALISM

Versions of rationalism developed by Plato and Descartes and versions of empiricism developed by Aristotle and Bacon are examples of "foundationalism," an epistemological doctrine asserting that a firm foundation for knowledge enables humans to transcend the limitations set by our own fallibility and achieve certain knowledge. As we have seen, these rationalists and empiricists disagree about the foundation for knowledge (reason versus the senses) and human access to it (rational philosophical analysis versus empirical scientific inquiry), but they agree that a sturdy foundation for knowledge exists. Antifoundationalists are not so sanguine. Although antifoundationalists, like foundationalists, wrestle with skepticism, in an important sense certain aspects of antifoundationalists' skepticism remains unabated.

Antifoundationalist Approaches to Problems of Knowledge

Challenges to the epistemological optimism of classical and modern versions of rationalism and empiricism come from various sources, but a common motif in these challenges is our inability to escape or counteract one or more of the sources of error already identified. Convinced that humans can never achieve "indubitable" or "absolutely certain" knowledge, antifoundationalists frame knowledge production within a different set of parameters. Although they do not reject all forms of knowledge, they reconceptualize knowledge as inherently fallible.

Thomas Hobbes, a contemporary of Bacon and Descartes, was profoundly influenced by each of them; Hobbes ultimately broke with their convictions that it is possible to have "absolutely certain" scientific knowledge of the natural world. In Hobbes's view, we can have certain scientific knowledge only of those subjects of which we are the cause, whose construction is in our power or depends upon our arbitrary will. Invoking a conception of productive knowledge as the only ground of certainty, Hobbes insisted that we can know only what we make. Because we do not make "nature"—whether understood as the earth, stars, the planets, oceans, deserts, forests, or as the "cosmos" at large—these natural phenomena remain less than fully intelligible to us. We invent theories to make sense of these phenomena, but according to Hobbes, our theories are and always will remain hypothetical, grounded on nothing more than supposition. Hobbes defines theories as instruments or tools that we create to help us make sense of and "master" nature. Our theoretical tools, then, have a pragmatic purpose, the conquest of nature. The only criteria we need to judge them is also pragmatic: "good" theories enable us to succeed in achieving our ends; "bad" theories do not. All ontological discussions of "truth" can be dispensed with as irrelevant. The natural world remains enigmatic. Instead, humans can proceed with our various projects guided only by an "instrumental" conception of knowledge judged by the criterion of success. Within this frame, the theory of aerodynamics counts as instrumental knowledge because it enables us to fly aircraft. We need nothing more than hypothetical constructs to bend the natural world to our purposes; but in Hobbes's view, we should not confuse our hypothetical theoretical constructs with absolute knowledge of the universe. Although profoundly influenced by Bacon's pragmatic criteria for judging the merits of particular theories, Hobbes contested Bacon's optimistic notion that "successful" theories provide accurate information about the world. Where Bacon argued that the "idols of the theater" could be dispelled by careful adherence to empirical inquiry and experimental method, Hobbes insisted that all theories, including "good theories," are a species of Baconian idol.

Hobbes shared Bacon's recognition that language raised pronounced problems for knowledge, but Hobbes did not believe that these problems could be resolved by scientific methods. On the contrary, he proposed a political solution for the complex issues raised by language. In his most famous work, *Leviathan* (1651), Hobbes defined speech as "the most noble and profitable" human invention, for it enables individuals to create names to register their thoughts, recall them from memory, and declare them to others. Words that "name things and their connections and relationships" enhance our reasoning abilities and make communication possible. But words also raise enormous difficulties in part because they can be "abused." We can misuse words to deceive ourselves and others, we can use words to make "evil appear good and good appear evil," and we can use words to inflict pain upon others. Beyond the "abuses of speech" that Hobbes identifies, words are problematic for another reason. Hobbes is a nominalist, who insists that words are quite arbitrary conventions: any name could be given to any object for there is no inherent or "essential" relation between words and things. Any person could use any idiosyncratic word to refer to an object, and there are no ontological grounds for preferring any particular usage to any other. If each person uses words idiosyncratically, however, no communication would be possible; misunderstanding, confusion, and chaos would ensue. For words to fulfill their communicative function, then, the definitions of terms must be agreed upon, and these conventional meanings of words must be enforced.

Hobbes is well known for his insistence that conventions gain their force only when a coercive power exists to compel compliance with them. Less frequently acknowledged is Hobbes's application of this maxim not only to the "social contract" that creates political sovereignty but also to the convention of speech. In the *Leviathan*, Hobbes defined "truth" as the "right ordering of names in our affirmations" (105). Noting that definitions are the key to truth speaking, Hobbes indicated that the creation and enforcement of a dictionary was a fundamental task of the Sovereign. Arguing that reasoning based on "metaphors and senseless and ambiguous words" ends in "contention and sedition," (116–117), Hobbes insisted that the Sovereign must appoint a judge to resolve all controversies that arise about the meanings of words. Hobbes noted that backed by the coercive power of the Sovereign, the judge's interpretation of words would be final. This did not imply that the interpretation the judge accredited was ontologically exact, an impossibility within Hobbes's nominalist framework, it simply meant that the judge's word was final, bringing the dispute to an end. Any speaker who then refused to use the word as the judge mandated would be liable for the punishment appropriate to "sedition." Hobbes's linkage of politics and language may seem somewhat less draconian when placed in the context of the civil war in England fueled by profound disagreements among certain Catholic and Protestant sects over the "meanings of words," that is, religious doctrines. But it is also instructive to consider the role that political authoritarianism can play with respect to the resolution of contentious claims concerning truth, when the ground for resolution is shifted from an evidentiary basis to politics.

In the eighteenth century, David Hume (1711–1776) launched a strenuous campaign to debunk the foundationalist pretenses of rationalism and empiricism. By a careful "mapping of the operations of the human mind," Hume sought to prove that metaphysical and ontological speculations of moral philosophy and natural philosophy were "fruitless efforts of human vanity . . . [to] penetrate into subjects utterly inaccessible to understanding" (Hume [1748] 1955, 20). In his *Enquiry Concerning Human Understanding* (1748), Hume provided compelling demonstrations that neither deductive logic, the tool endorsed by rationalists for the preservation of truth, nor inductive logic, the instrument accredited by empiricists for the discovery of truth, could perform up to the expectations of their respective proponents. Following the demarcation of domains of knowledge developed by rationalists and empiricists, Hume accepted that there are two possible kinds of knowledge: "relations of ideas" and "matters of fact." Hume was willing to grant that deduction operates admirably in some contexts, such as the system of Euclidean geometry where the "relations of ideas" are governed by logical necessity. For example, a triangle is a three-sided figure the sum of whose angles is 180 degrees. It would be logically impossible then for any four-sided figure to be a triangle. We can have "absolute certainty" then about what a triangle is and what it is not. In cases of such "relations of ideas," tautological definitions establish the "truth" of the major premise and demarcate the properties of the geometric figure that may be deduced through syllogistic demonstrations. If rationalists restricted their claims about knowledge to the sphere of geometry or to a limited set of tautological "relations of ideas," their case for deduction would be defensible. The problem arises, according to Hume, when rationalists claim that deduction can provide absolute knowledge about the material world, a domain governed by contingency rather than logical necessity.

