

37. Fred E. Silverstein et al., "Gastrointestinal Toxicity with Celecoxib vs. Non-steroidal Anti-Inflammatory Drugs for Osteoarthritis and Rheumatoid Arthritis: The CLASS Study," *Journal of the American Medical Association* 284.10 (September 13, 2000): 1247–55.
38. Letters, *Journal of the American Medical Association* 286.19 (November 21, 2001): 2398–2400. The quotation from the FDA Web site appears on p. 2398.
39. David J. Graham et al. (n. 22 above), p. 480, citing M. Kaufman, "Celebrex Trial Halted after Finding of Heart Risk: FDA Chief Urges Patients to Ask about Alternatives," *Washington Post*, December 18, 2004, A1.
40. Press Release, American Association for Cancer Research, "Studies Confirm Celecoxib May Help Prevent Colorectal Cancer in High Risk Patients," April 3, 2006, <http://www.aacr.org/home/about-us/news.aspx?d=608> (accessed April 4, 2006). Scott Hensley, "Drug Cuts Risks of Colon Cancer in Two Studies," *Wall Street Journal*, April 14, 2006, D6.
41. Sarah Treffinger, "Cardiologist at Clinic to Lead Study of Painkillers," *Plain Dealer* (Cleveland), December 14, 2005, A1.
42. Thomas H. Maugh II, "Probe Enters Mars Orbit," *Los Angeles Times*, March 11, 2006, A12.
43. Michael Hanlon, "Is This Proof of Life on Mars? The Meteorite That May Finally Have Resolved the Great Mystery," *Daily Mail*, February 10, 2006.
44. Dan Vergano, "Saturn Moon Spurts Icy Plume," *USA Today*, March 13, 2006.
45. Richard Mitchell, "A Minimum Competence to All, and to All a Good Night!" in *The Leaning Tower of Babel and Other Affronts by the Underground Grammarian* (Boston: Little, Brown and Company, 1984), pp. 26–28, p. 28.

PREFACE TO THE ORIGINAL EDITION

My title speaks of "Defending Science"; but, though every now and then you will hear the rumble of a distant skirmish, or smell a whiff of gunpowder, this book is not intended as another salvo in the so-called "Science Wars." Rather, its purpose is to articulate a new, and hopefully a true, understanding of what science is and does. Discussions of the Old Deferentialism, with its focus on the "logic of science," on structure, rationality, and objectivity, and of the New Cynicism, with its focus on power, politics, and rhetoric—and of the deep cultural currents of admiration for and uneasiness about science of which they are manifestations—serve only as background to this constructive project.

My title speaks of defending science "Within Reason," and the play on the two meanings is intentional. I shall defend the pretensions of science to tell us how the world is, but in only quite a modest, qualified way ("within reason" in its colloquial sense), and from the perspective of a more general understanding of human cognitive capacities and limitations, and our place as inquirers in the world ("within reason" in a more philosophical sense). Science has managed to discover a great deal about the world and how it works, but it is a thoroughly human enterprise, messy, fallible, and fumbling; and rather than using a uniquely rational method unavailable to other inquirers, it is continuous with the most ordinary of empirical inquiry, "nothing more than a refinement of our everyday

thinking,” as Einstein once put it. There is no distinctive, timeless “scientific method,” only the modes of inference and procedures common to all serious inquiry, and the multifarious “helps” the sciences have gradually devised to refine our natural human cognitive capacities: to amplify the senses, stretch the imagination, extend reasoning power, and sustain respect for evidence.

For a while I toyed with the idea of beginning: “There’s no such thing as scientific method, and this is a book about it.”¹ But that would have been too clever by half; or rather, it would have been half-right at best. For, once key ideas about scientific evidence and scientific inquiry had begun to come into focus, and I had learned enough of the history of molecular biology to illustrate those ideas from real-life scientific episodes, I glimpsed new ways of approaching difficult but fascinating questions far beyond my original agenda: about the differences between science and literature, the tensions between science and religion, the interactions of science with the law; and about the place of science in our lives, its value, its dangers, its limits, and even the possibility of its eventual annihilation, culmination, or completion. No doubt that’s why this now seems to me the most Pragmatist of my books: influenced here by Peirce, there by James, its approach to the social sciences informed by Mead’s work, its concern with science and values by Dewey’s; and above all, liberated by the example of this rich tradition from the uneasy reluctance of analytic philosophy to stray beyond strictly linguistic, logical, or conceptual questions.

