is science value free?

values and scientific understanding

Is Science Value Free?

> 'Hugh Lacey's book gives a careful and well-rounded treatment of the unceasingly topical and controversial question of the role of values in scientific inquiry. It is a particular virtue of the book that it combines a treatment of the epistemological and methodological debates with an engagement in more substantive questions about whose values may or may not be socially well placed to inform science, and about science's role in international development'
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> Miranda Fricker, Heythrop College

The view that science is value free has been challenged from a number of different sides, including post-modernists, feminists, radical ecologists, third-world advocates and religious fundamentalists.

In this book, Hugh Lacey explicates and appraises the view that science is value free. Lacey discusses how science and values interact, with a focus on a discussion of development and science's place in development—particularly in third-world countries.

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Is Science Value Free? gives us a refreshing and intriguing account of how we see and study science. Anyone interested in science and the philosophy of science will find this book an invaluable read.

Hugh Lacey is Professor of Philosophy at Swarthmore College. He is also the co-author (with Barry Schwartz) of *Behaviorism, Science, and Human Nature*.

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For Maria Ines, Andrew and Daniel

Like last summer's tomato harvest and many good things, this book is a product of living in our new home.

Contents

Preface

This book aims to explicate and appraise the view that science is value free: making a contribution both to analytical philosophy of science and (more speculatively) to substantive moral reflection on the place of science in contemporary society. Regarding the latter, I have discussed how science and values interact, keeping an eye toward discussions of "development," and the place of science in it, that are taking place in many "third-world" countries.

Only in passing (and through the intermediary of interlocutors whom I identify in the text) do I interact with other philosophical perspectives that discuss the interaction of values and scientific understanding, namely: critical theory, phenomenology, post-structuralism, pragmatism and social studies of science. This reflects my personal biography, not a judgment that important insights into the issues cannot be obtained from these perspectives. I hope that the readers of the book will bring my arguments into interaction with theirs.

In order to focus on my chosen themes—scientific understanding, values, and the relations between them—I have inevitably had to short-change others, concerning which of mine have presuppositions and implications. Thus, for example, I have skipped over issues about the nature of scientific theories and about how to interpret them (realism, empiricism, constructivism); and about whether scientific knowledge should be regarded as the possession of individuals or groups of individuals as social or as belonging to an abstract domain. While my arguments are intended to be independent of where one stands on the issues I do not discuss, I have not been able to develop an idiom that is completely neutral with respect to them. Throughout the book, I have used a *realist idiom,* and, except when explicitly noted, I discuss the objectives of science in *broadly realist terms*. My intention is not so much to endorse realist interpretations of science, as to show that, even with realist interpretations, which are usually bearers of the idea of science as value free, important criticisms of it can arise. I am confident that my arguments can readily be restated within, for example, empiricist perspectives. Moreover, their force does not depend upon adopting any controversial conception of the nature of scientific theories,

other than that generally the acceptance of theories is of specified domains of phenomena. Thus, I believe, my arguments can be stated (criticized and appraised) without entering into current controversies about the nature of theories and realist (and other) interpretations of science.

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In several chapters, I have drawn upon previously published work which has been in most cases significantly rewritten and developed. Parts from Lacey and Schwartz (1996) "The formation and transformation of values," in W.O'Donohue and R.Kitchener (eds) (1996) *The Philosophy of Psychology,* London: Sage, are reprinted in Ch. 2 by permission of Sage

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1
Introduction
The idea that science is value free

The idea that the sciences are value free has long played a key role in the self-understanding and the public image of modern science. Poincaré, writing early in this century, captured its core as follows:

> Ethics and science have their own domains, which touch but do not interpenetrate. The one shows us to what goal we should aspire, the other, given the goal, teaches us how to attain it. So they never conflict since they never meet. There can be no more immoral science than there can be scientific morals.
>
> (Poincaré 1920/1958:12)

Science and values only touch; they do not interpenetrate. To deny this is often perceived as to challenge that science is the pre-eminent or exemplary rational endeavor, to demean the cognitive credentials of science and to undercut its claim to produce knowledge. Lately, however, it has been much contested from an eclectic variety of viewpoints: feminism, social constructivism, pragmatism, deep ecology, fundamentalist religions, and a number of third world and indigenous people's outlooks. Exactly what is at issue does not always emerge clearly in these contestations. The rhetoric tends to be at high volume, but the argument thin. Incommensurability seems to reign. From one viewpoint, the mounting threat of multiple irrationalities and empty voluntarism looms large; from the other, the entrenchment of ideologies.