As a description of the material world, contingency captures the possibility that things could be other than they currently are. The sun "rises" each day, but not because it is logically required to do so. The physical forces governing the sun and the earth's movement around it could change. As a star, the sun could cease to exist. As a planet, the earth could also cease to exist. What we think we know about the sun and the earth are not matters of tautological definition. Thus the truth-preserving power of deductive logic, which depends on the truth of the major and minor premises in a syllogism, does not hold in cases where contingent propositions supplant tautologies in syllogistic reasoning. In the absence of tautologies, which are the key to "absolute certainty" in deductive arguments, rationalists cannot guarantee the truth of any claim they advance about the world we live in.

Hume pointed out that claims about the natural and social world rest on inductive generalizations, which are themselves prone to error in the face of contingency. In a famous discussion of the "problem of induction," Hume demonstrated that it is not possible to have sufficient empirical evidence to conclusively prove any inductive generalization. The quest for absolute certainty grounded on observation of particular cases is foiled in various ways. To achieve the status of a universal truth, an inductive generalization would have to hold for all past, present, and future cases. Consider, for example, the claim that women are nurturers. To prove this claim "absolutely" true, we would need to have observational evidence of the nurturing behavior of every woman who ever lived in the past, every woman who is currently alive, and every woman who will ever live. While it might be conceivable, given a large enough research team and computer compilation of data, to gather systematic evidence of all living women, it is not possible to gather comparable data about women who either lived in the past or have not yet been born. Hume, therefore, noted that empirical observation cannot provide an "absolute ground" for knowledge: no matter how much inductive evidence we have to support a generalization, it will never be enough to cover all past and future instances. Moreover, in a world of contingency, things can and do change. Thus, even if there were a moment in time when all living women were nurturing, there is no reason to believe that the future will be the same as the present or past. Any number of factors (for example, war, terrorism, domestic violence, rape, anger, animosity, ambition) could cause women to change their behaviors. If even one woman rejects nurturing and refuses to manifest that behavior, then a universal generalization—such as "all women are nurturers"—would be proven false. Contrary to the optimism of classical and modern empiricism, Hume suggested that the impossibility of gathering universal evidence as well as contingency undermine induction as an absolute ground for truth claims.

Hume did not rest content with a demonstration of the limitations of deductive and inductive logic. He also developed an argument that the human mind operated according to principles at great remove from what is commonly considered "reason." Hume agreed with empiricists that thoughts or ideas enter the mind through primary sensory impressions. He suggested, however, that the mind actively organizes these perceptions according to three principles: resemblance, contiguity, and causation. Breaking with a long line of thinkers who characterized the mind as a passive medium that simply receives impressions from the external world, Hume argued that the mind actively imposes order on our perceptions, thereby structuring our understanding of the world. If Hume's claim is interpreted only in the context of memory, then the association of ideas on the basis of resemblance, contiguity, and causation seems relatively unproblematic. According to the principle of resemblance, a picture "leads our thoughts back to the original," a photo reminds us of the person it portrays. Contiguity introduces a train of thoughts that leads our minds from one memory to another that was temporally or spatially adjacent to it. For example, if we see a coffee shop that we once frequented, it may trigger a series of memories of people we used to meet there, of buildings that used to surround it, of streets that led from the coffee shop to home. Similarly with respect to causation, if we think of a wound, our minds may quickly move to the incident that caused it or to the pain caused by it.

Hume does not claim, however, that resemblance, contiguity, and causation—the mechanisms for associating ideas—operate only at the level of

memory. On the contrary, he suggests that these principles support inferences that enable our minds to move beyond immediate experience and memory. Indeed, Hume notes that causal inferences, in particular, expand our knowledge of matters of fact beyond our sensory impressions and our memories of them. If we find a watch in the desert, for example, we infer that another person has been there. If we see a pregnant woman, we infer that she has had sexual intercourse with a man. As both these examples make clear, however, causal inferences may be mistaken. A watch may have fallen from a plane and landed in a part of a desert in which no person had ever been. A woman may be pregnant though artificial insemination without ever having experienced sexual intercourse with a man. Hume points out the fallibility of causal inferences as part of a larger critique of empiricist claims about causal knowledge.

Breaking the idea of cause and effect into its component parts as "analytic method" recommends, Hume suggests that a causal relationship typically implies priority in time (the cause precedes the effect), contiguity (the cause triggers the effect by temporal and spatial touching, as when pool balls move when physically hit by a pool cue), and necessary connection (the effect necessarily follows from the cause; its appearance is neither arbitrary nor coincidental). Following empiricist claims that knowledge of matters of fact derive from sensory observation, Hume tries to locate the primary sensory impressions from which the constitutive ideas of cause and effect arise. He points out that priority in time and contiguity are empirically observable, but necessary connection is not. "Constant conjunction" or "correlation" in the language of statistics—two things occurring together—is all that is empirically observable in a putative causal observation. Correlations, however, are notoriously fallible. Consider, for example, claims of nineteenth-century anthropologists that women are intellectually inferior to men because women have smaller brains. The putative causal claim was based on "observations" of a constant conjunction between the weight of women's brains and the absence of women from intellectually demanding positions. The "correlation," however, is spurious. As Stephen J. Gould (1981) and Carol Tavris (1992) have so eloquently demonstrated, brain size is related to body weight, not intellectual capacity; women's absence from intellectually demanding positions is related to discriminatory practices, such as laws and traditions that have barred them from educational and occupational opportunities, not to brain size.

According to Hume, a "habit of the mind" or a "mental custom" imposes "necessity" upon constant conjunction to "render our experience useful to us." Rather than allow us to be paralyzed by skepticism or by a lack of adequate evidence, our minds lead us to believe there is a causal connection when we observe constant conjunction. This mental habit helps us to survive. For example, when we are hungry and we see food, we do not hesitate to consume it, expecting its nourishment to allay our hunger. This expectation is based on a presumption that past experience is a reliable guide to the future because the future will be like the past, a presumption belied by contingency. Thus Hume points out that our convictions about the reliability of our causal inferences rest upon mental custom, not rational argument. In a world of contingency there is no reason that the future should replicate the past. Custom, not reason, makes us expect a future that conforms to our expectations. A simple mental habit shores up our confidence in our fallible perceptions of constant conjunction, a mental habit with certain affinities to "wishful thinking."