I came to see more clearly that science is valuable not only for the “magnificent edifice” of knowledge built over centuries by many generations of scientists, not only for the technological developments that have made our lives longer and more comfortable, but as a manifestation of the human talent for inquiry at its limited, imperfect, but sometimes remarkable best. I came to grasp more firmly that, though writers inquire, and scientists write, the word “literature” does not refer, like the word “science,” to a federation of kinds of inquiry, but to a federation of kinds of writing; and so to understand how pointless and unnecessary it is to worry about whether science or literature is more valuable.

How did I get involved in a project as vast, as demanding, as overwhelming as this turned out to be? For the usual reasons; or at least, *my* usual reasons. I thought—given the ideas I had sketched in *Evidence and Inquiry* about the place of the sciences within empirical inquiry generally, and the couple of essays in *Manifesto of a Passionate Moderate* in which I had taken on some extravagances of self-styled “cultural critics” of science—enough of the surrounding crossword entries were completed, enough letters supplied in as-yet uncompleted entries; so that it should be, not easy exactly, but well within the realm of the feasible to say something useful about scientific knowledge and scientific inquiry, and about the

place of science in our culture. As usual, when I began the work I had no idea what I was in for.

Spelling everything out proved almost as hard as thinking it all through. I have done my best to be as direct as possible, to eschew unnecessary technicalities, and to avoid the dreadful muddy blandness that pervades so much contemporary academic prose. But doubtless—as some readers will think that my ideas are too radical, and others that they are not radical enough; as some will complain that I spend too little time on the niceties of recent philosophy of science, or of the new “Science Studies,” and others that I spend too much; and as some will reproach me for devoting too little attention to arcane details of quantum mechanics, and others for devoting too little attention to ethical issues about stem-cell research—some will find my style too dryly analytic, and others will find it too exuberantly literary, or too wryly playful. What can I say, except that George Eliot was right: “even when you have no motive to be false, it is very hard to say the exact truth”; and even harder when you *have* a motive, such as the polite reluctance to give offense that I needed to overcome to say forthrightly that the scientific and the religious world-pictures really are incompatible, really can’t be reconciled.

As I write this Preface—almost the last step in a long journey of many false starts and wrong turnings, in which occasional moments of illumination and exhilaration had to compensate for long stretches of near-despair and a constant sense of my inadequacies—I think of Eliot again, this time reflecting, many years after its publication, on her *Romola*: “There is no book about which I more thoroughly feel that I swear by every sentence as having been written with my best blood.”² Unfashionable as such Victorian seriousness is in today’s academy, it captures my feelings about this book quite precisely.

January 2003

NOTES

Note: In endnotes, books and articles are referred to by short titles; full details are to be found in the bibliography.

1. Adapted from Steven Shapin’s nice line in *The Scientific Revolution*, p. 1: “There was no such thing as the Scientific Revolution, and this is a book about it.”

2. My source is Andrew Sanders’ introduction to the Penguin edition of *Romola*, p. 10.

NEITHER SACRED NOR A CONFIDENCE TRICK

The Critical Common-Sensist Manifesto

That men should rush with violence from one extreme, without going more or less into the contrary extreme, is not to be expected from the weakness of human nature.

—Thomas Reid, *Essays on the Intellectual Powers*¹

Attitudes to science range all the way from uncritical admiration at one extreme, through distrust, resentment, and envy, to denigration and outright hostility at the other. We are confused about what science can and what it can't do, and about how it does what it does; about how science differs from literature or art; about whether science is really a threat to religion; about the role of science in society and the role of society in science. And we are ambivalent about the value of science. We admire its theoretical achievements, and welcome technological developments that improve our lives; but we are disappointed when hoped-for results are not speedily forthcoming, dismayed when scientific discoveries threaten cherished beliefs about ourselves and our place in the universe, distrustful of what we perceive as scientists' arrogance or elitism, disturbed by the enormous cost of scientific research, and disillusioned when we read of scientific fraud, misconduct, or incompetence.

Complicated as they are, the confusions can be classified into two broad kinds, the scientific and the anti-scientific. Scientism is an exaggerated kind of

deference towards science, an excessive readiness to accept as authoritative any claim made by the sciences, and to dismiss every kind of criticism of science or its practitioners as anti-scientific prejudice. Anti-science is an exaggerated kind of suspicion of science, an excessive readiness to see the interests of the powerful at work in every scientific claim, and to accept every kind of criticism of science or its practitioners as undermining its pretensions to tell us how the world is. The problem, of course, is to say when the deference, or the suspicion, is “excessive.”

