

What is science and why should we care?

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I'd like to thank Dick, Tracey and everyone at *Sense About Science* for inviting me to give this Third Annual lecture. But they've given me a hard act to follow. Two years ago, Sir John Krebs provided a superb overview of the messiness of translating science into public policy. Last year, Raymond Tallis gave not only a masterful summary of the achievements of scientific medicine in enhancing human life, but also an astute analysis of the psychological attractions of junk science.

Now, my own scientific expertise is in statistical mechanics and quantum field theory — areas of physics that I don't imagine are likely to have urgent public-policy implications anytime soon. So I will have to speak tonight about a more general theme: namely, the nature of scientific inquiry and its importance for public life. At a superficial level you could say that my topic is the relation between science and society; but as I hope will become clear, my deeper theme is the importance, not so much of *science*, but of the *scientific worldview* — a concept that I shall define more precisely in a moment, and which goes far beyond the specific disciplines that we usually think of as “science” — in humanity's collective decision-making. I want to argue that clear thinking, combined with a respect for *evidence* — especially inconvenient and unwanted evidence, evidence that challenges our preconceptions — are of the utmost importance to the survival of the human race in the twenty-first century.

Of course, you might think that calling for clear thinking and a respect for evidence is a bit like advocating Motherhood and Apple Pie (if you'll pardon this Americanism) — and in a sense you'd be right. Hardly anyone will *openly* defend *muddled* thinking or *disrespect* for evidence. Rather, what people do is to surround these practices with a fog of verbiage designed to conceal from their listeners — and in most cases, I would imagine, from themselves as well — the true implications of their reasoning. George Orwell got it right when he observed that the main advantage of speaking and writing clearly is that “when you make a stupid remark its stupidity will be obvious, even to yourself”.¹ So I hope that I will be as clear tonight as Orwell would have wished. And I intend to illustrate *disrespect* for evidence with a variety of examples — coming from the Left and the Right and the Center — starting from some fairly lightweight targets and proceeding to heavier ones. I aim to show that the implications of taking seriously an evidence-based worldview are rather more radical than many people realize.

So let me start, perhaps a bit pedantically, by drawing some important distinctions.

The word *science*, as commonly used, has at least four distinct meanings: it denotes an intellectual endeavor aimed at a rational understanding of the natural and social world; it denotes a corpus of currently accepted substantive knowledge; it denotes the community of scientists, with its mores and its social and economic structure; and, finally, it denotes applied science and technology. In this talk I will be concentrating on the first two aspects, with some secondary references to the sociology of the scientific community; I will not address technology at all. Thus, by *science* I mean, first of all, a worldview giving primacy to reason and observation and a methodology aimed at acquiring accurate knowledge of the natural and social world. This methodology

¹Orwell (1953 [1946], p. 171).

is characterized, above all else, by the *critical spirit*: namely, the commitment to the incessant testing of assertions through observations and/or experiments — the more stringent the tests, the better — and to revising or discarding those theories that fail the test.² One corollary of the critical spirit is *fallibilism*: namely, the understanding that all our empirical knowledge is tentative, incomplete and open to revision in the light of new evidence or cogent new arguments (though, of course, the most well-established aspects of scientific knowledge are unlikely to be discarded entirely).

It is important to note that well-tested theories in the mature sciences are supported in general by a powerful web of interlocking evidence coming from a variety of sources; rarely does everything rest on one “crucial experiment”. Moreover, the progress of science tends to link these theories into a unified framework, so that (for instance) biology has to be compatible with chemistry, and chemistry with physics. The philosopher Susan Haack has illuminatingly analogized science to the problem of completing a crossword puzzle, in which any modification of one word will entail changes in interlocking words; in most cases the required changes will be fairly local, but in some cases it may be necessary to rework large parts of the puzzle.³

I stress that my use of the term “science” is not limited to the *natural* sciences, but includes investigations aimed at acquiring accurate knowledge of factual matters relating to *any* aspect of the world by using rational empirical methods analogous to those employed in the natural sciences. (Please note the limitation to questions of fact. I intentionally exclude from my purview questions of ethics, aesthetics, ultimate purpose, and so forth.) Thus, “science” (as I use the term) is routinely practiced not only by physicists, chemists and biologists, but also by historians, detectives, plumbers and indeed all human beings in (some aspects of) our daily lives.⁴ (Of course, the fact that we all practice science from time to time does not mean that we all practice it equally well, or that we practice it equally well in all areas of our lives.)

The extraordinary successes of the natural sciences over the last 400 years in learning about the world, from quarks to quasars and everything in-between, are well known to every modern citizen: science is a fallible yet enormously successful method for obtaining objective (albeit approximate and incomplete) knowledge of the natural (and to a lesser extent, the social) world.

But, surprisingly, not everyone accepts this; and here I come to my first — and most lightweight — example of adversaries of the scientific worldview, namely academic postmodernists and extreme social constructivists. Such people insist that so-called scientific knowledge does *not* in fact constitute objective knowledge of a reality external to ourselves, but is a mere social construction, on a par with myths and religions, which therefore have an equal claim to validity. If such a view seems so implausible that you wonder whether I am somehow exaggerating, consider the following assertions by

²See Bricmont (2005) for an illuminating discussion of the critical/skeptical aspect of science.

³Haack (1993, 1998, 2003).

⁴The allusion to historians and detectives was employed previously by Haack (1993, p. 137): “there is no reason to think that [science] is in possession of a special method of inquiry unavailable to historians, detectives, and the rest of us”. See also Haack (1998, pp. 96–97; 2003, pp. 18, 24, 95, 102 and *passim*).

prominent sociologists:

[T]he validity of theoretical propositions in the sciences is in no way affected by factual evidence. (Kenneth Gergen)⁵

The natural world has a small or non-existent role in the construction of scientific knowledge. (Harry Collins)⁶

For the relativist [such as ourselves] there is no sense attached to the idea that some standards or beliefs are really rational as distinct from merely locally accepted as such. (Barry Barnes and David Bloor)⁷

Since the settlement of a controversy is the *cause* of Nature's representation, not the consequence, we can never use the outcome — Nature — to explain how and why a controversy has been settled. (Bruno Latour)⁸

Science legitimates itself by linking its discoveries with power, a connection which *determines* (not merely influences) what counts as reliable knowledge ... (Stanley Aronowitz)⁹

Statements as clear-cut as these are, however, rare in the academic postmodernist literature. More often one finds assertions that are ambiguous but can nevertheless be interpreted (and quite often *are* interpreted) as implying what the foregoing quotations make explicit: that science as I have defined it is an illusion, and that the purported objective knowledge provided by science is largely or entirely a social construction. For example, Katherine Hayles, professor of English at UCLA and former president of the Society for Literature and Science, writes the following as part of her feminist analysis of fluid mechanics:

Despite their names, conservation laws are not inevitable facts of nature but constructions that foreground some experiences and marginalize others. ... Almost without exception, conservation laws were formulated, developed, and experimentally tested by men. If conservation laws represent particular emphases and not

⁵Gergen (1988, p. 37).