By impugning the epistemological optimism of rationalists and empiricists, Hume sought to demonstrate that neither deductive nor inductive reasoning could provide an absolute foundation for human knowledge. Toward that end, he wielded skepticism as a formidable weapon against the views of other philosophers, but Hume did not believe that skepticism provided a viable epistemological basis for human life. On the contrary, he argued that the "chief and most confounding objection to excessive skepticism [is] that no durable good can ever result from it. . . . All human life must perish were . . . [Pyrrhonian or excessive skepticism] universally and steadily to prevail. All discourse, all action would immediately cease, and men remain in total lethargy till the necessities of nature, unsatisfied, put an end to their miserable existence" (168). In place of defective epistemological doctrines such as rationalism, empiricism, and skepticism, Hume celebrated "custom" as the great guide to human life. Although the "powers and forces by which nature is governed are wholly unknown to us," custom renders our experience useful to us, extends our knowledge beyond the narrow sphere of senses and memory, enables means-ends analysis so that we can survive in the world (68). As a political conservative, Hume was more than happy to vindicate custom and tradition as an alternative to epistemological foundationalism. While far less coercive than Hobbes's appeal to political force to support epistemic conventions, Hume's celebration of custom, freighted with male privilege and androcentric bias, may, however, give feminist scholars pause. Constructing the epistemological options in such stark terms, custom or reason, may not be the only alternative for feminist knowledge production.

Twentieth-Century Debates in the Philosophy of Science

Most discussions of feminist knowledge production have been framed by debates in the philosophy of science that developed over the course of the twentieth century. Some familiarity with these debates are particularly helpful in considering how to move beyond the stark alternatives that pit foundationalist appeals to absolute truth grounded in deductive or inductive logic against antifoundationalist appeals to conventions shored up by force or customs that entrench male domination. The final section of this chapter provides an overview of the positivist version of foundationalism and a postpositivist version of antifoundationalism.

POSITIVISM

The term positivism was first coined by the French sociologist Auguste Comte, who suggested that scientific understanding operates in the realm of the "positive," which denotes "real" or "actual" existence. Advancing a version of empiricism, Comte suggested that scientists must eschew the metaphysical and theological realms and restrict their investigations to observable facts and the relations that hold among observed phenomena. Within this finite sphere of the empirically observable, scientific inquiry could discover the "laws" governing empirical events. In the early twentieth century, a group of philosophers of science, known as the "Vienna Circle," developed "logical positivism," which further restricted the possibilities for valid knowledge by elaborating the "verification criterion of meaning." Focusing on how to establish the truth of specific statements about the empirical world, the verification criterion stipulated that a contingent proposition is meaningful if, and only if, it can be empirically verified, that is, if there is an empirical method for deciding the proposition's truth or falsity.

Within the natural sciences and the social sciences, positivist commitments generated a number of methodological techniques designed to ensure the truth, not of propositions, but of scientific investigations. Chief among these is the dichotomous division of the world into the realms of the "empirical" and the "nonempirical." The empirical realm, comprising all that can be corroborated by the senses, is circumscribed as the legitimate sphere of scientific investigation. As a residual category, the nonempirical encompasses everything else—religion, philosophy, ethics, aesthetics, and evaluative discourse in general, as well as myth, dogma, and superstition—and is relegated beyond the sphere of science. Within this frame of reference, science, operating within the realm of the observable and restricting its focus to descriptions, explanations, and predictions that are intersubjectively testable, can achieve objective knowledge. The specific techniques requisite to the achievement of objective knowledge have been variously defined by positivism and critical rationalism.

On the grounds that only those knowledge claims founded directly upon observable experience can be genuine, positivists deployed the "verification criterion of meaning" to differentiate not only between science and nonscience, but between science and nonsense (Joergenson 1951; Kraft 1952; Ayer 1959). In the positivist view, any statement that could not be verified by reference to experience constituted nonsense: it was literally meaningless. The implications of the verification criterion for a model of science were manifold. All knowledge was believed to be dependent upon observation; thus any claims—whether theological, metaphysical, philosophical, ethical, normative, or aesthetic—that were not rooted in empirical observation were rejected as meaningless. The sphere of science was thereby narrowly circumscribed, and scientific knowledge was accredited as the only valid knowledge. In addition, induction, a method of knowledge acquisition grounded upon observation of particulars as the foundation for empirical generalizations, was taken to provide the essential logic of science.

The task of science was understood to comprise the inductive discovery of regularities existing in the external world. Scientific research sought to organize in economical fashion those regularities that experience presents in order to facilitate explanation and prediction. To promote this objective, positivists endorsed and employed a technical vocabulary, clearly differentiating facts (empirically verifiable propositions) and hypotheses (empirically verifiable propositions asserting the existence of relationships among observed phenomena) from laws (empirically confirmed propositions asserting an invariable sequence or association among observed phenomena) and theories (interrelated systems of laws possessing explanatory power). Moreover, the positivist logic of scientific inquiry dictated a specific sequence of activities as definitive of "the scientific method."

According to this model, the scientific method begins with the carefully controlled, neutral observation of empirical events. Sustained observation over time enables the regularities or patterns of relationships in observed events to be revealed and thereby provides for the formulation of hypotheses. Once formulated, hypotheses were to be subjected to systematic empirical tests. Those hypotheses which received external confirmation through this process of rigorous testing could be elevated to the status of scientific laws. Once identified, scientific laws provided the foundation for scientific explanation, which, according to the precepts of the "covering law model," consisted in demonstrating that the event(s) to be explained could have been expected, given certain initial conditions ($C_1, C_2, C_3, \ldots$) and the general laws of the field ($L_1, L_2, L_3, \ldots$). Within the framework of the positivist conception of science, the discovery of scientific laws also provided the foundation for prediction, which consisted in demonstrating that an event would occur given the future occurrence of certain initial conditions and the operation of the general laws of the field. Under the covering law model, then, explanation and prediction have the same logical form, but the time factor differs: explanation pertains to past events; prediction pertains to future events.

