DAVID HARKER

Creating Scientific Controversies

Uncertainty and Bias in Science and Society

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University Printing House, Cambridge CB2 8BS, United Kingdom

Cambridge University Press is part of the University of Cambridge.

It furthers the University's mission by disseminating knowledge in the pursuit of education, learning and research at the highest international levels of excellence.

www.cambridge.org
Information on this title: www.cambridge.org/9781107692367

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First published 2015

Printed in the United Kingdom by TJ International Ltd. Padstow Cornwall

A catalogue record for this publication is available from the British Library

Library of Congress Cataloguing in Publication data
Harker, David (David W.)
Creating scientific controversies : uncertainty and bias in science and society / David Harker.
pages cm
Includes bibliographical references and index.
ISBN 978-1-107-69236-7
1. Science – Philosophy. 2. Skepticism. I. Title.
Q175.H3245 2015
501–dc23
2015011610

ISBN 978-1-107-06961-9 Hardback
ISBN 978-1-107-69236-7 Paperback

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Creating Scientific Controversies

For decades, cigarette companies helped to promote the impression that there was no scientific consensus concerning the safety of their product. The appearance of controversy, however, was misleading, designed to confuse the public and to protect industry interests. Created scientific controversies emerge when expert communities are in broad agreement but the public perception is one of profound scientific uncertainty and doubt. In the first book-length analysis of the concept of a created scientific controversy, David Harker explores issues including climate change, Creation science, the anti-vaccine movement and genetically modified crops. Drawing on work in cognitive psychology, social epistemology, critical thinking and philosophy of science, he shows readers how to better understand, evaluate and respond to the appearance of scientific controversy. His book will be a valuable resource for students of philosophy of science, environmental and health sciences, and social and natural sciences.

DAVID HARKER is Associate Professor of Philosophy at East Tennessee State University. He has published articles in journals including *British Journal for the Philosophy of Science, Philosophical Studies* and *Studies in History and Philosophy of Science*.

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For Harry and Isla, in the hopes that someday they might choose to read it, and then review it favourably

Preface

For several years I have enjoyed teaching an introductory college course that explored many of the issues discussed in this book. My thanks go out to all those students who have helped me think through these issues, who have challenged me to find better ways of explaining the material, and who have helped me see which aspects were of greater or lesser relevance. Several friends and colleagues were extremely generous with their time and talents, reading through large sections of the book, and providing wonderful feedback that greatly improved the book. Thanks in particular to Bob Schroer, Justin Sytsma, Matt Lund, Dave Hilbert, Nick Huggett and Bob Fischer. Parts of the book were presented to audiences in Durham, Leeds and Bristol. I am very grateful to those who made these events possible, and to those who attended and offered helpful questions and discussion. An anonymous referee from Cambridge University Press made several excellent suggestions that I'm sure have made the book better. My editors, Hilary Gaskin and Rosemary Crawley, were incredibly helpful with the book's preparation, for which I am very grateful. My thanks are also owed to the College of Arts and Science at East Tennessee State University, for awarding me a Summer Research Fellowship in 2014, which helped in the final stages of writing. My sister and parents have always provided enormous encouragement and support. There are many reasons why this book wouldn't have been written if it wasn't for them. Finally, my wife is a perennial source of inspiration and optimism. With respect to this project she was always willing to offer support, advice and reassurance. For the many ways she enriches my life I am indebted.

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Introduction: scientific authority and the created controversy

The word *science* can conjure up for us a variety of ideas and images. It can whisk us back to cluttered classrooms, furnished with tall stools and long benches, Bunsen burners, and glass-doored cupboards stocked with assorted paraphernalia. The word might bring to mind the names and faces of famous scientists: Newton, Faraday, Hawking, Curie, Galileo and Mendel all jostle for attention, but ultimately are crowded out by a mental image of Freud and his cigar, Einstein and his untamed hair, or Darwin and an almost equally untamed beard. Maybe it rouses important scientific concepts, activities or instruments, the atom, star gazing, the test tube or the microscope. Perhaps we imagine a pristine laboratory, a young technician dressed in an immaculate white coat, scrutinizing a vial of blue translucent fluid for reasons unknown.

