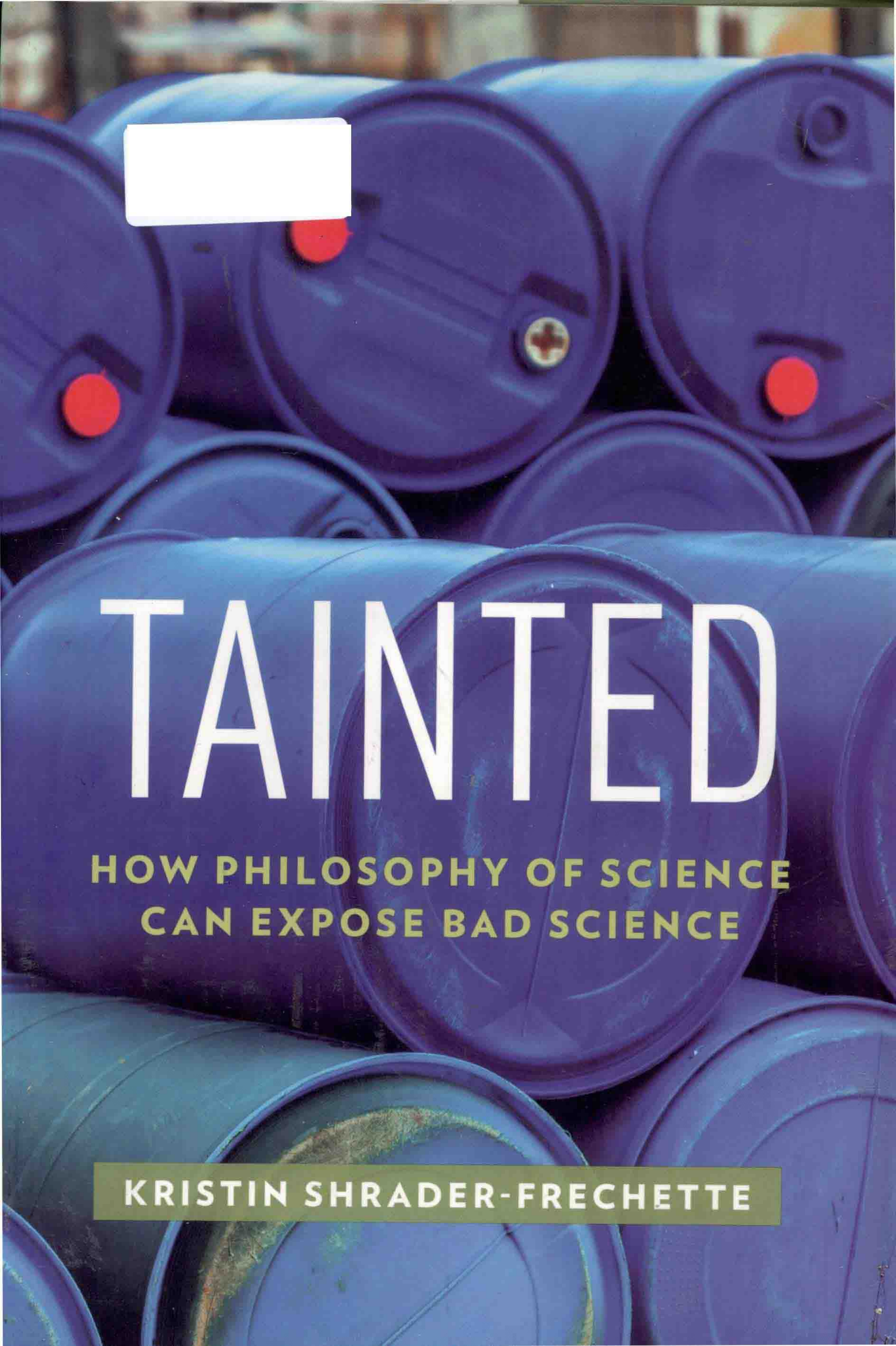

# TAINTED

## HOW PHILOSOPHY OF SCIENCE CAN EXPOSE BAD SCIENCE

KRISTIN SHRADER-FRECHETTE

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*For Evelyn,*
*that you and your sister may help create an even better world*
*than the one into which we brought you.*

Tainted

# CONTENTS

CHAPTER 1

# Speaking Truth to Power

## UNCOVERING FLAWED METHODS, PROTECTING LIVES AND WELFARE

Although Westerners formally repudiate racism, sometimes their science may encourage it. For instance, many people assume that Aboriginal dominance by industrialized peoples exhibits a Darwinian survival of the fittest, that technologically primitive people retain more evolutionary traces of descent from apelike beings. After all, says Pulitzer-Prize–winning biologist Jared Diamond, Aborigines had lived in Australia for 40,000 years as hunter-gatherers. Yet within a century of colonizing Australia, white immigrants built a literate, democratic, industrialized, politically centralized state. Given identical Australian environments, many drew the scientific conclusion that divergent Aboriginal and European achievements arose from biological and cognitive differences between the peoples themselves.[1]