Positivists were also committed to the principle of the "unity of science," that is, to the belief that the logic of scientific inquiry was the same for all fields. Whether natural phenomena or social phenomena were the objects of study, the method for acquiring valid knowledge and the requirements for explanation and prediction remained the same. Once a science had progressed sufficiently to accumulate a body of scientific laws organized in a coherent system of theories, it could be said to have achieved a stage of "maturity" that made explanation and prediction possible. Although the logic of mature science remained inductive with respect to the generation of new knowledge, the logic of scientific explanation was deductive. Under the covering law model, causal explanation, the demonstration of the necessary and sufficient conditions of an event, involved the deductive subsumption of particular observations under a general law. In addition, deduction also played a central role in efforts to explain laws and theories: the explanation of a law involved its deductive subsumption under a theory; and explanation of one theory involved its deductive subsumption under wider theories.

CRITIQUES OF POSITIVISM

The primary postulates of positivism have been subjected to rigorous and devastating critiques (Popper 1959, 1972a, 1972b). Neither the logic of induction nor the verification criterion of meaning can accomplish positivist objectives; neither can guarantee the acquisition of truth. As Hume demonstrated, the inductive method is incapable of guaranteeing the validity of scientific knowledge because of the "problem of induction." Because empirical events are contingent, that is, because the future can always be different from the past, generalizations based upon limited observations are necessarily incomplete and, as such, highly fallible. For this reason, inductive generalizations cannot be presumed to be true. Nor can "confirmation" or "verification" of such generalizations by reference to additional cases provide proof of their universal validity. For, as Hume made clear, the notion of universal validity invokes all future, as well as all past and present, occurrences of a phenomenon; yet no matter how many confirming instances of a phenomenon can be found in the past or in the present, these can never alter the possibility that the future could be different, that the future could disprove an inductively derived empirical generalization. Thus, a demonstration of the truth of an empirical generalization must turn upon the identification of a "necessary connection" establishing a causal relation among observed phenomena.

The notion of necessary connection raises serious problems for an empirical account of science, however. If the notion of necessity invoked is logical necessity, then the empirical nature of science is jeopardized. If, however, positivism appeals to an empirical demonstration of necessity, it falls foul of the standard established by the verification criterion of meaning, for the "necessity" required as proof of any causal claim cannot be empirically observed. As Hume pointed out, empirical observation reveals "constant conjunction"; it does not and cannot reveal necessary connection. As a positivist logic of scientific inquiry, then, induction encounters two serious problems: it is incapable of providing validation for the truth of its generalizations, and it is internally inconsistent; any attempt to demonstrate the validity of a causal claim invokes a conception of necessary connection that violates the verification criterion of meaning.

The positivist conception of the scientific method also rests upon a flawed psychology of perception. In suggesting that the scientific method commences with "neutral" observation, positivists invoke a conception of "manifest truth," which attempts to reduce the problem of the validity of knowledge to an appeal to the authority of the source of that knowledge (for example, "the facts 'speak' for themselves"). The belief that the unmediated apprehension of the "given" by a passive or receptive observer is possible, however, misconstrues both the nature of perception and the nature of the world. The human mind is not passive but active; it does not merely receive an image of the given, but rather the mind imposes order upon the external world through a process of selection, interpretation, and imagination. Observation is always linguistically and culturally mediated. It involves the creative imposition of expectations, anticipations, and conjectures upon external events.

Scientific observation, too, is necessarily theory-laden. It begins not from "nothing," nor from the "neutral" perception of given relations, but rather from immersion in a scientific tradition that provides frames of reference or conceptual schemes that organize reality and shape the problems for further investigation. To grasp the role of theory in structuring scientific observation, however, requires a revised conception of "theory." Contrary to the positivist notion that theory is the result of observation, the result of systematization of a series of inductive generalizations, the result of the accumulation of an interrelated set of scientific laws, theory is logically prior to the observation of any similarities or regularities in the world; indeed, theory is precisely that which makes the identification of regularities possible. Moreover, scientific theories involve risk to an extent that is altogether incompatible with the positivist view of theories as summaries of empirical generalizations. Scientific theories involve risky predictions of things that have never been seen and hence cannot be deduced logically from observation statements. Theories structure scientific observation in a manner altogether incompatible with the positivist requirement of neutral perception, and they involve unobservable propositions that violate the verification criterion of meaning: abstract theoretical entities cannot be verified by reference to empirical observation.

That theoretical propositions violate the verification criterion is not in itself damning, for the verification criterion can be impugned on a number of grounds. As a mechanism for validating empirical generalizations, the verification criterion fails because of the problem of induction. As a scientific principle for demarcating the "meaningful" from the "meaningless," the verification criterion is self-referentially destructive. In repudiating all that is not empirically verifiable as nonsense, the verification criterion repudiates itself, for it is not a statement derived from empirical observation nor is it a tautology. Rigid adherence to the verification criterion then would mandate that it be rejected as metaphysical nonsense. Thus, the positivist conflation of that which is not amenable to empirical observation with nonsense simply will not withstand scrutiny. Much, including the verification criterion itself, that cannot be empirically verified can be understood, and all that can be understood is meaningful.

CRITICAL RATIONALISM

As an alternative to the defective positivist conception of science, Karl Popper advanced "critical rationalism" (1972a, 1972b). On this view, scientific theories are bold conjectures that scientists impose upon the world. Drawing insights from manifold sources in order to solve particular problems, scientific theories involve abstract and unobservable propositions that predict what may happen as well as what may not happen. Thus scientific theories generate predictions that are incompatible with certain possible results of observation; that is, they "prohibit" certain occurrences by proclaiming that some things could not happen. As such, scientific theories put the world to the test and demand a reply. Precisely because scientific theories identify a range of conditions that must hold, a series of events that must occur, and a set of occurrences that are in principle impossible, they can clash with observation; they are empirically testable. Although no number of confirming instances could ever prove a theory to be true, owing to the problem of induction, one disconfirming instance is sufficient to disprove a theory. If scientific laws are construed as statements of prohibitions, forbidding the occurrence of certain empirical events, then they can be definitively refuted by the occurrence of one such event. Thus, according to Popper, "falsification" provides a mechanism by which scientists can test their conjectures against reality and learn from their mistakes. Falsification also provides the core of Popper's revised conception of the scientific method.

According to the "hypothetico-deductive model," the scientist always begins with a problem. To resolve the problem, the scientist generates a theory, a conjecture, or hypothesis that can be tested by deducing its empirical consequences and measuring them against the world. Once the logical implications of a theory have been deduced and converted into predictions concerning empirical events, the task of science is falsification. In putting theories to the test of experience, scientists seek to falsify predictions, for that alone enables them to learn from their mistakes. On this view, the rationality of science is embodied in the method of trial and error, a method that allows error to be purged by eliminating false theories.