I will attempt to sort out what is at stake in the contestation of "science is value free," an idea that incorporates several distinct views about ways in which science and values do (ought) not interpenetrate. But those who affirm it have always recognized Poincaré's distinction, and held that science and values touch in various ways with more or less significant effects. Too often the critics point only to aspects of the touch, but even when the focus is on alleged interpenetrations a further ambiguity arises. For "science is value free" in general hardly represents a fact. Perhaps it represents an idealization of fact.[1] It also represents a value, a goal or aspiration of scientific practices and a criterion for appraising its

products and their consequences. The fact and value components cannot be separated. To the extent that "science is value free" represents a fact, or an idealization of a fact, that is because "science is value free" has been held as a value; and its being held as a value is without foundation if it is not possible for it to be increasingly manifest in fact. Thus to refute "science is value free" it is not enough to display cases where it is not manifested in fact; rather, the cognitive resources of the practices of science must be assessed for their ability and likelihood to bring about its manifestations increasingly and systematically.

In this introductory chapter I will provide an overview of the various sources of the idea that science is value free, leading to the proposal that it should be regarded as constituted by three component views: *impartiality, neutrality* and *autonomy*. Then I will outline some of the important ways in which science and values may interact without (from the proponents' viewpoint) the idea being challenged. Finally I will preview the focus, argument and methodology of the book.

SOURCES

"Science is value free" has several sources. Its kernel is present already in the works of Galileo and Bacon. Galileo (1623/1957:270) refers to "the facts of Nature, which remains deaf and inexorable to our wishes"; and Bacon affirms, warning us to be alert to the "Idols of the mind," the sources of error to which we are prone: "The human understanding is no dry light, but receives an infusion from the will and affections; whence proceed sciences which may be called 'sciences as one would'" (Bacon 1620/1960: Aphorism 49).

Metaphysical/Galilean

The Galilean input to the idea of science as value free is metaphysical. It leads to:"…the discarding by scientific thought of all considerations based upon value-concepts, such as perfection, harmony, meaning and aim, and finally the utter devalorization of being, the divorce of the world of value from the world of facts" (Koyré 1957:4).

Let me summarize it in contemporary dress. The world, "the facts of nature," the spatio-temporal totality, is fully characterizable and explicable

in terms of "its underlying order"—its underlying structures, processes and laws. All objects belonging to the underlying order can be fully characterized in quantitative terms; all interactions are lawful; and the laws (not necessarily deterministic) are expressible in mathematical equations. Such objects are not construed as objects of value. *Qua* objects of the underlying order, they are part of no meaningful order, they have no natural ends, no developmental potentials, and no essential relatedness to

human life and practices. Values—and objects, *qua* objects of value—are not represented as emergent from the underlying order of the world.

An object may come to acquire value through its relationship to human experience, practice, or social organization, but any role it plays there is played in virtue of its causal powers, of what it is *qua* part of the underlying order of the world, so that for explanatory purposes that it may have acquired value is irrelevant. Since human beings are part of the world, some of the historically contingent states of affairs in the world will be a consequence of human causal agency. But, the view maintains, the structures, processes and laws that make up the underlying order of the world are ontologically independent of human inquiry, perception and action; they do not vary with the theoretical commitments, outlooks, interests or values of investigators. On this view, it is a "fact" that value derives from an object's relationship to human experience, practice or social organization (that human agents generate value), and so this "fact" is explicable, in principle, in terms of underlying structure, process and law. But it does not follow from a theory that explains this "fact" that human agents themselves are objects of value.

The underlying order of the world, and its constituent entities, are simply there to be discovered—the world of pure "fact" stripped of any link with value (MacIntyre 1981:80–1). The aim of science is to represent this world of pure "fact," the underlying order of the world, independently of any relationship it might bear contingently to human practices and experiences. Such representations are posited in theories which, in order to be faithful to the object of inquiry, must deploy only categories devoid of evaluative content or implications. Thus, they must not use categories that can be applied to things only in virtue of their being related to human experiences or practices. Concretely, simplifying a little, this means using in theories only quantitative concepts, or more generally, materialist concepts (those that designate properties of material objects *qua* material objects, not *qua* related to human experience) and, in any case, no teleological, intentional or sensory concepts.

Thus we arrive at one dimension of the idea of the "neutrality" of science: scientific theories have no value judgments among their logical implications. They cannot, it is said, for they contain no value categories. A second dimension is often taken to follow: that accepting a theory has no cognitive consequences at all concerning the values one holds. A third dimension is suggested too: that scientific theories are available to be applied so as to further projects linked with any values. After all, they represent "fact" about the world, which can—so far as science is concerned—be related to, or come to serve the interests of any values whatever. If in fact they do not serve to inform the projects motivated by particular values, that is an entirely contingent matter. Notice that this last claim rests uneasily with another that has been heralded in the modern scientific

tradition, that science serves especially well the projects of material progress; and it clashes strongly with those world-views (that "progress" intends to supplant) that consider the world to be infused with meaning or value.