Disentangling the confusions is made harder by an awkward duality of usage. Sometimes the word “science” is used simply as a way of referring to certain disciplines: physics, chemistry, biology, and so forth, usually also anthropology and psychology, sometimes also sociology, economics, and so on. But often—perhaps more often than not—“science” and its cognates are used honorifically: advertisers urge us get our clothes cleaner with new, scientific, Wizzo;² teachers of critical thinking urge us to reason scientifically, to use the scientific method; juries are more willing to believe a witness when told that what he offers is scientific evidence; astrology, water-divining, homeopathy or chiropractic or acupuncture are dismissed as pseudo-sciences; skeptical of this or that claim, people complain that it lacks a scientific explanation, or demand scientific proof. And so on. “Scientific” has become an all-purpose term of epistemic praise, meaning “strong, reliable, good.” No wonder, then, that psychologists and sociologists and economists are sometimes so zealous in insisting on their right to the title. No wonder, either, that practitioners in other areas—“Management Science,” “Library Science,” “Military Science,” even “Mortuary Science”—are so keen to claim it.

In view of the impressive successes of the natural sciences, this honorific usage is understandable enough. But it is thoroughly unfortunate. It obscures the otherwise obvious fact that not all and not only practitioners of disciplines classified as sciences are honest, thorough, successful inquirers; when plenty of scientists are lazy, incompetent, unimaginative, unlucky, or dishonest, while plenty of historians, journalists, detectives, etc., are good inquirers. It tempts us into a fruitless preoccupation with the problem of demarcating *real* science from pretenders. It encourages too thoughtlessly uncritical an attitude to the disciplines classified as sciences, which in turn provokes envy of those disciplines, and encourages a kind of scientism—inappropriate mimicry, by practitioners of other disciplines, of the manner, the technical terminology, the mathematics, etc., of the natural sciences. And it provokes resentment of the disciplines so classified, which encourages anti-scientific attitudes. Sometimes you can even see the envy and the resentment working together: for example, with those self-styled ethnomethodologists who undertake “laboratory studies” of science, observing, as

they would say, part of the industrial complex in the business of the production of inscriptions;³ or—however grudgingly, you have to admit the rhetorical brilliance of this self-description—with “creation science.”⁴ And, most to the present purpose, this honorific usage stands in the way of a straightforward acknowledgment that science—science, that is, in the descriptive sense—is neither sacred nor a confidence trick.

Science is not sacred: like all human enterprises, it is thoroughly fallible, imperfect, uneven in its achievements, often fumbling, sometimes corrupt, and of course incomplete. Neither, however, is it a confidence trick: the natural sciences, at any rate, have surely been among the most successful of human enterprises. The core of what needs to be sorted out concerns the nature and conditions of scientific knowledge, evidence, and inquiry; it is epistemological. (No, I haven’t forgotten Jonathan Rauch’s wry observation: “If you want to empty the room at a cocktail party, say ‘epistemology’”;⁵ but the word is pretty well indispensable for my purposes because, unlike “theory of knowledge,” it has adjectival and adverbial forms.) What we need is an understanding of inquiry in the sciences which is, in the ordinary, non-technical sense of the word, realistic, neither overestimating nor underestimating what the sciences can do.

What we have, however, is a confusing Babel of competing, unsatisfactory accounts of the epistemology of science. How did we come to such a pass?

FROM THE OLD DEFERENTIALISM TO THE NEW CYNICISM

Once upon a time—the phrase is a warning that what follows will be cartoon history—the epistemological *bona fides* of good empirical science needed to be defended against the rival claims of sacred scripture or a priori metaphysics. In due course it came to be thought that science enjoys a peculiar epistemological authority because of its uniquely objective and rational method of inquiry. In the wake of the extraordinary successes of the new, modern logic, successive efforts to articulate the “logic of science” gave rise to umpteen competing versions of what I call the “Old Deferentialism”:⁶ science progresses inductively, by accumulating true or probably true theories confirmed by empirical evidence, by observed facts; or deductively, by testing theories against basic statements and, as falsified conjectures are replaced by corroborated ones, improving the verisimilitude of its theories; or instrumentally, by developing theories which, though not themselves capable of truth, are efficient instruments of prediction; or, etc., etc. There were numerous obstacles: Humean skepticism about induc-