In mandating that all scientific theories be tested, in stipulating that the goal of science is the falsification of erroneous views, the criterion of falsifiability provides a means by which to reconcile the fallibility of human knowers with a conception of objective knowledge. The validity of scientific claims does not turn on a demand for an impossible neutrality on the part of individual scientists, on the equally impossible requirement that all prejudice, bias, prejudgment, expectation, or value be purged from the process of observation or on the implausible assumption that the truth is manifest. The adequacy of scientific theories is judged in concrete problem contexts in terms of their ability to solve problems and their ability to withstand increasingly difficult empirical tests. Those theories that withstand multiple intersubjective efforts to falsify them are "corroborated," identified as "laws" that with varying degrees of verisimilitude capture the structure of reality, and for that reason they are tentatively accepted as "true." But, in keeping with the critical attitude of science, even the strongest corroboration for a theory is not accepted as conclusive proof. For Popperian critical rationalism posits that truth lies beyond human reach. As a regulative ideal that guides scientific activity, truth may be approximated, but it can never be established by human authority. Nevertheless, error can be objectively identified. Thus informed by a conception of truth as a "regulative ideal" and operating in accordance with the requirements of the criterion of falsifiability, science can progress by the incremental correction of errors and the gradual accretion of objective problem-solving knowledge.

Although Popper subjected many central tenets of logical positivism to systematic critique, his conception of "critical rationalism" shares sufficient ground with positivist approaches to the philosophy of science that it is typically considered to be a qualified modification of, rather than a comprehensive alternative to, positivism (Stockman 1983). Indeed, Popper's conception of the hypothetico-deductive model has been depicted as the "orthodox" positivist conception of scientific theory (Moon 1975, 143–187). Both positivist and Popperian approaches to science share a belief in the centrality of logical deduction to scientific analysis; both conceive scientific theories to be deductively related systems of propositions; both accept a deductive account of scientific explanation; both treat explanation and prediction as equivalent concepts; and both are committed to a conception of scientific progress dependent upon the use of the hypothetico-deductive method of testing scientific claims (Stockman 1983, 76; H. Brown 1977, 65–75). In addition, both positivist and Popperian conceptions of science are committed to the "correspondence theory of truth" and its corollary assumption: the objectivity of science ultimately rests upon an appeal to the facts. Both are committed to institutionalizing the fact/value dichotomy in order to establish the determinate ground of science. Both accept that, once safely ensconced within the bounds of the empirical realm, science is grounded upon a sufficiently firm foundation to provide for the accumulation of knowledge, the progressive elimination of error, and the gradual accretion of useful solutions to technical problems. And although Popper suggested that reason could be brought

to bear upon evaluative questions, he accepted the fundamental positivist principle that, ultimately, value choices rested upon nonrational factors.

Most research strategies developed within the natural sciences and the social sciences in the twentieth century draw upon either positivist or Popperian conceptions of the scientific method. The legacy of positivism is apparent in behavioralist methods that emphasize data collection, hypothesis formulation and testing, and other formal aspects of systematic empirical enterprise, as well as in approaches that stress scientific, inductive methods, statistical models, and quantitative research designs. Likewise, the positivist legacy surfaces in conceptions of explanation defined in deductive terms and in commitments to the equivalence of explanation and prediction; it emerges in claims that social science must be modeled upon the methods of the natural sciences, for those alone are capable of generating valid knowledge. Moreover, evidence of positivism is unmistakable in the assumption that "facts" are unproblematic, that they are immediately observable or "given"; hence, their apprehension requires no interpretation. It is embodied in the presumption that either confirmation or verification provides a criterion of proof of the validity of empirical claims. And it is conspicuous in the repudiation of values as arbitrary preferences, irrational commitments, or meaningless propositions that lie altogether beyond the realm of rational analysis.

Popper's insistence upon the centrality of problem solving and incrementalism also resonates in many approaches to scientific inquiry and social analysis. Popperian assumptions surface in the recognition that observation and analysis are necessarily theory-laden, as well as in the commitment to intersubjective testing as the appropriate means by which to deflect the influence of individual bias from scientific studies. The Popperian assumptions are manifest in the substitution of testability for verifiability as the appropriate criterion for demarcating scientific hypotheses and in the invocation of falsification and the elimination of error as the strategy for accumulating knowledge. Popperian assumptions are obvious in the critique of excessive optimism concerning the possibility of attaining "absolute truth" about the world through the deployment of inductive, quantitative techniques, in the less pretentious quest for "useful knowledge," and in the insistence that truth constitutes a regulative ideal rather than a current possession of science. They are conspicuous in arguments that the hypothetico-deductive model is appropriate for scientific research and in appeals for developing a critical, nondogmatic attitude among researchers.

As we see in chapters 2 and 3, feminist scholars in the social and natural sciences, wrestling with positivist and critical rationalist conceptions of knowledge and scientific inquiry, have found them to be inaccurate accounts of actual research practices and obstructive to feminist efforts to generate scholarship that challenges androcentric bias. In attempting to break with the problematic assumptions of, and the limitations on, research practices associated with positivism and critical rationalism, feminist social scientists have gravitated toward a form of antifoundationalism explicated in recent post-positivist approaches in the philosophy of science.

POST-POSITIVIST PRESUPPOSITION THEORIES OF SCIENCE

Although Popper's critical rationalism significantly improves early positivist conceptions of science, it too suffers from a number of grave defects. The most serious challenge to critical rationalism has been raised by post-positivist presupposition theories of science (Polanyi 1958; Humphreys 1969; Suppe 1977; H. Brown 1977; Bernstein 1976, 1983; Hesse 1980; Longino 1990; Stockman 1983; Gunnell 1986, 1995, 1998). Presupposition theories of science concur with Popper's depiction of observation as "theory-laden." They agree that "there is more to seeing than meets the eye" (Humphreys 1969, 61) and that perception involves more than the passive reception of allegedly manifest sense-data. They suggest that perception depends upon a constellation of theoretical presuppositions that structure observation, accrediting particular stimuli as significant and specific configurations as meaningful. According to presupposition theories, observation is not only theory-laden but theory is essential to, indeed, constitutive of all human knowledge. Thus post-positivist presupposition theorists reject "instrumentalist" conceptions of theory, the view that theories are merely "tools" intentionally created to solve problems, consciously held, fully explicable, and easily abandoned when falsified. Instead, these theorists suggest that we live within theories, which structure our perceptions and understandings in ways that defy our conscious grasp. Operating at the tacit level, theories provide the criteria of intelligibility for the world and for ourselves.