⁶Collins (1981, p. 3). Two qualifications need to be made: First, this statement is offered as part of Collins' introduction to a set of studies (edited by him) employing the relativist approach, and constitutes his summary of that approach; he does not *explicitly* endorse this view, though an endorsement seems implied by the context. Second, while Collins appears to intend this assertion as an empirical claim about the history of science, it is possible that he intends it neither as an empirical claim nor as a normative principle of epistemology, but rather as a methodological injunction to sociologists of science: namely, to act *as if* "the natural world ha[d] a small or non-existent role in the construction of scientific knowledge", or in other words to *ignore* ("bracket") whatever role the natural world may in fact play in the construction of scientific knowledge. I have argued elsewhere (Bricmont and Sokal 2001, 2004) that this approach is seriously deficient *as methodology* for sociologists of science.

⁷Barnes and Bloor (1981, p. 27), clarification added by me.

⁸Latour (1987, pp. 99, 258), emphasis in the original. See Sokal and Bricmont (1998, chapter 4) for a detailed analysis of this claim and its various possible meanings.

⁹Aronowitz (1988, p. 204), emphasis in the original.

inevitable facts, then people living in different kinds of bodies and identifying with different gender constructions might well have arrived at different models for [fluid] flow.¹⁰

(What an interesting idea: perhaps “people living in different kinds of bodies” will learn to see beyond those masculinist laws of conservation of energy and momentum.) And Andrew Pickering, a prominent sociologist of science, asserts the following in his otherwise-excellent history of modern elementary-particle physics:

[G]iven their extensive training in sophisticated mathematical techniques, the preponderance of mathematics in particle physicists’ accounts of reality is no more hard to explain than the fondness of ethnic groups for their native language. On the view advocated in this chapter, there is no obligation upon anyone framing a view of the world to take account of what twentieth-century science has to say.¹¹

But let me not spend time beating a dead horse, as the arguments against postmodernist relativism are by now fairly well known — rather than plugging own writings, let me suggest the superb book by Canadian philosopher of science James Robert Brown, *Who Rules in Science?: An Opinionated Guide to the Wars*.¹² Suffice it to say that postmodernist writings systematically confuse truth with *claims* of truth, fact with *assertions* of fact, and knowledge with *pretensions* to knowledge — and then sometimes go so far as to deny that these distinctions have any meaning.

Now, it’s worth noting that the postmodernist writings I have just quoted all come from the 1980s and early 1990s. In fact, over the past decade, academic postmodernists and social constructivists seem to have backed off the most extreme views that they previously espoused. Perhaps I and like-minded critics of postmodernism can take some small credit for this, by initiating a public debate that shed a harsh light of criticism on these views and forced some strategic retreats. But most of the credit, I think, has to be awarded to George W. Bush and his friends, who have shown just where science-bashing can lead in the real world. Nowadays, even sociologist of science Bruno Latour, who spent several decades stressing the so-called “social construction of scientific facts”¹³, laments the ammunition he fears he and his colleagues have given to the Republican right-wing, helping them to deny or obscure the scientific consensus on global warming, biological evolution and a host of other issues.¹⁴ He writes:

¹⁰Hayles (1992, pp. 31–32).

¹¹Pickering (1984, p. 413). Can Pickering, who was initially trained as a physicist, really be unaware of four centuries’ work demonstrating the extraordinary power of mathematics as a tool for formulating and solving problems in the physical (and, to a lesser extent, the biological) sciences? See Wigner (1960) for a prominent physicist’s reflections on the “unreasonable effectiveness” of mathematics in the natural sciences.

¹²Brown (2001).

¹³This is the subtitle of Latour and Woolgar (1979).

¹⁴See Mooney (2005) for an extensively documented account of the assault on science being carried out by Republican politicians on behalf of an unholy (and uneasy) alliance of big corporations seeking to escape environmental and safety regulations and religious fundamentalists seeking to impose their dogmas on education and health policy.

While we spent years trying to detect the real prejudices hidden behind the appearance of objective statements, do we now have to reveal the real objective and incontrovertible facts hidden behind the *illusion* of prejudices? And yet entire Ph.D. programs are still running to make sure that good American kids are learning the hard way that facts are made up, that there is no such thing as natural, unmediated, unbiased access to truth, that we are always prisoners of language, that we always speak from a particular standpoint, and so on, while dangerous extremists are using the very same argument of social construction to destroy hard-won evidence that could save our lives.¹⁵

That, of course, is exactly the point I was trying to make back in 1996 about social-construction talk taken to subjectivist extremes. I hate to say I told you so, but I did. As did, several years before me, Noam Chomsky, who recalled that in a not-so-distant past,

Left intellectuals took an active part in the lively working class culture. Some sought to compensate for the class character of the cultural institutions through programs of workers' education, or by writing best-selling books on mathematics, science, and other topics for the general public. Remarkably, their left counterparts today often seek to deprive working people of these tools of emancipation, informing us that the "project of the Enlightenment" is dead, that we must abandon the "illusions" of science and rationality — a message that will gladden the hearts of the powerful, delighted to monopolize these instruments for their own use.¹⁶

Let me now pass to a second set of adversaries of the scientific worldview, namely the advocates of pseudoscience. This is of course an enormous area, so let me focus on one socially important aspect of it, namely so-called "complementary and alternative therapies" in health and medicine.

It was recently reported that U.K. Government will be introducing standards of competence in homeopathy, aromatherapy, reflexology and other "alternative" therapies, in order to protect the public from inadequately trained practitioners.¹⁷ That sounds nice, at first glance. But what, precisely, does it mean to be "competent" in a system of pseudo-medicine that has never been demonstrated to be efficacious beyond the placebo effect? Perhaps for its next act, the NHS will introduce bloodletting and trepanation, duly guaranteed by rigorous standards of competence for practitioners.

It's worth looking in a bit of detail at one of the most widely used "alternative" therapies, namely homeopathy, because its advocates sometimes claim that there *is* evidence from meta-analyses of clinical trials that homeopathy works. Now, one basic principle

¹⁵Latour (2004, p. 227), italics in the original.

¹⁶Chomsky (1993, p. 286). See also Albert (1992), Chomsky (1992) and Ehrenreich (1992) for related commentary.