Epistemological and methodological/Baconian

In contrast to the Galilean, the Baconian source is epistemological and methodological. Again I summarize a contemporary version. It is through experience that we gain access to the world, which can be considered a complex repository of possibilities, of which the ones that are realized may be (increasingly) connected with our practices and our planned interventions. But the world is not generally what we would have it be. Not everything that we desire or imagine to be possible is among the world's repository of possibilities. Considerations derived from values cannot determine what is possible. We find out what is possible only in the course of engagement with the world, through successful practices, including most importantly experimental ones. A scientific theory aims to encapsulate whatever it can of this repository of possibilities of the domains of phenomena within its compass; hence, the centrality in methodology of experiment.

Sound scientific knowledge, that which we can count on for practical adoption, is rooted in replicability and agreement. Only what is observed, especially in experimental settings, and certified by replication and agreement—independently of our desires, value perspectives, cultural and institutional norms and presuppositions, expedient alliances and their interests—can properly serve as evidence for scientific posits and for choosing among scientific theories. As Hempel puts it: "The grounds on which scientific hypotheses are accepted or rejected are provided by empirical evidence, which may include observational findings as well as previously established laws and theories, but surely no value judgments" (Hempel 1965:91). This is one of the sources of the idea of the "impartiality" of science, an idea concerning the proper grounds for accepting scientific posits or making scientific judgments.

The Baconian source of *impartiality* is often complemented by a view about the nature of scientific inference, or about how empirical data are related to theories so that they can serve as evidence for accepting theoretical posits, or choosing which theories to accept. The view is that scientific inference can be reconstructed in terms of accordance with certain formal rules (Chapter 3). The rules mediate between empirical data and theories in such a way that following them leads to unambiguous choices about which theories to accept, reject or deem as requiring further investigation, or at least to unambiguous assignments of degrees of confirmation to theoretical hypotheses. They provide, as it were, the means

to transfer intersubjective acceptance from the available data to the theory. While there has been at times widespread agreement that scientific inference, and any rational inference, can be explicated in terms of formal rules, there has never been anything approaching unanimity about what the rules are, or even about whether they are deductive, abductive, statistical, inductive, or some combination of these. Bacon himself is usually interpreted as holding that they are inductive.

The general view (though not any particular account of what the rules are) became reinforced with the logical empiricists' and critical rationalists' distinction between the contexts of discovery and justification, and thence with holding the rule-governed account of scientific inference to apply only in the context of justification. Oversimplifying: a theory is properly accepted (or justified) if and only if it is related to the data in accordance with the rules. Values (and, for example, metaphysics) may play a role in the process of discovery in the course of generating and exploring the merits of the theory, but they can have nothing to do with assessments of its proper acceptance. As Carnap (1928/1967: xvii) put it, after conceding a role to "emotions, drives, dispositions and general living conditions" in the process of discovery:"…for the justification of a thesis the physicist does not cite *irrational factors* [my emphasis], but gives a purely empirical-rational justification."

The success of modern science

Both *neutrality* and *impartiality* concern the content of what is posited in scientific theories: *neutrality,* its implications and consequences; *impartiality,* the grounds for accepting it. One derives from "objectivity," representing faithfully the object of inquiry; the other from "intersubjectivity" as a condition on empirical inquiry. In practice, the two ideas tend to fuse.[2] In order that there be any scientific knowledge, the Galilean idea needs to be complemented with a methodology (or procedures that can give it empirical content); and, methodologically, since objectivity cannot be had directly, intersubjectivity seems to be the best available substitute. Conversely, Baconian methodology is deployed characteristically in testing theories that meet requirements derived from the Galilean idea, although the Baconian idea itself encompasses any inquiry that is systematic and empirical (Chapters 5 and 8).

The fusion of the Galilean and Baconian ideas underlies the manifest success of modern science. Bacon promised that utility would follow from deploying his methodology. That is not what I have directly in mind. Rather it is the manifest success of modern science in increasing "the stock of knowledge." One may identify this success primarily in terms of the discovery of objects (for example atoms, electromagnetic radiation, viruses, genes) or of the definitive entrenchment of some relatively circumscribed

theories (for example the heliocentric theory of planetary motion, theories of molecular chemistry, theories of the bacterial and viral causation of diseases, theories that explain the workings of instruments). Such knowledge, of course, has been widely applied in practice: in technology, in medicine, in interpreting various phenomena of the world of daily experience; and, successful application is powerful confirming evidence in support of the knowledge. Items in the stock of knowledge have been accepted in accordance with *impartiality* and so their cognitive claims are compelling regardless of what values one holds. The sustained success of modern science, as it were, speaks unambiguously to the strength (but not to the certainty or unrevisability) of its cognitive claims.