Science is ubiquitous. Its boundaries are fuzzy, its range bewildering. Distinctions have been drawn between different *types* of science, natural versus social, hard versus soft, historical versus experimental, and so on. Disagreement reigns over whether economics is science, whether anthropology is science, whether history is science. Creation science calls itself science, but many call foul. Politicians have suggested – what sounds thoroughly reasonable – that policy should utilize *sound science* and eschew *junk science*. Scientific discoveries are reported in the media; scientific concepts are utilized in novels, film and television. Science is popularized and demonized. It offers explanations of our most commonplace observations, but in terms that are peculiar and hard to comprehend. Scientific developments are integral to some of society's most remarkable achievements, but also some of our most horrifying tragedies. Science is both utterly familiar and an immediate source of controversy and debate.

The fact that science occupies an extraordinarily important place within modern society makes it important to think more carefully about what science is. A great deal of scientific research is conducted in service to issues of public safety and perceived public need, is funded by taxpayers, and is overseen at least to some extent by political systems. It is sensible to consider whether the research being pursued is of genuine value, of greater value than research that doesn't get funded, and whether the degree of political oversight is appropriate. The technological fruits of scientific labours often give rise to hard questions about the ethics of warfare, human reproduction, food production, energy development and more. To some extent at least science interacts with every other aspect of society, and at each point of interaction there is room to evaluate whether sensible goals have been identified, and whether sensible methods are being deployed with respect to those goals.

The *applications* of scientific research generate critical questions, but even if we restrict our attention to science as it seems principally concerned with generating facts, or knowledge, or information, our preconceptions deserve closer scrutiny. Insofar as the laboratory white coat seems emblematic of science, do we forget those scientists who work predominantly in the field, or at a computer, or with human subjects? Do we regard some of these activities as *less scientific* and, if so, on what grounds? Newton and Galileo are famous figures from the history of science, but how sure are we that today's scientists would agree with them about what counts as science, and how science should be conducted? Distinguishing scientific from non-scientific disciplines sounds like a sensible and worthwhile endeavour, but significant efforts have accomplished little consensus among philosophers of science; neither the struggles, with what's known as the problem of demarcation, nor their implications, are widely appreciated. Thus, even ignoring the broader roles of science in the modern world, attempts to understand the nature of science – its methods, assumptions, limitations and achievements – prompt difficult questions and sensible concerns. Making sense of even this much is important, as we'll see, but not straightforward (as we'll also see).

Regardless of where precisely we define or find its edges, however, and what exactly we imagine happens between them, most of us appear, at least most of the time, willing to admit science as our most reliable means of acquiring knowledge of both ourselves and the world we inhabit. Scientists are our most respected authorities on an incredibly wide variety of issues. We look to them for answers concerning the deep past and the near future, the living and the inanimate, the farthest reaches of the universe and the innermost secrets of the human mind. An enormously diverse range of subjects are lumped together under the banner of science, and one of the few attributes these subjects share in common is that *because they're science* we attach special significance to their conclusions. We assume science is more *objective* than alternative ways of investigating the world, that it is guided by *facts* and thus less influenced by fads and impulse, its results unvarnished by personal agenda, prejudice and bias. By overcoming biases science is considered more *rational* than alternative ways of investigating, and thereby achieves something that is absent from many other human activities: the histories of literature, art, and music contain ample evidence of change, but science seems to do more – it makes *progress*. Our confidence in its methods means we trust science to tell us how things are, at least most of the time. The reason it is sometimes thought important whether psychology, for example, can properly be called a *science* is that the term has significant rhetorical force; merely labelling a discipline *scientific* can improve its profile and credentials, hence the occasionally bitter disputes over whether a particular discipline deserves the honorific.

The confidence we place in science deserves close inspection. Can we justify our preference for distinctively scientific conclusions? Can we identify those features that make science more rational and more objective? As we'll see, that science is purportedly more objective, more rational, based on facts, and so on are ideas that have all been challenged. In the early 1960s a fresh approach to questions about the nature of science revolutionized philosophy of science and neighbouring disciplines, and influenced many more distantly related fields. Some who were stirred by the new methodology advanced yet more radical challenges during the 1970s and 1980s, which ultimately led to what the media dramatically dubbed *The Science Wars*. What appeared to be at stake was nothing less than scientific authority itself – that widespread assumption which admits science as our most reliable means of generating knowledge. Many would defend a triumphal, laudatory attitude towards science, but others were far less sanguine. In subsequent chapters, we'll discuss, in broad outline, both the evolution of these ideas and their foundations.