¹⁷Hawkes (2008).

in all of science is GIGO: garbage in, garbage out. This principle is particularly important in statistical meta-analysis: because if you have a bunch of methodologically poor studies, each with small sample size, and then subject them to meta-analysis, what can happen is that the systematic biases in each study — if they mostly point in the same direction — can reach statistical significance when the studies are pooled. And this possibility is particularly relevant here, because meta-analyses of homeopathy invariably find an inverse correlation between the methodological quality of the study and the observed effectiveness of homeopathy: that is, the sloppiest studies find the strongest evidence in favor of homeopathy.¹⁸ When one restricts attention only to methodologically sound studies — those that include adequate randomization and double-blinding, pre-defined outcome measures, and clear accounting for drop-outs — the meta-analyses find no statistically significant effect (whether positive or negative) of homeopathy compared to placebo.¹⁹

But the lack of convincing statistical evidence for the efficacy of homeopathy is *not*, in fact, the main reason why I and other scientists are skeptical (to put it mildly) about homeopathy; and it's worth taking a few moments to explain this main reason. Most people — perhaps even most users of homeopathic remedies — do not clearly understand what homeopathy is. They probably think of it as a species of herbal medicine.²⁰

¹⁸Kleijnen *et al.* (1991), Linde *et al.* (1997, 1999), Linde and Melchart (1998), Cucherat *et al.* (2000), Shang *et al.* (2005). See also Ernst (2002) for a useful review of meta-analyses of homeopathy. In fairness, it should be pointed out that the inverse correlation between methodological quality and observed treatment efficacy holds also in conventional medicine: see e.g. Schulz *et al.* (1995), Khan *et al.* (1996), Moher *et al.* (1998), Shang *et al.* (2005), and Poolman *et al.* (2007). The difference is that, in at least some cases of conventional medicine, analyses restricted to high-quality studies can show an indisputably significant treatment effect. For a lucid explanation of the importance of allocation concealment and double-blinding — and the distinction between the two — see Schulz (2000).

¹⁹There was one apparent exception: a 1997 meta-analysis of homeopathy published in the *Lancet* (Linde *et al.* 1997), which is frequently cited by advocates of homeopathy because it found positive effects that were statistically significant at the 95% confidence level even when restricting attention to the 26 studies (out of 119) that met the authors' criteria for "high quality". However, a subsequent reanalysis of the same data by the same group (Linde *et al.* 1999), paying greater attention to the effects of study quality, found "clear evidence that in the study set investigated more rigorous trials tended to yield smaller effects" (p. 634), with the five highest-quality studies showing an effect that is no longer statistically significant at the 95% confidence level (Table 2: odds ratio 1.55 for homeopathy over placebo, with the 95% confidence interval running from 0.77 to 3.10). The authors conclude that

The most plausible explanation of this finding is bias. . . . The evidence of bias weakens the findings of our original meta-analysis. . . . It seems, therefore, likely that our meta-analysis at least overestimated the effects of homeopathic treatments. (pp. 634–635)

Furthermore, in response to a letter-writer who suggested "an analysis restricted to good-quality studies . . . with a clear predefined main endpoint" (Seed 1998), the authors admitted that "there are insufficient studies to conduct a useful analysis of only high-quality investigations with predefined outcome measures" (Linde and Jonas 1998, p. 367) — which suggests that the small residual effect in the "highest-quality" studies might itself be a result of bias. See also Ernst (2002).

²⁰Some politicians apparently share the same misunderstanding. For example, Peter Luff MP (Conservative, Mid-Worcestershire), an advocate of expanded NHS provision of "complementary and alternative" therapies, wrote to a constituent in September 2007 that "I am convinced that homeopathy does offer some genuine relief. When one considers the number of pharmaceutical products on the market

Of course plants contain a wide variety of substances, some of which can be biologically active (with either beneficial or harmful consequences, as Socrates learned). But homeopathic remedies, by contrast, are pure water and starch: the alleged “active ingredient” is so highly diluted that in most cases *not a single molecule* remains in the final product.

And so, the fundamental reason for rejecting homeopathy is that there is no plausible mechanism by which homeopathy could possibly work, unless one rejects everything that we have learned over the last 200 years about physics and chemistry: namely, that matter is made of atoms, and that the properties of matter — including its chemical and biological effects — depend on its atomic structure. There is simply no way that an *absent* “ingredient” could have a therapeutic effect. High-quality clinical trials find no difference between homeopathy and placebo because homeopathic remedies *are* placebos.²¹ (So homeopathic remedies are not just useless but also *harmless* — unlike conventional or herbal medicines. There is no danger of an overdose!)

Now, advocates of homeopathy sometimes respond to this argument by asserting that the curative effect of homeopathic remedies arises from a “memory” of the vanished active ingredient that is somehow retained by the water in which it was dissolved (and then by the starch when the water is evaporated!). But the difficulty, once again, is not simply the lack of any reliable experimental evidence for such a “memory of water”. Rather, the problem is that the existence of such a phenomenon would contradict well-tested science, in this case the statistical mechanics of fluids. The molecules of any liquid are constantly being bumped by other molecules — what physicists call thermal fluctuations — so that they quickly lose any “memory” of their past configuration. (Here when I say “quickly”, I’m talking picoseconds, not months.)

In short, all the millions of experiments confirming modern physics and chemistry also constitute powerful evidence *against* homeopathy. For this reason, the flaw in the justification of homeopathy is not merely the lack of statistical evidence showing the efficacy of homeopathic remedies over placebo at the 95% or 99% confidence level. Even an experiment at the 99.9% confidence level would not begin to compete with all the evidence in favor of modern physics and chemistry. Extraordinary claims require extraordinary evidence. (And in the unlikely event that such convincing evidence is ever forthcoming, the person who provides it will assuredly win a triple Nobel Prize in physics, chemistry and biology — beating out Marie Curie, who won only two.)

that have their origins in the natural world it shows that pharmacists also believe nature has a lot to teach us.” See <http://www.quackometer.net/blog/2007/08/state-sponsored-quackery.html> See also Whipple (2007) for the reactions of some other MPs who advocate homeopathy.

²¹Moreover, “different” homeopathic remedies — for instance, *nux vomica* and *excrementum caninum* — are the *same* placebo. This was inadvertently admitted by Kate Chatfield of the Society of Homeopaths in testimony before the House of Lords Select Committee on Science and Technology (21 February 2007):

Q538 Lord Broers: I have a simple, technical question about homeopathy and drugs. Is it possible to distinguish between homeopathic drugs after they have been diluted? Is there any means of distinguishing one from the other?

Ms Chatfield: Only by the label.