A claim that is accepted in accordance with *impartiality* is binding regardless of the values that are held—so that the presuppositions of all practices, and the beliefs that inform all actions, should (rationally) all be made consistent with it.[3] This "binding equally" should not be confused with what I have earlier called "neutrality" with its three dimensions: "consistent with all value judgments," "no (cognitive) consequences in the realm of values," "evenhandedly applicable regardless of values held"; nor with the stronger view (Chapter 3) that all practices and actions, regardless of the values they are intended to further, should be informed by scientific knowledge to the extent possible. *Neutrality* presupposes *impartiality;* and, when the Galilean and Baconian ideas are fused—especially if the metaethical and logical views described in the next two subsections are endorsed—it may appear that *impartiality* implies *neutrality*. But, I will argue (Chapter 4) "binding equally" is not consistent with endorsing all three strands of the idea of *neutrality;* and subsequent attempts to revise *neutrality* into a coherent thesis confront numerous difficulties.

Metaethical

Components of both *neutrality* and *impartiality* have been held to gain further credibility from a widespread metaethical view: that values represent subjective phenomena, preferences or utilities so that "value judgments" are considered to be only articulations of personal preferences not open to rational appraisal. As such, value judgments lack truth value: "…they do not express assertions" (Hempel 1965:86). A person's making them is open to scientific investigation and explanation, but not fundamentally to critical evaluation. On this view, they cannot be among a theory's logical implications, not just on the ground that theories lack value categories, but because (lacking truth value) no proposition at all can have them among its entailments. Similarly, a value judgment, in principle, cannot cognitively affect either empirical data or scientific inferences.

Logical

Closely connected with the metaethical source is a logical view: statements of fact do not entail statements of value (Hume 1739/1968); and statements of value do not entail statements of fact (Bacon's Aphorism 49, quoted on p. 2). The metaethical view is often thought to explain the logical; but the latter may be entertained in combination with other views about the nature of values. The Galilean idea may be seen as a particular instance of the general Humean schema: "Fact does not imply value," but the argument sketched for it there does not depend on affirming the general schema. The metaphysical source is independent of the logical source, and arguments (Bhaskar 1979; Margolis 1995; Murdoch 1992; Midgley 1979; Putnam 1978, 1981, 1987, 1990; Scriven 1974) against the logical view may leave the metaphysical idea untouched. On the other hand, the Baconian schema: "Value does not imply fact," seems to me to be correct and not dependent on accepting the above metaethical view. It is, however, consistent with values having implications about the interest or relevance of facts, and the adopting of values having factual presuppositions.

Both the Humean and Baconian schemata, however, draw attention away from some other logical relations involving fact and value. From fact (especially as it is represented in scientific theory) one can infer certain matters about what is possible and impossible. And judgments of value (Chapter 2) have presuppositions about what is possible and impossible. Here, at least, is an avenue through which fact and value may logically interact with important implications for working out the idea of neutrality in detail.

Practical and institutional

The fundamental sources of the idea of science as value free are those from metaphysics (ontological primacy of underlying structure, process and law), epistemology (intersubjectivity of data, rule-bound scientific inference) and methodology (centrality of experiment), and success in producing knowledge. The currency of the metaethical and logical views has provided reinforcement, rhetorically of service, but inessential. So far I have considered the idea as being about the content and consequences of scientific theoretical products, and about the character of scientific assessment and knowledge claims.

But science should not be identified with its theories. We do not grasp enough of the character of scientific theories if we abstract them from the processes in which they are generated, tested, assessed, reproduced, transformed, interlinked with other theories, adopted in practice, transmitted and surpassed. Scientific theories are both products of and of

instrumental importance to *scientific practices,* and our cognitive attitudes toward theories are shaped within these practices. Members of the *scientific community* engage in these practices, which are made intelligible in the light of a long tradition; and they are conducted within various kinds of *scientific institutions*. These institutions, in turn, depend on other institutions in society at large for the provision of their necessary material and social conditions.

We can look at scientific theories from various points of view: the appropriate cognitive attitudes to hold toward them in virtue of their relations with empirical data; as products of a practice; as produced by practitioners who have certain characteristics (including qualifications and perhaps moral qualities); and as produced within certain types of institutions which express particular values, perhaps linked with those of the institutions that provide the material and social conditions needed for research or whose interests are best served by practical applications of scientific results. Since scientific practice must be conducted within institutions, the possibility of there being constraints on its conduct and outcomes, derived from the institution's interests and values, cannot be summarily excluded. The potential for tension with "science is value free" is obvious; not an idle potential, for sometimes it turns into outright conflict. I indicated an avenue on p. 7 whereby fact and value may interact through the intermediary of what is possible and impossible. A possibility presupposed by a valuative outlook (endorsed widely in society, in institutions that materially support science or by a significant political movement) may be confirmed to be impossible in a scientific theory Then, in the name of the values, there can be a strong motive to overrule the scientific claim. Or, more subtly, where such a conflict is incipient, the scientific community (consciously or not) may simply withhold from investigating the inconvenient possibility. My point is that it is quite intelligible that values intrude on the scientific claims that are heldwhether or not this intrusion is considered rationally admissible.