Within recent work in the philosophy of science, the epistemological and ontological implications of the post-positivist understanding of theory have been the subject of extensive debate. Arguing that the theoretical constitution of human knowledge has ontological as well as epistemological implications, "antirealists" have suggested that there is no point in asking about the nature of the world independent of our theories about it (Laudan 1990). Consequently the truth status of theories must be bracketed. Echoing Hobbes, antirealists have insisted that theories need not be true to be good, that is, to solve problems (van Fraassen 1980; Churchland and Hooker 1985). Metaphysical "realists," however, have emphasized that, even if the only access to the world is through theories about it, a logical distinction can still be upheld between reality and how we conceive it, between truth and what we believe (Harre 1986). Hilary Putnam (1981, 1983, 1988, 1990) has advanced "pragmatic realism" as a more tenable doctrine. Putnam accepts that all concepts are theoretically constituted and culturally mediated and that the "world" does not "determine" what can be said

about it. Nonetheless, it makes sense on pragmatic grounds to insist that truth and falsity are not merely matters of decision and that an external reality constrains our conceptual choices. Following Putnam's lead, "scientific realists" have argued that scientific theories are referential in an important sense and as such can be comparatively assessed in terms of their approximations of truth (Glymour 1980; Newton-Smith 1981; Miller 1987).

While the debates among realists and antirealists about the criteria of truth and the nature of evidence are intricate and complex, both realists and antirealists share convictions about the defects of positivism and critical rationalism and accept the broad contours of presupposition theories of science. On this view, science, as a form of human knowledge, depends upon theory in multiple and complex ways. Presupposition theories of science suggest that the notions of perception, meaning, relevance, explanation, knowledge, and method, central to the practice of science, are all theoretically constituted concepts. Theoretical presuppositions shape perception and determine what is taken as a "fact"; they confer meaning on experience and control the demarcation of significant from trivial events; they afford criteria of relevance according to which facts can be organized, tests envisioned, and the acceptability or unacceptability of scientific conclusions assessed; they accredit particular models of explanation and strategies of understanding; and they sustain specific methodological techniques for gathering, classifying, and analyzing data. Theoretical presuppositions set the terms of scientific debate and organize the elements of scientific activity. Moreover, they typically do so at a tacit or preconscious level, and for this reason they appear to hold such unquestionable authority.

The pervasive role of theoretical assumptions upon the practice of science has profound implications for notions such as empirical "reality" and the "autonomy" of facts, which posit that facts are "given," and that experience is ontologically distinct from the theoretical constructs advanced to explain it. The post-positivist conception of a "fact" as a theoretically constituted entity calls into question such basic assumptions. It suggests that "the noun, 'experience,' the verb, 'to experience,' and the adjective 'empirical' are not univocal terms that can be transferred from one system to another without change of meaning. . . . Experience does not come labeled as 'empirical,' nor does it come self-certified as such. What we call experience depends upon assumptions hidden beyond scrutiny which define it and which in turn it supports" (Vivas 1960, 76). Recognition that "facts" can be so designated only in terms of prior theoretical presuppositions implies that any quest for an unmediated reality is necessarily futile. Any attempt to identify an "unmediated fact" must mistake the conventional for the "natural," as in cases that define "brute facts" as "social facts which are largely the product of well-understood, reliable tools, facts that are not likely to be vitiated by pitfalls . . . in part [because of] the ease and certainty with which [they] can be determined and in part [because of] the incontestability of [their] conceptual base" (Murray 1983, 321). Alternatively, the attempt to conceive a "fact" that exists prior to any description of it, prior to any theoretical or conceptual mediation, must generate an empty notion of something completely unspecified and unspecifiable, a notion that will be of little use to science (Williams 1985, 138).

Recognition of the manifold ways in which perceptions of reality are theoretically mediated raises a serious challenge to not only notions of "brute data" and the "givenness" of experience but also the possibility of falsification as a strategy for testing theories against an independent reality. For falsification to provide an adequate test of a scientific theory, it is necessary that there be a clear distinction between the theory being tested and the evidence adduced to support or refute the theory. According to the hypothetico-deductive model, "theory-independent evidence" is essential to the very possibility of refutation, to the possibility that the world could prove a theory to be wrong. If, however, what is taken to be the "world," what is understood to be "brute data" is itself theoretically constituted (indeed, constituted by the same theory that is undergoing the test), then no conclusive disproof of a theory is likely. The independent evidence upon which falsification depends does not exist; the available evidence is preconstituted by the same theoretical presuppositions as the scientific theory under scrutiny (Moon 1975, 146; Brown 1977, 38–48; Stockman 1983, 73–76).

Contrary to Popper's confident conviction that empirical reality could provide an ultimate court of appeal for the judgment of scientific theories and that the critical, nondogmatic attitude of scientists would ensure that their theories were constantly being put to the test; presupposition theorists emphasize that it is always possible to "save" a theory from refutation. The existence of one disconfirming instance is not sufficient to falsify a theory because it is always possible to evade falsification on the grounds that future research will demonstrate that a counterinstance is really only an "apparent" counterinstance. Moreover, the theory-laden character of observation and the theory-constituted character of evidence provide ample grounds upon which to dispute the validity of the evidence and to challenge the design or the findings of specific experiments that claim to falsify respected theories. Furthermore, post-positivist examinations of the history of scientific practice suggest that, contrary to Popper's claim that scientists are quick to discard discredited theories, there is considerable evidence that neither the existence of counterinstances nor the persistence of anomalies necessarily lead to the abandonment of scientific theories. Indeed, the overwhelming evidence of scientific practice suggests that scientists cling to long-established views tenaciously, in spite of the existence of telling criticisms, persistent anomalies, and unresolved problems (Ricci 1984; Harding 1986).

Thus, it has been suggested that the "theory" that scientists themselves are always skeptical, nondogmatic, critical of received views, and quick to repudiate questionable notions has itself been falsified and should be abandoned.

The problem of falsification is exacerbated by the conflation of explanation and prediction in the Popperian account of science, for the belief that a corroborated prediction constitutes proof of the validity of a scientific explanation fails to recognize that an erroneous theory can generate correct predictions (Moon 1975, 146–47; H. Brown 1977, 51–57). The logical distinction between prediction and explanation thus further supports the view that no theory can ever be conclusively falsified. The problem of induction also raises doubts about the possibility of definitive refutations. In calling attention to the possibility that the future could be different from the past and present in unforeseeable ways, the problem of induction arouses the suspicion that a theory falsified today might not "stay" falsified. The assumption of regularity, which sustains Popper's belief that a falsified theory will remain falsified permanently, is itself an inductionist presupposition, which suggests that the falsifiability principle does not constitute the escape from induction that Popper had hoped (Stockman 1983, 81–82). Thus, despite the logical asymmetry between verification and falsification, no falsification can be any stronger or more final than any corroboration (H. Brown 1977, 75).