(House of Lords 2007)

Despite the utter scientific implausibility of homeopathy, the NHS actively promotes homeopathy on its website²² and provides homeopathic “treatment” at the taxpayers’ expense. And there are five homeopathic hospitals in the UK, four of which are funded by NHS money.²³

Alas, no one, not even the Health Minister, seems to know how much the NHS spends annually on unproven (or disproven) “complementary and alternative” therapies, because the NHS does not bother to keep track²⁴ — but estimates range from £50 million to £450 million.²⁵ Granted, that’s a tiny fraction of the £92 billion NHS budget, but

²²See especially <http://www.nhsdirect.nhs.uk/articles/article.aspx?articleId=197> and <http://www.nhs.uk/Conditions/Homeopathy/Pages/Introduction.aspx> and subsequent pages. The NHS asserts uncritically that “Homeopathy ... has been reported to help menopause symptoms such as hot flushes and sweats, tiredness, and mood problems.” (<http://www.nhs.uk/Conditions/Menopause/Pages/Alternative%20treatments.aspx>) They even go so far as to claim that “There is some evidence that alternative therapies including ... homeopathy ... have been found helpful in people with schizophrenia.” (<http://www.nhsdirect.nhs.uk/articles/article.aspx?articleId=329§ionId=11>)

To be fair, there are other pages on the NHS website where the absence of evidence of effectiveness of homeopathy for certain conditions (asthma, eczema, hay fever, multiple sclerosis) is clearly stated. And if one bothers to look at the glossary (<http://www.nhsdirect.nhs.uk/glossary/index.aspx#H>), one finds the forthright statement that “There is currently no clear clinical evidence that homeopathy works.”

²³Until recently all five were funded by the NHS; but in September 2007 the West Kent Primary Care Trust decided to withdraw NHS funding for the Tunbridge Wells Homeopathic Hospital, effective March 2008, on the grounds that “the NHS has to decide the best use of money on the evidence of clinical effectiveness” (BBC News 2007; see also Colquhoun 2007 and Samarasekera 2007).

Many other NHS trusts are also cutting back on funding for homeopathy, “prompting hospitals such as the Royal London Homeopathic Hospital — which provides a range of alternative treatments — to warn that they may be forced to close because of lack of NHS business” (Randerson 2007; see also Henderson 2007 and Randerson 2008). This news report also contains a delicious tidbit of celebrity gossip:

In April [2007], Peter Fisher, personal homeopath to the Queen and clinical director of the Royal London Homeopathic Hospital, wrote an open letter to the monarch, its patron, asking for her support to save the hospital. The Queen reportedly takes 60 vials of homeopathic remedies with her when she goes abroad in case she falls ill. (Randerson 2007)

²⁴Henderson and Yeoman (2006). On 12 June 2006, Norman (alias Lord) Warner, the then-Minister of State for the Department of Health, confirmed (House of Lords 2006) that “there are ... no centrally held records of NHS referrals for homoeopathic treatment”. He justified this policy on the grounds that “the Government consider that decision-making on individual clinical interventions, whether conventional, or complementary or alternative treatments, is a local matter” — which is a strange justification, because the issue here is statistical record-keeping, not decision-making on *individual* clinical interventions. Does the NHS also not keep track of how much it spends on cancer drugs?

²⁵Hawkes (2008) says £50 million but gives no source. Henderson and Yeoman (2006) estimate £450 million on the basis of Smallwood (2005), who suggests that Britain’s total annual spending on complementary and alternative medicine (CAM) could be as large as £4.5 billion (p. 22) — though he also says there that £2.8–3.7 billion might be more accurate — and that approximately 10% of these therapies were provided by the NHS (p. 122). Thomas *et al.* (2001) find a rather lower figure: based on a 1998 survey, they estimate that residents of England (the rest of the U.K. is excluded) spend approximately £580 million annually on complementary therapies (with an error band of $\pm 20\%$), of

it's still money that could give thousands of cancer patients provably effective therapies that are now denied for cost reasons.

which an estimated £56 million was provided by the NHS. If expenditures on CAM are rising at a 10–15% annual rate regardless of economic climate, as Smallwood (2005, p. 22) suggests, one can infer a current total expenditure of £1.2–2.8 billion annually, of which £120–280 million would come from the NHS. Thomas *et al.* (2001, Table 5) estimate that approximately 46% of the NHS CAM expenditures are for acupuncture, 18% for osteopathy, 15% for chiropractic, 9% for hypnotherapy, and 6% each for homeopathy and reflexology. It is not clear which (if any) of these treatments are supported by good evidence of effectiveness.

Let me stress that I have no objection whatsoever to NHS funding of “complementary and alternative” therapies that *have* been demonstrated to be effective by randomized, placebo-controlled, double-blind studies (i.e. exactly the same standards one would apply in evaluating a conventional therapy). For instance, saw palmetto (*Serenoa repens*) appears to be modestly effective in treating benign prostatic hyperplasia (Wilt *et al.* 2002). Of course, such therapeutic effects of herbal medicines are not surprising; after all, many conventional medicines were originally derived from plants. Indeed, once the therapeutic effects of an herbal medicine have been established, there is no reason for the treatment to be labeled “complementary and alternative”; it ought to become part of conventional medicine. Furthermore, it is an empirical question whether the therapeutic effects, when they exist, are caused by a single “active ingredient” or by the combined effect of several substances, and whether a “natural” or synthesized form of the drug is more effective. Similar comments hold, *mutatis mutandis*, with respect to non-drug types of “complementary and alternative” therapy: for instance, the use of music in reducing pre-operative anxiety (Wang *et al.* 2002, Cooke *et al.* 2005).

I do, however, consider it a scandal that the manufacturers of “complementary” remedies are allowed to make health claims unsupported by evidence, unlike the manufacturers of conventional drugs, who are rightly required to submit solid evidence of safety and efficacy. Indeed, the U.K. government has gone farther and created a special regulatory regime for homeopathic products. At first glance, the Medicines for Human Use (National Rules for Homoeopathic Products) Regulations 2006 would seem to require an applicant “for the grant of a United Kingdom marketing authorization for a national homoeopathic product . . . [to] submit with his application particulars and documents relating to . . . the efficacy of that product, in accordance with Part 3 of this Schedule.” But a look at Part 3 reveals that the required data of “efficacy” are defined as consisting of

at least one [emphasis added by me] of the following types of data—

- (a) study reports in relation to the product which is the subject of the application,
- (b) published scientific literature, or
- (c) the results of investigations, commonly known as homoeopathic provings, which consist of the administration of a substance to a human subject in order to ascertain the symptoms produced by that substance.

In other words, it suffices to perform so-called homeopathic “provings” of the undiluted active ingredient, which in reality have nothing at all to do with the efficacy of the homeopathically diluted remedy; no other proof of efficacy is required. (Granted, the applicant is also required to include “an explanation as to how the data establishes [*sic*] that the product has a recognised level of efficacy in the therapeutic indication for which authorization is sought”, but there is no requirement that this “explanation” be based on science rather than on homeopathic pseudoscience.) If these regulations were not written by the homeopathic industry, they might as well have been.