The idea that science is value free regards all such intrusion as distortion, and thus to be kept out of scientific practices:

> One of the strongest, if still unwritten, rules of scientific life is the prohibition of appeals to heads of state or to the populace at large in scientific matters. Recognition of a uniquely competent professional group and acceptance of its role as the exclusive arbiter of professional achievement has further implications. The group's members, as individuals and by virtue of their shared training and experience, must be seen as the sole possessors of the rules of the game or of some equivalent basis for unequivocal judgments.
>
> (Kuhn 1970:168)

Because there is an intelligible mechanism through which such intrusion can readily occur, counter-mechanisms need to be operative within scientific practice. Thus arises the further idea of the "autonomy" of the practices and institutions in which scientific theories are generated, entertained, tested and evaluated. In practice, according to this idea, *autonomy* is a condition for gaining *impartiality* of theoretical appraisal and *neutrality* of theoretical claims.

Autonomy tends to be a rather slippery idea—reflecting diverse and even contradictory currents—and one that is often and easily trivialized. At one level it is a *political* proposal: leave science to the scientists, but also provide them with the resources to conduct their inquiries with no strings attached. Appeals to *neutrality,* and to success in gaining knowledge and informing practical applications, are often made to support this proposal. It also presumes that the growth of scientific knowledge (and of the body of accepted theories that manifest *impartiality* and *neutrality)* will take place most effectively within practices that involve and are under the control of practitioners of the scientific community. A certain reading of the *history* of science might support this presumption. *Autonomy* also draws on the idea that science has its own internal dynamic, that science defines its own problems, asks its own questions, identifies its own research priorities, seeking to gain ever more accurate, more unified, more encompassing representations of the underlying order. The internal dynamic, it is said, responds only to the evidence and to the appropriate criteria of cognitive value. According to this view, in the long run the history of science is the unfolding of this internal dynamic, punctuated by moments of intrusion from outside values and interests which always retard the process.

The proposal for *autonomy* normally grants sole authority to the scientific community with regard not only to defining problems and appraising theories, but also to determining the qualifications required for membership in the scientific community, and deciding the content of science education. This draws on the *sociological* posits that members of the scientific community conduct their scientific practice motivated by the objectives of *impartiality* and *neutrality* or, more likely, that their activities are so structured that in the long run accord with *impartiality* and *neutrality* is virtually assured; and that scientific education adequately attunes them to accept as knowledge only that which accords with *impartiality*.

These posits are bolstered by the claim, common in the public image presented by the tradition of modern science, that the scientific community has successfully cultivated among its members in their conduct as scientists the "scientific ethos" (Merton 1957)[4], the practice of such virtues as honesty, disinterestedness, forthrightness in recognizing the contributions (and opening one's own contribution publicly to the rigorous scrutiny) of

others, humility and courage to follow the evidence where it leads. Clearly this is the stuff of which myths are made.

Autonomy is not easy to render in a precise thesis, and its historical and sociological presuppositions are open to further empirical investigation. It is better regarded, I think, as a reaction affirming a value in the face of unhappiness occasioned by its perceived rejection or subordination—a reaction that provides a ready and unthreatening explanation of why sometimes science has gone astray. The meaning of *autonomy* is shaped in opposition to troubling events, symbolized by the trial of Galileo, the horrors of Lysenkoism, the bemusing stubbornness of the creationists and, among some, also by the ready willingness of scientists to engage in classified research when called to do so for the sake of national security and to keep their results secret or legally limited in their use for the sake of corporate profits.

While the idea of autonomy arises as a reaction to certain kinds of "outside interferences," hinted at in symbols rather than specified sharply, there is one kind of "outside influence" that generally is tolerated, even overtly welcomed—when the institutions which fund and support science are granted an important role in determining research agendas, the problems to be investigated and the domains of phenomena to be studied. Where this happens (and it happens commonly enough) research priorities are generally not set according to the posited internal dynamic of science, but by negotiation with the bearers of non-scientific values and interests—typically for a practical reason. This need not undermine *impartiality,* though it may (Lewontin 1993), for the role of the values and interests may be restricted to the choice of research domain and need not extend to having impact on which specific theory comes to be accepted of that domain. We will see much later on p. 251 (Chapter 10) what impact it may have on *neutrality*. *Impartiality,* however, might be threatened if there was in fact an identity of (personal and social) interest among the scientific community and the agencies of support. The myth of the scientific ethos functions to deny that there are such identities of interest. Others counter that a greater diversity (of personal and social values and interests) among the practitioners of science would make a more convincing argument; but public pressure to bring about such greater diversity tends to be opposed in the name of *autonomy*.