Despite the influence of these sceptical attitudes towards science, in many circles, and in many contexts, scientific authority remains unsullied. Even putting radically sceptical attitudes towards science aside, however, the authority of science can still seem somewhat surprising if we pause to reflect on some modern scientific conclusions. Physics and chemistry trade in objects that seem almost impossibly small. Consider that there are more atoms in a grain of sand than there are grains of sand on almost any given beach. (Read that sentence again if at first glance it seemed just too incredible.) Cosmology and geology deal with events on enormous scales, both in space and time, and processes that take so long to unfold that the entire history of mankind is negligible by comparison. Compress the history of Earth into one calendar year and the birth of Jesus Christ occurs with less than fifteen seconds of the year remaining. (You might try pondering on that when you're about to begin the countdown next New Year's Eve.) Molecular biologists tell us that the information needed to create something as complicated as a human being is contained within twenty-three pairs of chromosomes, that two copies of each chromosome can be found in almost every cell in your body, but most of these cells are so small that they're invisible to the naked eye. Einstein's theories of special and general relativity, quantum physics, neuroscience, biochemistry, evolutionary biology, and a great deal more besides, can simultaneously stupefy and delight. Science presents us with a fascinating description of the world, often highly unexpected, and sometimes so mind bogglingly bizarre that it stretches credulity.

Yet in spite of its astonishing conclusions most of us appear willing to accept most scientific claims without fuss, perhaps through familiarity, or a tendency to massage the claims into a more digestible form. The truly remarkable nature of some of science's most important discoveries can be easily overlooked, but should serve to illustrate that our personal intuitions, speculations and extrapolations from familiar experiences, our common-sense judgements, and even just our very best efforts to think really hard, rarely produce results that even remotely approximate the scientific image. Conceding the authority of science requires that we relinquish the right to reject scientific conclusions just because they don't sit right with us. If our gut reactions were a reliable guide to the plausibility of scientific conclusions, then scientific successes wouldn't keep building on ideas that at first sound preposterous. That our planet spins on its axis at hundreds of miles an hour, and completes an annual orbit of the Sun, were deeply disconcerting ideas to Galileo's contemporaries in the early seventeenth century. The size of the universe that was needed by the heliocentric model, to account for the absence of what's known as stellar parallax, was nothing short of astounding.[1] The discomfort felt by those who were challenged by Galileo was in itself an unreliable reason for rejecting heliocentricism. Mere discomfort isn't a better reason for rejecting a scientific conclusion today.

Nevertheless, on a wide range of issues many people are accused of dismissing well-established scientific claims, despite the absence of any good reason for doing so. Advocates for certain scientific ideas insist that the science is now beyond dispute, and that its main conclusions can't be ignored. Those who continue to resist these conclusions are accused of relying on superstition, or wishful thinking, or simply of being ignorant and confused. Science proponents insist that too many people, without relevant qualifications or understanding, trust their own ability to evaluate the state of the science above the combined acumen of scores of experts. And the result is more serious than simply a misinformed public. By ignoring our scientists, it is suggested, we are risking our health and the health of our children, flirting with unprecedented environmental disaster, and thereby incalculable human cost, embracing naïve attitudes about the world around us, denying ourselves technological advances that hold the potential for momentous improvements to our quality of life and unnecessarily endangering members of society that deserve far greater protection. Throughout this book I'll assume that such consequences are bad and that we should be motivated to

[1] It's familiar from everyday experience that objects change their apparent position, relative to more distant objects, as we change our perspective. For example, with just one eye open, hold your thumb out at arm's length so that it fully obstructs your view of some object. Now switch eyes and the object becomes visible, with your thumb located some distance to the left or right of that same object within your visual field. The change in perspective affects the apparent position of your thumb, relative to the more distant object. If the Earth orbits the Sun, then our perspective on any given star changes. Stars that are closer should, therefore, appear to change their positions, relative to more distant stars. These effects are now discernible, but the technologies available to Galileo were insufficient to reveal this effect. Heliocentricism was reconciled with this failure to observe stellar parallax by supposing that even the closest stars were much farther from Earth than anyone had previously believed. The change in perspective, as the Earth orbits the Sun, thus becomes negligible relative to the distance to the stars, and hence the absence of stellar parallax is explained.

avoid them. Since I imagine that most readers would agree on both scores, the more important questions become: Are we really ignoring well-established scientific opinion without good reason, and, if so, how is this happening? How sure are we that science has got it right? Science has been wrong before, so why should we trust what today's scientists say? Furthermore, with respect to many scientifically informed, hot-button issues, like climate change, homeopathy, stem cell research, evolutionary biology, the safety of vaccinations, and so on, we are often aware of objections to the science, and to the presence of dissenting voices seemingly from within the relevant scientific community. In some instances, we might suspect that certain scientists have an agenda to promote their ideas regardless of the quantity and quality of the evidence that's available to them. Although some insist the science is unassailable, isn't it reasonable to still have doubts and concerns about even the most basic conclusions?