In its Explanatory Memorandum concerning the new rules, the Medicines and Healthcare Products Regulatory Agency (MHRA) lamented that “because of the philosophy of homoeopathy and the nature of the products, it is difficult to establish efficacy for homoeopathic products by way of clinical trials”

Let me now discuss a third and yet more dangerous set of adversaries of the evidence-based worldview, namely the advocates of religion.

When analyzing religion, a few distinctions are perhaps in order. For starters, religious doctrines typically have two components: a factual part, consisting of a set of claims about the universe and its history; and an ethical part, consisting of a set of prescriptions about how to live. In addition, all religions make, at least implicitly, epistemological claims concerning the methods by which humans can obtain reasonably reliable knowledge of factual or ethical matters. These three aspects of each religion obviously need to be evaluated separately.

Furthermore, when discussing any set of ideas, it is important to distinguish between the intrinsic merit of those ideas, the objective role they play in the world, and the subjective reasons for which various people defend or attack them.

(Alas, much discussion of religion fails to make these elementary distinctions: for instance, confusing the intrinsic merit of an idea with the good or bad effects that it may have in the world.)

Tonight I want to address only the most fundamental issue, namely, the intrinsic merit of the various religions' factual doctrines. And within that, I want to focus on the epistemological question — or to put it in less fancy language, the relationship between belief and evidence. After all, those who believe in their religion's factual doctrines presumably do so for what they consider to be good reasons. So it's sensible to ask: What are these alleged good reasons?

Each religion makes scores of purportedly factual assertions about everything from the creation of the universe to the afterlife. But on what grounds can believers presume to know that these assertions are *true*? The reasons they give are various, but they ultimately boil down to one: *because our holy scriptures say so*. But how, then, do we know that our holy scriptures are free from error? *Because the scriptures themselves say so*. Theologians specialize in weaving elaborate webs of verbiage to avoid saying anything quite so bluntly, but this gem of circular reasoning really is the epistemological bottom line on which all “faith” is grounded. In the words of Pope John Paul II: “By the authority of his absolute transcendence, God who makes himself known is also the source of the credibility of what he reveals.”²⁶ It goes without saying that this begs the question of whether the texts at issue really were authored or inspired by God, and on

(true enough!). They justified the new rules on the grounds that “sections of the homeopathic industry are discontented with the current situation” in which producers are mostly prohibited from making specific health claims unless they can provide evidence that those claims are true, and that failure to introduce the new relaxed rules “would inhibit the expansion of the homeopathic industry by the prevention of the development of new products with indications [i.e., specific health claims].” The MHRA went so far as to make the Orwellian assertion that “our proposals will benefit . . . the general public . . . by strengthening the protection of users of homeopathic medicinal products”.

See Secretary of State for Health (2006) for the regulations, and Medicines and Healthcare Products Regulatory Agency (2006) for the explanatory memorandum. See Goldacre (2006a, 2006b) for appropriately acerbic commentary; and see <http://www.ebm-first.com/?cat=76> and <http://www.senseaboutscience.org.uk/index.php/site/project/86> for links to further information.

²⁶John Paul II (1998, paragraph 13).

what grounds one knows this. “Faith” is not in fact a rejection of reason, but simply a lazy acceptance of bad reasons. “Faith” is the pseudo-justification that some people trot out when they want to make claims without the necessary evidence.

Let me give another paradigmatic example of theological obfuscation, this time from the Professor of Historical Theology at Oxford University, Anglican theologian Alister McGrath. McGrath defines “faith” as follows:

[Faith] affects the whole of man’s nature. It commences with the conviction of the mind based on adequate evidence; it continues in the confidence of the heart or emotions based on conviction, and it is crowned in the consent of the will, by means of which the conviction and confidence are expressed in conduct.²⁷

As Michael Shermer accurately observes in his review of McGrath’s book, nearly all of this definition “describes the psychology of belief. The only clause of relevance to a scientist [or, I would add, to an epistemologist] is ‘adequate evidence,’ which raises the follow-up question, ‘Is there?’”²⁸ Alas, McGrath does not bother to address this perfectly obvious question anywhere in his 200-page book.

Worse yet, McGrath wants to have his cake and eat it too: when it suits his argumentative purposes, he reverts to the everyday meaning of the word “faith”, flatly contradicting his own definition:

It is increasingly recognized that philosophical argument about the existence of God has ground to a halt. The matter lies beyond rational proof, and is ultimately a matter of faith, in the sense of judgments made in the absence of sufficient evidence.²⁹

(By the way, I never did get a straight answer when I asked some Oxford colleagues why Oxford has a Faculty of Theology but no Faculty of Astrology.)

The American commentator David Morris has recently made the useful suggestion that the word “religion” — or its currently fashionable ecumenical-sounding euphemism, “faith” — be replaced by the epistemologically more illuminating term, “superstition”.³⁰ For instance, President Bush could extol religion as follows:

²⁷McGrath (2005, p. 86), quoting Griffith-Thomas (1930, p. xviii).

²⁸Shermer (2005, p. 206).

²⁹McGrath (2004, p. 179).

³⁰Morris (2005). The American Heritage Dictionary defines superstition as

1. An irrational belief that an object, action, or circumstance not logically related to a course of events influences its outcome. 2a. A belief, practice, or rite irrationally maintained by ignorance of the laws of nature or by faith in magic or chance. 2b. A fearful or abject state of mind resulting from such ignorance or irrationality.

The Oxford English Dictionary defines superstition as

- 1a. Unreasoning awe or fear of something unknown, mysterious, or imaginary, esp. in connexion with religion; religious belief or practice founded upon fear or ignorance. 1b. In particularized sense: An irrational religious belief or practice; a tenet, scruple, habit, etc. founded on fear or ignorance. 2. An irrational religious system; a false, pagan, or idolatrous religion. Now *rare* or *Obs.* 4. *transf.* (from 1). Irrational or unfounded belief in general; an unreasonable or groundless notion.

I believe in the power of superstition in people's lives. Our government should not fear programs that exist because a church or a synagogue or a mosque has decided to start one. We should not discriminate against programs based upon superstition in America. We should enable them to access federal money, because superstition-based programs can change people's lives, and America will be better off for it.

and then go on to stress that

The superstition-based initiative is not about a single superstition. In this country we're great because we've got many superstitions, and we're great because you can choose whatever superstition you choose, or if you choose no superstition at all, you're still equally American.³¹

The clarity of our national discourse would be notably improved by this simple rephrasing.

This clarification would also be salutary here in Britain, where former Prime Minister Tony Blair assiduously promoted government subsidies for so-called "faith-based schools". After it was reported that a publicly funded Christian school in Gateshead had been teaching creationism, Blair was asked in Parliament whether he was "happy to allow the teaching of creationism alongside Darwin's theory of evolution in state schools". Blair (always the consummate politician) avoided a direct answer, but defended the school in question and said that "In the end, a more diverse school system will deliver better results for our children."³² Shall we also, in the name of "diversity", subsidize schools teaching that the moon is made of green cheese?