It is a compromise of the idea of autonomy of scientific practice to grant a role to non-scientific values and interests in choosing a domain of investigation. I do not criticize such compromises *per se,* for scientific practice may be impossible without some of them (and less than complete manifestation of a value does not mean that it is not a seriously adopted value). However, in particular cases, I do criticize the choice from the perspective of other values. In its most compelling form, *autonomy* is claimed so that the responsibility of scientists—concerning *impartiality* and

neutrality—can be exercised. In a trivial form, which has become more common in recent years, it amounts to little more than the special plea to be free to enter into compromises with whatever agencies one sees fit, without regard to the broader social interests that may be affected by the choices.

Scientific method

The ideas about empirical data and scientific inference, often functioning in concert with the Galilean idea, may be put together under the idea that modern science has a *method*. The accepted theories of modern science are the product of following a method in which intersubjectivity and often constraints grounded in the Galilean metaphysical idea are the defining elements. The method matters; not who is following the method. I mentioned on p. 10 the related idea that the practitioners of science, insofar as they engage in scientific practice, are the bearers of the virtues of the scientific ethos. *Qua* bearers of these virtues they are interchangeable, reinforcing that who is following the method does not matter, subject to the condition that the practitioner has the relevant *competencies* (observational, experimental, mathematical, inferential, conceptual, theoretical) necessary to follow the method. "Method," as used here, pertains principally to how theories come to be properly accepted or appraised, not (except as a constraint) to how they come to be put forward and entertained in the first place; it is held to pertain to the context of justification, not that of discovery.

According to common views, the other side of method *is free creativity,* for that is what supposedly enables a theory to be put forward for consideration. (A theory is created; then it is appraised following the norms of the method.) In the "context of discovery," individuality is celebrated and no potential (conscious or unconscious) stimulus to creativity (which flourishes on analogies) including values, is ruled out a priori. Perhaps values can slip in here and play unnoticed roles. Theory appraisal is comparative: it involves choice among competing theories, but the competitors have first to be "created." Values may be hidden because a competing theory that would enable the values to become manifest may not have been "created." Intersubjective agreement, obtained through following the method, may not be enough to overcome this, especially if the agreement is among practitioners selected in a context where competence is the only explicitly recognized necessary requirement, and the assumption prevails that they embody the scientific ethos. For they, the "creative innovator," the research institution and its funders may share identical interests that, in the absence of tension derived from competing interests, may simply fall into the unproblematic and unrecognized background. Thus, it is possible that values are in play and not "noticed" because the intersubjective agreement

extends to include agreements about them. Here is a hint that who the practitioners are may matter.

Perhaps *impartiality* can be regularly achieved only if there is a diversity (with respect to values and interests) of practitioners in critical interaction and some diffusion of cognitive authority. "Method" may require clashing value perspectives rather than the activities of practitioners who act individually out of the scientific ethos.[5] Scientific appraisal may be communal or social: the product of interaction rather than the sum of individual acts of following the method (Longino 1990; Solomon 1992; 1994).

PERMISSIBLE INTERACTIONS BETWEEN SCIENCE AND VALUES

The ideas of impartiality, neutrality and autonomy sum up what I think is the core of the idea that science is value free. Endorsing them is compatible with values playing many roles in connection with science, most importantly: values may play decisive roles in connection with the stances adopted toward theories prior to their acceptance; cognitive values help to articulate the idea of impartiality; and the three ideas themselves function as values that may not always be well reflected in actual scientific practice.

Theories: acceptance, application, significance

Earlier, I have used expressions like "accepting" and "choosing" a theory. The idea that science is value free concerns characteristics of the theories that we accept and ought to accept, their consequences and the practices in which they are considered and come to be accepted. I will now introduce in some detail the key notion of "accepting a theory" (which is deployed frequently throughout the text) and distinguish it from several other stances that may be taken toward theories. Values may play a variety of roles in connection with the other stances.

Accepting theories

I will stipulate a usage[6] of "to accept a theory," and distinguish it from some other important stances that may be taken toward theories (hypotheses, proposals, posits, or conjectures): provisionally entertaining them, adhering to them in research practices, endorsing their greater evidential support (compared to rival theories) and applying them in practical life. A theory (T) is accepted of a domain (D) or domains of phenomena; one "accepts T of D."

To *accept T of D* is to judge that, in the light of the available evidence, T of D is sufficiently well supported that it need not be submitted to further investigation—where, for example, it is judged that further investigation can be expected only to replicate what has already been replicated many times over and to bring minor refinements of accuracy and sharper identification of the bounds of D. It is to consider it among the items. of rationally consolidated beliefs (Chapter 3) or to include it in the stock of knowledge so that *ceteris paribus* it is sufficiently well established to be applied to inform practical projects (pertaining to the phenomena of D). Acceptance is a strong stance to take toward a theory. It also always remains, in principle, open to revision that might be occasioned by new developments concerning either empirical data or theory. To *reject T of D D* is to accept T′ of D, where T and T′ are held to be inconsistent.