Presupposition theorists acknowledge that "ideally, scientists would like to examine the structure of the world which exists independent of our knowledge—but the nature of perception and the role of presuppositions preclude direct access to it: the only access available is through theory-directed research" (H. Brown 1977, 108). Recognition that theoretical presuppositions organize and structure research by determining the meanings of observed events, identifying relevant data and significant problems for investigation, and indicating both strategies for solving problems and methods by which to test the validity of proposed solutions, seriously challenges the correspondence theory of truth. Presupposition theory both denies that "autonomous facts" can serve as the ultimate arbiter of scientific theories and suggests that science is no more capable of achieving the Archimedean point or of escaping human fallibility than is any other human endeavor. Indeed, it demands acknowledgment of science as a human convention rooted in the practical judgments of a community of fallible scientists struggling to resolve theory-generated problems under specific historical conditions. Presupposition theory sustains an image of science that is far less heroic and far more human.

As an alternative to the correspondence theory of truth, presupposition theorists suggest a coherence theory of truth premised upon the recognition that all human knowledge depends upon theoretical presuppositions whose congruence with nature cannot be established conclusively by reason or experience.

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Theoretical presuppositions, rooted in living traditions, provide the conceptual framework through which the world is viewed; they exude a "natural attitude" that demarcates what is taken as normal, natural, real, reasonable, or sane, from what is understood as deviant, unnatural, utopian, impossible, irrational, or insane. In contrast to Popper's conception of theories as conscious conjectures that can be systematically elaborated and deductively elucidated, the notion of theoretical presuppositions suggests that theories operate at the tacit level. They structure "pre-understandings" and "pre-judgments" in such a way that it is difficult to isolate and illuminate the full range of presuppositions that affect cognition at any given time (Bernstein 1983, 113–67). Moreover, any attempt to elucidate presuppositions must operate within a "hermeneutic circle." Any attempt to examine or to challenge certain assumptions or expectations must occur within the frame of reference established by the other presuppositions. Certain presuppositions must remain fixed if others are to be subjected to systematic critique. This does not imply that individuals are "prisoners" trapped within the framework of theories, expectations, past experiences, and language in such a way that critical reflection becomes impossible (Bernstein 1983, 84). Critical reflection upon and abandonment of certain theoretical presuppositions is possible within the hermeneutic circle; but the goal of transparency, of the unmediated grasp of things as they are, is not. For no reflective investigation, no matter how critical, can escape the fundamental conditions of human cognition.

A coherence theory of truth accepts that the world is richer than the theories devised to grasp it; it accepts that theories are underdetermined by "facts" and, consequently, that there can always be alternative and competing theoretical explanations of particular events. It does not, however, imply the relativist conclusion that all theoretical interpretations are equal. That there can be no appeal to neutral, theory-independent facts to adjudicate between competing theoretical interpretations does not mean that there is no rational way of making and warranting critical evaluative judgments concerning alternative views. Indeed, presupposition theorists have pointed out that the belief that the absence of independent evidence necessarily entails relativism itself depends upon a positivist commitment to the verification criterion of meaning. Only if one starts from the assumption that the sole test for the validity of a proposition lies in its measurement against the empirically "given" does it follow that, in the absence of the "given," no rational judgments can be made concerning the validity of particular claims (Bernstein 1983, 92; H. Brown 1977, 93–94; Stockman 1983, 79–101; Gunnell 1986, 66–68).

Once the "myth of the given" (Sellars 1963, 164) has been abandoned and once the belief that the absence of one invariant empirical test for the truth of a theory implies the absence of all criteria for evaluative judgment has been repudiated, then it is possible to recognize the rational grounds for assessing the merits of alternative theoretical interpretations. To comprehend the nature of such assessments it is necessary to acknowledge that, although theoretical presuppositions structure the perception of events, they do not create perceptions out of nothing. Theoretical interpretations are "world-guided" (Williams 1985, 140). They involve both the preunderstanding brought to an event by an individual perceiver and the stimuli in the external (or internal) world which instigate the process of cognition. Because of this dual source of theoretical interpretations, objects can be characterized in many different ways, "but it does not follow that a given object can be seen in any way at all or that all descriptions are equal" (Brown 1977, 93). The stimuli that trigger interpretation limit the class of plausible characterizations without dictating one absolute description.

Assessment of alternative theoretical interpretations involves deliberation, a rational activity which requires that imagination and judgment be deployed in the consideration of the range of evidence, and arguments that can be advanced in support of various positions. The reasons offered in support of alternative views marshal evidence, organize data, apply various criteria of explanation, address multiple levels of analysis with varying degrees of abstraction, and employ divergent strategies of argumentation. This range of reasons offers a rich field for deliberation and assessment. It provides an opportunity for exercising judgment and ensures that scientists reject a theory only because they believe they can demonstrate that the reasons supporting that theory are deficient. That the reasons advanced to sustain the rejection of one theory do not constitute absolute proof of the validity of an alternative theory is simply a testament to human fallibility. Admission that the cumulative weight of current evidence and compelling argument cannot protect scientific judgments against future developments, which may warrant the repudiation of those theories currently accepted, is altogether consonant with the recognition of the finitude of human rationality and the contingency of empirical relations.

Presupposition theorists suggest that any account of science, which fails to accredit the rationality of the considered judgments that inform the choice between alternative scientific theories, must be committed to a defective conception of reason. Although the standards of evidence and the criteria for assessment brought to bear upon theoretical questions cannot be encapsulated in a simple rule or summarized in rigid methodological principles, deliberation involves the exercise of a range of intellectual skills. Conceptions of science that define rationality in terms of one technique, be it logical deduction, inductive inference, or empirical verification, are simply too narrow to encompass the multiple forms of rationality manifested in scientific research. The interpretive judgments, characteristic of every phase of scientific investigations and culminating in the rational choice of particular scientific theories on the basis of the cumulative weight of evidence and argument, are too rich and various to be captured by the rules governing inductive or deductive logic. For this reason, the Aristotelian conception of *phronesis*, practical reason, manifested in the processes of interpretation and judgment, is advanced by some presupposition theorists as an alternative to logic as the paradigmatic form of scientific rationality (H. Brown 1977, 148–52; Bernstein 1983, 54–78).