The stakes are high. Needlessly risking our health, our lives, and our planet, is something we all wish to avoid, but if the science is wrong, then endorsing its recommendations will also have avoidable and perhaps devastating consequences. We must strive to make decisions, whether on a personal, regional or global level, that are based on the best information we have, and hence we can afford to ignore prevailing scientific conclusions only if we have good reasons for doing so. In this book, we'll be concerned to learn how we can better evaluate the state of debates that are advertised as scientifically controversial, and to see what kinds of objections to scientific controversy are worth worrying about. In part this is a book about how we have been led astray on certain issues, and what we can do to avoid being misled again. We'll seek to improve our critical thinking skills and better appreciate some of our shortcomings as rational agents. We'll look to philosophy of science for help in developing more sensible attitudes towards the nature of scientific inquiry and, in the final chapters of the book, towards particular issues surrounding matters of public health, as well as climate change and Creation science. Reviewing an example now, however, will help better illustrate some of the book's principal themes; a particularly instructive example concerns the conduct of the tobacco companies during the middle of the twentieth century.[2]

The cigarette deception

The first machine-rolled, modern cigarettes appeared in the 1880s. Almost from their inception there were concerns about possible health risks. The effects of smoking on circulation, physical and mental development, as well as fertility and lactation in women, were all explored during the first few decades of the twentieth century, but

[2] The actions of the cigarette industry during the second half of the twentieth century are very well documented. Brandt (2009) and Proctor (2012) are excellent resources.

studies produced only ambiguous results. Excessive smoking was generally judged inadvisable, although it was unclear exactly what qualified as excessive. Smoking was also widely regarded as harmful to children, though this was seemingly based on little more than suspicion. Largely, however, medical opinion settled on moderate smoking as a safe practice for most adults. The fact that cigarettes increase the risks of developing lung cancer owed its discovery to several factors. Allan Brandt, a historian of medicine, argues that one of the most important factors was the introduction of new statistical methods into medical research during the late 1940s, methods that were introduced by the very researchers who were curious about the cigarette-lung cancer connection.

During the early decades of the twentieth century, the study of disease was dominated by laboratory-based techniques. The German physician, Robert Koch, had advanced four principles for identifying the causes of infectious disease. If a certain microorganism is found predominantly in organisms diagnosed with a given disease, and can then be isolated from the diseased organism and grown in culture, utilized to induce disease in an otherwise healthy organism, and, finally, isolated from the inoculated organism and shown to be identical with the original microorganism, then we can conclude that this particular type of microorganism causes the particular disease. Koch's postulates were hugely influential, although recognized even by Koch as having significant limitations; they also played an important role in the more general, dominant penchant for studying disease at the cellular level. An important implication of this preference for laboratory methods was the marginalization of statistics within medical research.

In 1950 two important papers were published, one by American researchers, Ernst Wynder and Evarts Graham, and a second by British scientists, Bradford Hill and Richard Doll.[3] These presented impressive statistical evidence relating cigarette smoking to lung cancer. Within their sample populations, lung cancer was extremely rare among non-smokers, and cigarette use was high among those diagnosed with lung cancer. Among lung cancer patients, the high ratio of males to females was attributed to the fact that smoking had been a predominantly male activity. The evidence was, however, as the authors were only too aware, *merely* statistical. The use of statistics is by now so common that it's hard to appreciate how things could ever have been otherwise. Nevertheless, within the medical profession, overcoming scepticism and resistance towards the connection between cigarettes and lung cancer involved, in large part, convincing the medical community that statistics could provide a legitimate form of scientific evidence.

What's easy to overlook, in our efforts to better understand the nature of scientific inquiry, is that some scientific debates concern the propriety of particular *methods*.

[3] In the 1930s German and Argentine scientists had gathered evidence that cigarettes cause lung cancer, both through animal experimentation and statistical studies, but these were largely ignored. See Proctor (2012) for more details.

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