Accepting T (of D) is a stronger stance than *endorsing that,* on balance *the available evidence points more toward T than toward rival theories* that have been entertained, for then one anticipates that the balance may well be disrupted by further research including that which may provisionally entertain novel rival theories. Acceptance is a stance adopted when relevant research has become considered as effectively completed, like (ideally) in the cases mentioned (in the preceding section) as successes of modern science. In these cases it seems reasonable to maintain, and the consensus of the scientific community confirms, that further research will not could!—not lead to a change of judgment about T, except at the levels of refinement and meeting standards of accuracy. It involves (ideally) judging that the degree of evidential support is sufficiently high according to the highest available standards for estimating it, so that consistency with an approximation of T (of D) becomes a constraint upon any theory that has more encompassing scope than T (Joseph 1980). Accepting T (of D) is accompanied by a sort of (pragmatic) certitude, but that should not be confused with (epistemic) certainty.

Accepting a theory comes at the end of a process of research in which it has been developed from predecessors, which have been provisionally entertained and adhered to by committed investigators, and separated out from both their predecessors and other rival theories by way of numerous judgments of comparative evidential support or rational acceptability—acceptance of a theory follows (properly) after having made numerous theory choices. A theory (an early version of one that may eventually be accepted) may be *provisionally entertained* for the sake of exploring its implications, its potential to generate and solve problems, and its relationship with empirical data and with other theories. Generally this involves *endorsing the plausibility of* T: To hold that T provides conceptual and hypothetical resources sufficient to shape (reshape, contribute toward) a research agenda, and that the agenda is sufficiently promising to warrant material, financial and institutional support. In order

to be developed and reshaped into an acceptable form a theory must also be *adhered to,* that is, a research agenda framed by it must be participated in and commitment must be made to its furtherance.

Applying theories

Finally, accepting T (of D) is not the same thing as applying it. "Application" concerns the role of T in the realm of daily life and practical activity. T may not be applicable because D does not include significant phenomena of daily life and experience (Chapter 7) or because it cannot be deployed significantly in practices which express one's adopted value complex. To *apply* T, I stipulate, is to apply T *to* significant phenomena of daily life and experience and/or to apply it *in* practical activity. T is applied *to* phenomena when it is used (by way of providing representations of them with its categories and principles) to provide understanding of them—so that when the relevant phenomena of daily life are included in D, acceptance of T (of D) suffices to ensure its applicability to them. T is applied *in* practical activity when it is used to inform practical (often technological) activities related to the phenomena to which it applies concerning such matters as the workings of things, means to ends, the attainability of ends and the consequences of realizing the possible.

My usage of "apply" is more general than the one commonly associated with the phrase "applied science", which limits "apply" to the second component, that is, essentially to *technological applications,* when scientific knowledge is deployed as an instrument that informs effectively practical innovations in daily life, and particularly the development, introduction, operation and maintenance of technological devices and practices, where the outcomes of scientific inquiry become causal factors in transforming the social "world." On this common usage, the making and exploding of an atomic bomb is referred to as an application of physical theory, but explaining how the sun is a source of light and heat in terms of its thermonuclear activity is not. As a widespread and socially significant phenomenon technological application is relatively recent, dating from only about 150 years ago (White 1968), though applications of theories to explain the workings of technological objects, and theoretical reflection on technological objects as a source of scientific ideas, date at least from the time of Galileo, as do theoretical applications to numerous other phenomena of daily life and experience.

Significance of a theory

Clearly (moral and social) values must play a role when a theory is applied. No matter how strongly a theory is taken to be accepted it is applied only if applying it accords with one's values. One may apply a theory *to*

significant phenomena of daily life, but not *in* one's central practical activities. In the case of technological applications, a condition of (legitimately) applying T is the moral propriety of the intended consequences and the anticipated side effects. The highest degree of cognitive value is never sufficient to legitimate practical application, so that any move from acceptance to application in practical activity should always explicitly involve considerations of moral and social values. Accepting a theory does not imply the desirability or legitimacy of applying it practically, but only that there is no cognitive barrier to doing so. The legitimate applicability of a theory in practical activity requires support from one's adopted value complex.

I will say that T (of D) is *significant for specified values* if T is applicable *to* important phenomena of daily life and experience and/or is applicable *in* practical activities in ways that further (and do not undermine) the interests shaped from adherence to the values. A theory is more or less significant for given values; and it may be highly significant, for example, concerning applications to phenomena but not concerning applications in practical activities. Significance is a matter of degree, multifaceted and subject to historical variation, and it does not follow from acceptance (cf. Anderson 1995b).