Presupposition theorists suggest that a conception of practical reason more accurately depicts the forms of rationality exhibited in scientific research. In contrast to the restrictive view advanced by positivism that reduces the arsenal of reason to the techniques of logic and thereby rejects creativity, deliberative judgment, and evaluative assessment as varying forms of irrationality, *phronesis* constitutes a more expansive conception of the powers of the human intellect. Presupposition theorists suggest that a consideration of the various processes of contemplation, conceptualization, representation, remembrance, reflection, speculation, rationalization, inference, deduction, and deliberation (to name but a few manifestations of human cognition) reveals that the dimensions of reason are diverse. They also argue that an adequate conception of reason must encompass these diverse cognitive practices. Because the instrumental conception of rationality advanced by positivists is clearly incapable of accounting for these various forms of reason, it must be rejected as defective. Thus, presupposition theorists suggest that science must be freed from the parochial beliefs that obscure reason's diverse manifestations and restrict its operation to the rigid adherence to a narrow set of rules. The equation of scientific rationality with formal logic must be abandoned not only because there is no reason to suppose that there must be some indubitable foundation or some ahistorical, invariant method for scientific inquiry in order to establish the rationality of scientific practices, but also because the belief that science can provide final truths cannot be sustained by the principles of formal logic, the methods of empirical inquiry, or the characteristics of fallible human cognition. Phronesis constitutes a conception of rationality that can encompass the diverse uses of reason in scientific practices, identify the manifold sources of potential error in theoretical interpretations, and illuminate the criteria of assessment and the standards of evidence and argument operative in the choice between alternative theoretical explanations of events. As a conception of scientific rationality, then, phronesis is more comprehensive and has greater explanatory power than the discredited positivist alternative.

Presupposition theorists offer a revised conception of science that emphasizes the conventional nature of scientific practices and the fallible character of scientific explanations and predictions. Confronted with a world richer than any partial perception of it, scientists draw upon the resources of tradition and imagination in an effort to comprehend the world before them. The theories they devise to explain objects and events are structured by a host of presuppositions

concerning meaning, relevance, experience, explanation, and evaluation. Operating within the limits imposed by fallibility and contingency, scientists employ creative insights, practical reason, formal logic and an arsenal of conventional techniques and methods in their effort to approximate the truth about the world. But their approximations always operate within the parameters set by theoretical presuppositions; their approximations always address an empirical realm that is itself theoretically constituted. The underdetermination of theory by data ensures that multiple interpretations of the same phenomena are possible.

When alternative theoretical explanations conflict, the judgment of the scientific community is brought to bear upon the competing interpretations. Exercising practical reason, the scientific community deliberates upon the evidence and arguments sustaining the alternative views. The practical judgment of the practitioners in particular fields of science is exercised in examining presuppositions, weighing evidence, replicating experiments, examining computations, investigating the applicability of innovative methods, assessing the potential of new concepts, and considering the validity of particular conclusions. Through a process of deliberation and debate, a consensus emerges among researchers within a discipline concerning what will be taken as a valid theory. The choice is sustained by reasons that can be articulated and advanced as proof of the inadequacy of alternative interpretations. The method of scientific deliberation is eminently rational: it provides mechanisms for identifying charlatans and incompetents, as well as for recognizing more subtle errors and more sophisticated approximations of truth. But the rationality of the process cannot guarantee the eternal verity of particular conclusions. The exercise of scientific reason is fallible; the judgments of the scientific community are corrigible.

The revised conception of science advanced by presupposition theorists suggests that attempts to divide the world into ontologically distinct categories of "facts" and "values," or into dichotomous realms of the "empirical" and the "normative," are fundamentally flawed (Hawkesworth 1988). Such attempts fail to grasp the implications of the theoretical constitution of all knowledge and the theoretical mediation of the empirical realm. They fail to come to grips with valuative character of all presuppositions and the consequent valuative component of all empirical propositions. In the theoretically mediated world description, explanation, and evaluation are inextricably linked. Any attempt to impose a dichotomous relation upon such inseparable processes constitutes a fallacy of false alternatives, which is as distorting as it is logically untenable. For the suggestion that "pure" facts can be isolated and analyzed free of all valuation masks the theoretical constitution of facticity and denies the cognitive processes through which knowledge of the empirical realm is generated. Moreover, the dichotomous schism of the world into "facts" and "values" endorses an erroneous and excessively limiting conception of human reason; this conception fails both to comprehend the role of practical rationality in scientific deliberation and to recognize that science is simply one manifestation of the use of practical reason in human life. Informed by flawed assumptions, the positivist conception of reason fails to understand that phronesis is operative in philosophical analysis, ethical deliberation, normative argument, political decisions, and the practical choices of daily life as well as in scientific analysis. Moreover, in stipulating that reason can operate only in a naïvely simple, "value-free," empirical realm, the positivist presuppositions that inform the fact/value dichotomy render reason impotent and thereby preclude the possibility that rational solutions might exist for the most pressing problems of the contemporary age.

Although the arguments that have discredited positivism are well known to philosophers, they have had far too little impact upon contemporary research practices in the natural and social sciences, where dominant paradigms remain positivist. This is especially unfortunate because the critique of positivism has wide-ranging implications, especially concerning the politics of knowledge. The post-positivist conception of knowledge suggests that theoretical assumptions have a pervasive influence upon our understandings of the world by accrediting contentious definitions of phenomena and validating particular strategies of inquiry while invalidating others. Moreover, positivist assumptions mask the controversial character of evidence adduced and the contestability of accredited strategies of explanation. Rather than providing a faithful method for the acquisition of truth, defective positivist assumptions themselves become a source of error shielded from scrutiny.

Post-positivist conceptions of science open new areas of investigation concerning sources of error within the presuppositions of particular research practices that have been particularly helpful to feminist researchers. Feminist scholars have explored androcentric presuppositions of particular research methods. They have probed the limitations imposed upon the constitution of knowledge within male-dominant disciplines. They have investigated the mechanisms by which androcentric accounts of the world have been accredited and rendered unproblematic. They have questioned the adequacy of standards of evidence, modes of analysis, and strategies of explanation privileged by dominant traditions. They have demonstrated how accredited methodologies subtly circumscribe our understanding of women's lives as well as raced and gendered practices within the world.

By illuminating the political implications of determinate modes of inquiry, feminist scholars have demonstrated that the politics of knowledge is a legitimate focus of analysis, for the analytic techniques developed in particular cognitive traditions have political consequences that positivist precepts render invisible. In circumscribing the subject matter appropriate to "science," restricting the activities acceptable as "empirical inquiry," establishing the norms for assessing the

results of inquiry, identifying the basic principles of practice, and validating the ethos of practitioners, methodological strictures may sustain particular modes of life that entrench oppressive practices. Throughout the past three decades, feminist scholars have attempted to grapple with the politics of knowledge production across the disciplines. Chapters 2, 3, and 4 examine their efforts to debunk myths of neutrality, problematic conceptions of objectivity, and defective models of scientific method. They also explore feminist debates about the prospects for deploying an antifoundationalist conception of truth in interdisciplinary feminist research practices.