Of course, Muslim, Hindu, Sikh and Jewish Britons can rightly complain that the state has long funded Church of England and Roman Catholic schools. But the proper remedy is not to extend state patronage from Christianity to other superstitions; rather, it is to implement a complete separation of church from state, and more generally to insist that taxpayer-funded institutions have no business propagating dogmas unsupported by evidence.

Moreover, segregating children of Muslim parents from children of Christian parents for separate indoctrination is woefully misguided. Instead, why not bring together students of both backgrounds in a high-school history class to examine the historical evidence bearing on the composition of the New Testament and the Qur'an?

In all these examples I have been at pains to distinguish clearly between *factual* matters and *ethical* or *aesthetic* matters, because the epistemological issues they raise

³¹The first quotation was used by Morris (2005). The original texts can be found on the website of the White House Office for Faith-Based and Community Initiatives at <http://www.whitehouse.gov/government/fbci/guidance/charitable.html> and <http://www.whitehouse.gov/news/releases/2005/03/20050301-4.html>

³²House of Commons (2002).

are so different. And I have restricted my discussion almost entirely to factual matters, simply because of the limitations of my own competence.

But if I am preoccupied by the relation between belief and evidence, it is not solely for intellectual reasons — not solely because I, like my friend Norm Levitt, am “[a] grumpy old fart who aspire[s] to the sullen joy of having it known that [I] don’t suffer fools gladly”.³³ Rather, my concern that public debate be grounded in the best available evidence is, above all else, *ethical*.

To illustrate the connection I have in mind between epistemology and ethics, let me start with a fanciful example: Suppose that the leader of a militarily powerful country believes, sincerely but erroneously, on the basis of flawed “intelligence”, that a smaller country possesses threatening weapons of mass destruction; and suppose further that he launches a preemptive war on that basis, killing tens of thousands of innocent civilians as “collateral damage”. Aren’t he and his supporters *ethically* culpable for their epistemic sloppiness?

I stress that this example is fanciful. All the available evidence suggests that the Bush and Blair administrations *first* decided to overthrow Saddam Hussein, and *then* sought a publicly presentable pretext, using dubious or even forged “intelligence” to “justify” that pretext and to mislead Congress, Parliament and the public into supporting that war.³⁴

Which brings me to the last, and in my opinion most dangerous, set of adversaries of the evidence-based worldview in the contemporary world: namely, propagandists, public-relations flacks and spin doctors, along with the politicians and corporations who employ them — in short, all those whose goal is not to analyze honestly the evidence for and against a particular policy, but is simply to manipulate the public into reaching a predetermined conclusion by whatever technique will work, however dishonest or fraudulent.

So the issue here is no longer mere muddled thinking or sloppy reasoning; it is fraud.

Now I’m aware that the English libel laws are rather stringent, so just to avoid any misunderstanding about whether I am accusing George Bush and Tony Blair of fraud, let me be clear: I am. (I’m relying here on the fact that, even in England, truth is an absolute defense against a charge of libel.³⁵)

³³Levitt (1996).

³⁴See e.g. Prados (2004), Miller (2006, chapter I) or Rich (2006) for extensive documentation. As the 23 July 2002 Downing Street Memo candidly put it (for private consumption within the Prime Minister’s inner circle), “the intelligence and facts were being fixed around the policy” (Smith 2005).

Of course, by saying “all the available evidence” I do not mean to exclude the possibility that there might exist a few pieces of evidence that are compatible with, or even favor, an alternative interpretation. I simply mean that the overwhelming weight of available evidence favors the interpretation I have given here.

³⁵See e.g. Neill and Rampton (1983, chapter 11), Price and Duodu (2003, chapter 8), or Milmo and Rogers (2004, chapter 11). See also Loveland (2000) for a fascinating analysis of the recent (non-)evolution of English libel law to better protect the legitimate public interest in wide-ranging debate on matters related to politics and public policy, sharpened by a comparison with developments in the United States, Australia and New Zealand. Since that book was written, the English courts have given somewhat stronger protection to the freedom of the press, in a series of cases starting with *Reynolds v Times Newspapers Ltd* [2001] 2 AC 127 (1999 UKHL 45) and continuing through *Jameel v*

The Oxford English Dictionary defines “fraud” as “the using of false representations to obtain an unjust advantage or to injure the rights or interests of another”. Black’s Law Dictionary defines “fraud” rather more ornately as

all the multifarious means which human ingenuity can devise, which are resorted to by one individual, to get an advantage over another by false suggestions or suppression of the truth. . . . [I]t includes all surprise, trick, cunning, dissembling, and any unfair way by which another is cheated.³⁶

In the Anglo-American common law, a “false representation” can take many forms, including³⁷:

Wall Street Journal Europe [2006] UKHL 44. See Weaver *et al.* (2004) for a fascinating empirical study of the (modest) impact that the *Reynolds* decision has had on British journalism.

In the United States, the freedom of public debate is protected by a much stronger rule, emanating from the First and Fourteenth Amendments to the Constitution and enunciated by the Supreme Court in a series of cases starting with *New York Times Co. v. Sullivan*, 376 U.S. 254 (1964): namely, that a public official or “public figure” can recover for libel concerning his public role only if the false and defamatory statement is made (a) in the knowledge that it is false, or (b) with reckless disregard of whether it is true or false. For a brief summary, see American Law Institute (1977, §580A); and for a riveting account of the political and legal background to the *Sullivan* case, see Lewis (1991).

³⁶Black (1979), citing *Barr v. Baker*, 9 Mo. 850 (1846), at 854. Black goes on to say that “the only boundaries defining [fraud] are those which limit human knavery.” In subsequent editions of Black’s Law Dictionary, the definitions have become less eloquent, though the meaning is unchanged.

Elsewhere, Black (1916, p. 43) observes that “to defraud another is not only to deprive or withhold from him that which belongs to or is due to him, but also to deprive him of any right . . . by any artifice or wrong practised upon him. And it is not essential that fraud should be accomplished by means of spoken or written falsehoods. If the intended result is accomplished, it is immaterial whether the means employed are affirmative or negative, that is, whether they consist of false pretenses or representations, deceptive acts or conduct, or the fraudulent suppression of material facts.”