The role of cognitive values

The idea of impartiality denies that value judgments are among the grounds for accepting and rejecting theories. But to accept or reject a theory is itself to make a judgment of *cognitive value* (worth, merit) (Scriven 1991). One interpretation of *impartiality* is that judgments of "non-cognitive" (personal, moral, social, aesthetic, etc.) value play no role in choosing theories. Another, drawing heavily from the metaethical and logical sources, wants to keep out all value judgments. It proposes to do so effectively by reducing theory appraisal to the recognition of the outcomes of rule-governed operations involving formal relations between theories and empirical data. I favor the first interpretation (Chapter 3), and I will develop it in detail (Chapters 4 and 10). Regardless of interpretation, however, to choose a theory is to grant it cognitive value, to affirm (at least) that it is a better theory than some other competitor. Such affirmations are intended to be "objective"; there is a fact of the matter about which theory has greater cognitive value, causing if not outright paradox at least perplexing tension with both the metaethical and logical views that partially ground the second interpretation (Scriven 1974, 1991; Putnam 1981).

It fits with the interpretation of *impartiality* that I favor that judgments of cognitive value can be construed as the outcomes of estimates of how well theories fare when appraised in the light of certain criteria (for

example, empirical adequacy, explanatory and predictive power), that is, estimates of how well theories manifest certain *cognitive values* (Chapter 3). "Science is value free," thus, should be considered compatible with the view that cognitive value judgments play essential roles in the accepting and rejecting of theories; it thus presupposes that cognitive values can be clearly distinguished from other kinds of values.

Throughout the book I will follow the *terminological convention* that the word "values," used without qualification, will mean "personal, moral, social and other values, but not cognitive values." I beg no questions of substance in doing so; should it be established that cognitive cannot be distinguished from other kinds of values the convention will have to be dropped—so too will *impartiality*. The role granted to cognitive values of course penetrates to the very heart of scientific practices. So long as no non-cognitive values penetrate in similar ways, there is nothing that the proponents of "science is value free" need regard as threatening.

Where science and values "touch": a miscellany

To use Poincaré's evocative words there are many places where science and values may touch but not interpenetrate. I will list some of what have been considered the more important places of "touch,"[7] without further comment, simply for the sake of clarifying what is, and what is not, at stake (for its proponents) in the idea that science is value free:

- Science itself is a value (not necessarily an unsubordinated one). This affirmation comes in many versions: knowledge (truth) is a value; science informs practices that produce value; its own practice requires the exercise of rationality, a universal value (Nagel 1961), or more generally, it cultivates in its practitioners characteristics that are conducive to human flourishing or well-being (Putnam 1981, 1990); it creates beauty (Poincaré 1920/1958).
- The making of value judgments, and relations among value judgments, can be informed (and criticized) by scientific knowledge of means to ends and the attainability of ends.
- There can be scientific (psychological, sociological, historical and perhaps biological) studies of values: Of their being held, manifested and embodied in persons, institutions and cultures, and of how particular values come to be held and transformed (Lacey and Schwartz 1996).
- There can be ethical evaluation of, and restrictions on, scientific practice and applications. There are, for example, ethical issues that arise in connection with the choice of research goals, the staffing of research activities, the selection of research methods (and experimental subjects), the specification of standards of proof, the dissemination of research findings, the control of scientific information, and the credit for research

accomplishments (Rescher 1965:274). Deploying a soundly accepted theory in practical application, its specific manner of application, and judgments about its "significance" reflect ethical evaluation. That a theory is sufficiently well supported to warrant its practical application, in view both of the "side effects" of applications (Scriven 1974) and of the risks of its application should it turn out to be false, involves ethical judgments (Rudner 1953).

- Values may play numerous roles (either positive or negative) in the "context of discovery," concerning judgments made in connection with the various stances that precede acceptance of a theory; in sensitizing researchers to the importance of certain facts; in motivating research efforts (Rescher 1965); and in assessing "scientific performances," such as carrying out experiments or writing papers (Scriven 1974).
- Values may play a role in connection with the compromises reached involving *autonomy* (discussed in the preceding section), for example concerning questions raised, research supported and problems selected; and in making judgments about whether a certain line of research should be carried out in view of probable applications that would follow.
- Commitment to certain values may motivate scrutiny of common scientific practices for "biases," focus on particular problems and policies regarding membership of the scientific community; there may be value-based criticism of scientific practices and institutions.
- The practices of science may require that their practitioners manifest certain personal and moral values (the "scientific ethos") and reinforce the valuing of certain personal traits (for example, creativity, mathematical and experimental capabilities). Since it has social and material conditions, it may progress, or its rate of progress may be affected at a given time, where particular social and personal values are dominant, and what these values are may vary with the historical moment (Hull 1988:76). It may also, for the sake of the fuller manifestation of *impartiality,* require that a variety of (social and moral) values be held among its many practitioners.
- The practitioners of science may incur special moral and social responsibilities in the light of their activities and discoveries.

Science as value free: fact, idealization, or value?

That science is value free, I repeat, does not mean that there is no interplay between science and values; only that what interplay there is leaves the three component views untouched. Thus, matters of values may illuminate all sorts of aspects of the practice, sociology, institutionalization and history of science. It is not enough to impugn that science is value free to display ways in which science and values "touch" each other.