In English law, the definition of fraud is essentially identical to that given by Black:

Fraud . . . may be said to include properly all acts, omissions, and concealments which involve a breach of legal or equitable duty, trust or confidence, justly reposed, and are injurious to another, or by which an undue or unconscientious advantage is taken of another. All surprise, trick, cunning, dissembling and other unfair way that is used to cheat any one is considered as fraud. (McDonnell and Monroe 1952, p. 1)

[F]raud is proved when it is shewn that a false representation has been made (1) knowingly, or (2) without belief in its truth, or (3) recklessly, careless whether it be true or false. To prevent a false statement being fraudulent, there must, I think, always be an honest belief in its truth. . . . [I]f fraud be proved, the motive of the person guilty of it is immaterial. [*Derry v Peek* (1889) 14 App Cas 337 at 374, per Lord Herschell]

Furthermore,

if I thought that a person making a false statement had shut his eyes to the facts, or purposely abstained from enquiring into them, I should hold that honest belief was absent, and that he was just as fraudulent as if he had knowingly stated that which was false. [*ibid.*, at 376]

³⁷See Spencer Bower and Handley (2000, chapters 2–5) for a detailed discussion. See also <http://en.wikipedia.org/wiki/Fraud> and <http://en.wikipedia.org/wiki/Misrepresentation> for a brief summary.

- A false statement of fact, known to be false at the time it was made;
- A statement of fact with no reasonable basis to make that statement³⁸;
- A promise of future performance made with an intent, at the time the promise was made, not to perform as promised³⁹;
- An expression of opinion that is false, made by one claiming or implying to have special knowledge of the subject matter of the opinion — where “special knowledge” means knowledge or information superior to that possessed by the other party, and to which the other party did not have equal access.^{40,41}

Anything here sound familiar? These are the standards that we would use if George Bush and Tony Blair had sold us a used car. In fact, they sold us a war that has thus far cost the lives of 174 British soldiers, 3973 American soldiers, and somewhere between 80,000 and 1 million Iraqis⁴² — a human toll, that is, of somewhere between 25 and

³⁸“Although an absence of reasonable grounds for believing a statement to be true is not itself a ground for liability [as fraud], it is important evidence that no such belief really exists and therefore that the defendant is guilty not of negligence but of fraud.” (Heuston and Buckley 1996, p. 372)

³⁹“[For there to be fraud] there must be a misstatement of an existing fact: but the state of a man’s mind is as much a fact as the state of his digestion. It is true that it is very difficult to prove what the state of a man’s mind at a particular time is, but if it can be ascertained it is as much a fact as anything else. A misrepresentation as to the state of a man’s mind is, therefore, a misstatement of fact.” [*Edgington v Fitzmaurice* (1885) 29 Ch.D. 459 at 483, CA, per Bowen LJ]

⁴⁰“[I]f the facts are not equally known to both sides, then a statement of opinion by the one who knows the facts best involves very often a statement of a material fact, for he impliedly states that he knows facts which justify his opinion.” [*Smith v Land and House Property Corporation* (1885) 28 Ch.D. 7 at 15, per Bowen LJ]

⁴¹It is worth noting the analogy, in this last case, with scientific fraud. A scientist frequently has privileged access to information concerning his own research: raw experimental data, unpublished details of calculations, etc. For this reason, every scientist is ethically obliged to bend over backwards to disclose all potentially relevant information (and to make further data available to other scientists upon request), especially if it might cast doubt on his or her own theory.

It is also worth stressing that, in law as well as in science, misrepresentation is not limited to asserting as true a proposition that one knows for a fact to be false; it also — and far more importantly — includes misrepresenting the *strength* of the evidence that one possesses for or against a particular proposition. See American Law Institute (1977, §526b,c) and Prosser (1971, p. 701), cited in footnote 44 below. This is crucial, both in science and in public policy, because one rarely possesses, in the case of any controversial scientific or policy question, “proof beyond a reasonable doubt”.

⁴²The 80,000 figure is a *lower bound*, based on reports of civilian deaths between March 2003 and January 2008 — due to coalition and insurgent military action, sectarian violence and increased criminal violence — that have been published in English-language media (including Arabic media translated into English). See <http://www.iraqbodycount.org/>

Other reputable estimates, based on professional polling, of deaths due to violence range from 151,000 through June 2006 (Iraq Family Health Survey Study Group 2008) to 601,000 through July 2006 (Burnham *et al.* 2006) and 1,033,000 through August 2007 (Opinion Research Business 2007, 2008: these latter studies have not, however, been published in a peer-reviewed journal).

For an extremely detailed account of the radically divergent estimates of excess Iraqi deaths by violence since 2003, along with methodological criticisms and rebuttals, see http://en.wikipedia.org/wiki/Casualties_of_the_Iraq_War and the pages to which it links.

300 September 11ths; that has thus far cost the American taxpayers a staggering \$498 billion (with ultimate estimates ranging from \$1–2 trillion)⁴³; and that has strengthened both al-Qaeda and Iran — in short, a war that may well turn out to be the greatest foreign-policy blunder of American history. (You British have a longer history, and hence a longer history of blunders to compete with.)

Now, in the common law there are in fact two distinct torts of misrepresentation: *fraudulent misrepresentation* and *negligent misrepresentation*. Fraudulent misrepresentation is of course difficult to prove because it involves the state of mind of the person making the misrepresentation, i.e. what he actually knew or believed at the time of the false statement.⁴⁴ Which means that the question becomes — as it was in the case of

⁴³The \$498 billion estimate (as of 27 February 2008) is due to the National Priorities Project (http://www.nationalpriorities.org/cost_of_war_counter_notes). It includes military and non-military (e.g. reconstruction) spending in Iraq (incremental costs only, e.g. combat pay but not soldiers' regular pay). It does not include future medical care for wounded soldiers, interest payments on Iraq-related debt, or any indirect economic costs (e.g. increased oil prices). Broadly similar figures are found by the Congressional Research Service (Belasco 2007) and the Congressional Budget Office (Orszag 2007), as well as by Lawrence Lindsey, former chief economist to President Bush (and former Enron consultant, see Toedtman 2002) and a continuing supporter of the war (Lindsey 2008). The war currently costs approximately \$0.3 billion per day.

Economists' estimates of the ultimate total cost of the Iraq war (to the U.S. alone) range from approximately \$1 trillion (Wallsten and Kosec 2005) to over \$2 trillion (Bilmes and Stiglitz 2006); but all such estimates are rendered imprecise by uncertainty about how long the U.S. intends to keep troops in Iraq. See Leonhardt (2007) for an illuminating perspective on “what \$1.2 trillion can buy”.

⁴⁴In English law, see *Derry v Peek*, quoted in footnote 36 above; and see Spencer Bower and Handley (2000, chapters 2–5) for more details.

The definition in American law is as follows (American Law Institute 1977):

§526. Conditions Under Which Misrepresentation Is Fraudulent (Scienter)

A misrepresentation is fraudulent if the maker (a) knows or believes that the matter is not as he represents it to be, (b) does not have the confidence in the accuracy of his representation that he states or implies, or (c) knows that he does not have the basis for his representation that he states or implies.

The following addendum is also relevant to the cases of Bush and Blair:

§527. Ambiguous Representation A representation that the maker knows to be capable of two interpretations, one of which he knows to be false and the other true is fraudulent if it is made: (a) with the intention that it be understood in the sense in which it is false, or (b) without any belief or expectation as to how it will be understood, or (c) with reckless indifference as to how it will be understood.

The subsequent commentary adds that

Even though the maker of the statement did not realize the ambiguity of the statement when he made it, if he subsequently becomes aware that as a result of its ambiguity the statement is understood by the recipient in a sense that would make it false, he is under a duty to use reasonable care to disclose to the recipient information to prevent him from being misled by the statement.

Furthermore,

§529. Representation Misleading Because Incomplete A representation stating the truth so far as it goes but which the maker knows or believes to be materially

an earlier American president who stood accused of far lesser crimes and misdemeanors: What did George Bush and Tony Blair know and when did they know it? Unfortunately, the documents that could elucidate this question are top secret, so we may not know the answer for 50 years, if ever. But enough documents have been leaked so far to support, I think, a verdict of fraudulent misrepresentation. Given that time is running short, I shall refrain from taking the next 3 hours to bore you with the details of this evidence; you can find those details in the book-length report compiled at the courageous direction of U.S. Representative John Conyers (which is available for free download on the web)⁴⁵, in a briefer but equally damning report compiled at the direction of U.S. Representative Henry Waxman⁴⁶, or in New York Times journalist Frank Rich’s book *The Greatest Story Ever Sold*⁴⁷.

Now, all this is very likely old hat to most of the people in this room. We know perfectly well that our politicians (or at least some of them) lie to us; we take it for granted; we are inured to it. And that may be precisely the problem. Perhaps we have become so inured to political lies — so hard-headedly cynical — that we have lost our ability to become appropriately outraged. We have lost our ability to call a spade a spade, a lie a lie, a fraud a fraud. Instead we call it “spin”.⁴⁸

We have now travelled a long way from “science”, understood narrowly as physics, chemistry, biology and the like. But the whole point is that any such narrow definition of science is misguided. We live in a single real world; the administrative divisions used for convenience in our universities do not in fact correspond to any natural philosophical boundaries. You can’t use one set of standards of evidence in physics, chemistry and biology, and then suddenly relax your standards when it comes to medicine, religion or politics. (Or rather, you *can* do so — as all too many people do — but you have no

misleading because of his failure to state additional or qualifying matter is a fraudulent misrepresentation.

Note, finally, that “a defendant who asserts a fact as of his own knowledge, or so positively as to imply that he has knowledge, under circumstances where he is aware that he will be so understood when he knows that he does not in fact know whether what he says is true, is found to have the intent to deceive, not so much as to the fact itself, but rather as to the extent of his information.” (Prosser 1971, p. 401)

⁴⁵Miller (2006, chapter I).

⁴⁶U.S. House of Representatives (2004). The associated website contains “a searchable collection of 237 specific misleading statements made by Bush Administration officials about the threat posed by Iraq. It contains statements that were misleading based on what was known to the Administration at the time the statements were made. It does not include statements that appear mistaken only in hindsight. If a statement was an accurate reflection of U.S. intelligence at the time it was made, it was excluded even if it now appears erroneous.”

⁴⁷Rich (2006).

⁴⁸One of the additional corrupting effects of cynicism is that it undermines our ability to properly appreciate those politicians who *do* have the courage to tell us the truth — even when it is unsettling, even when it contradicts our (and their own) preconceptions.

justification for doing so.) Lest this sound to you like a scientist's imperialism, I want to stress that it is exactly the contrary. As the philosopher Susan Haack lucidly observes,

Our standards of what constitutes good, honest, thorough inquiry and what constitutes good, strong, supportive evidence are not internal to science. In judging where science has succeeded and where it has failed, in what areas and at what times it has done better and in what worse, we are appealing to the standards by which we judge the solidity of empirical beliefs, or the rigor and thoroughness of empirical inquiry, generally.⁴⁹

The bottom line is that science is not merely a bag of clever tricks that turn out to be useful in investigating some arcane questions about the inanimate and biological worlds. Rather, the natural sciences are nothing more or less than one particular application — albeit an unusually successful one — of a more general rationalist worldview, centered on the modest insistence that empirical claims must be substantiated by empirical evidence.

Conversely, the philosophical lessons learned from four centuries of work in the natural sciences can be of real value — if properly understood — in other domains of human life. Of course, I am not suggesting that historians or policy-makers should use exactly the same methods as physicists — that would be absurd. But neither do biologists use precisely the same methods as physicists; nor, for that matter, do biochemists use the same methods as ecologists, or solid-state physicists as elementary-particle physicists. The detailed methods of inquiry must of course be adapted to the subject matter at hand. What remains unchanged in all areas of life, however, is the underlying philosophy: namely, to constrain our theories as strongly as possible by empirical evidence, and to modify or reject those theories that fail to conform to the evidence. That is what I mean by the scientific worldview.

It is because of this general philosophical lesson, far more than any specific discoveries, that the natural sciences have had such a profound effect on human culture since the time of Galileo and Francis Bacon. The affirmative side of science, consisting of its well-verified claims about the physical and biological world, may be what first springs to mind when people think about “science”; but it is the critical and skeptical side of science that is the most profound, and the most intellectually subversive. The scientific worldview inevitably comes into conflict with all non-scientific modes of thought that make purportedly factual claims about the world. And how could it be otherwise? After all, scientists are constantly subjecting their colleagues' theories to severe conceptual and empirical scrutiny. On what grounds could one reject phlogistic chemistry, the inheritance of acquired characteristics or Newton's particle theory of light and yet accept astrology, homeopathy or the virgin birth?

The critical thrust of science even extends beyond the factual realm, to ethics and politics. Of course, as a logical matter one cannot derive an “ought” from an “is”.⁵⁰ But historically — starting in the 17th and 18th centuries in Europe and then spreading gradually to more or less the entire world — scientific skepticism has played the role of

⁴⁹Haack (1998, p. 94).

⁵⁰Many postmodernists reject the fact-value distinction, but I strongly uphold it.

an intellectual acid, slowly dissolving the irrational beliefs that legitimated the established social order and its supposed authorities, be they the priesthood, the monarchy, the aristocracy, or allegedly superior races and social classes.⁵¹ Four hundred years later, it seems sadly evident — as I have tried to demonstrate tonight — that this revolutionary transition from a dogmatic to an evidence-based worldview is very far from being complete.

I'd like to thank you all for your patience in sitting through this long diatribe, and to open the floor to all the comments and criticisms that you'd care to throw at me.

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⁵¹The argument (as well as some of the phraseology) in the preceding two paragraphs is shamelessly plagiarized from Bricmont (2005, pp. 21–23 and 32–33).

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