Diamond rejects this scientific conclusion as invalid and racist. He argues that on average, stone-age peoples probably are more intelligent than industrialized peoples because they must learn to cope with high-mortality societies facing tribal warfare, accidents, and food-procuring difficulties. Westerners, however, often fail to learn from their environment. Instead they waste more time in passive entertainment—7 hours/day of TV in average American households. But if Westerners often survive, regardless of their abilities, what explains their dominance? Real estate, says Diamond. Because Europeans were fortunate to live in regions with accessible metals, they built guns and steel tools that were unavailable to stone-tool people. Because they lived in urban centers and developed nastier germs, they and not colonized peoples became immune to them. Because guns, germs, and steel indirectly conferred political and economic power on colonizers, Diamond says colonized and enslaved peoples have never competed on a level playing field. Thus there is no scientific evidence for their supposed inferiority.[2]

Diamond's analysis of the case of Australian Aborigines suggests that science can be done well or badly. It can be used for advancing knowledge or allowing oppression. As the ace in the deck of knowledge and action, science has the power to trump opinion and to create or settle disputes. Because science is so powerful, those who ignore its evaluation do so at their own peril.

## Practical and Theoretical Evaluations of Science

Arguing for a new focus in evaluating science, this book is the first devoted entirely to practical philosophy of science—to using classic philosophy-of-science analyses to help uncover flawed science, promote reliable science, and thus help liberate people from science-related societal harms. It illustrates traditional philosophy of science—how to analyze concepts, methods, and practices in a variety of sciences. Yet it does so by investigating parts of biology, economics, physics, and other sciences that can make life-and-death differences for humans. Instead of autopsies on dead scientific theories—purely theoretical or historical evaluations—practical philosophy of science has at least four characteristics. It analyzes science having critical, welfare-related uses and *consequences*. It analyzes science naturalistically, using the logic and *methods* that scientists use. It analyzes science at the heart of *contemporary controversies*. It illustrates *how to* evaluate scientific methods and does not merely describe what they are. In its focus on practice and the *how* of evaluating science, this book is eminently practical in illustrating how to use methodological criticisms of science to liberate people from the flawed science that often harms them. It aims to be a philosophy-of-science analogue for the practical legal analyses of the Innocence Project—used by law students who work pro bono to liberate death-row inmates from the flawed legal system that often kills them in error.

Practical evaluation of science is important because, at least in the United States, 75 percent of all science is funded by special interests in order to achieve specific practical goals, such as developing pharmaceuticals or showing some pollutant causes only minimal harm. Of the remaining 25 percent of US-science funding, more than half addresses military goals. This means that less than one-eighth of US-science funding is for basic science; roughly seven-eighths is for practical projects.[3] Yet, as later paragraphs reveal, most philosophy of science focuses on evaluating the one-eighth of science that is theoretical, while almost none assesses the seven-eighths that is practical. This book seeks to broaden the scope of philosophy of science, to evaluate contemporary scientific methods that make a difference in the world.

While traditional or theoretical philosophy of science focuses on understanding science, this book addresses both understanding and justice. It seeks understanding by assessing classic questions of philosophers of science. It seeks justice by addressing these classic questions in ways that also assess their practical consequences for welfare. What are some of these classic questions?

Scientists and philosophers of science typically ask at least 5 types of traditional *theoretical* questions about

- how to analyze concepts,
- how to make inferences about data,
- how to discover or develop hypotheses,
- how to test or justify hypotheses, and
- how to deal with unavoidable value judgments that arise, especially in situations of scientific uncertainty.

Given this roughly chronological account of some classic philosophy-of-science questions, this book asks them about science that has practical, often life-and-death consequences for human welfare. Following this 5-question framework, the book has 4 sections:

- *conceptual analysis* and *logical analysis*
- *heuristic analysis*, questions about hypothesis-discovery/development
- *methodological analysis*, questions about testing/justifying hypotheses
- *values analysis*, questions about normative judgments in science.

Thus the book's framework and questions focus on traditional philosophy of science, but its analyses, cases, and illustrations assess science with welfare-related consequences.

## What Is Science?

More than today, early science probably was dominated by practical concerns, by devising inventions that would help humans. In fact, the English word "scientist" arose rather late, in 1834, when the naturalist-theologian William Whewell coined the word. Until that time, scientists often were called artisans or inventors, as when philosopher-scientist Francis Bacon said, "the good effects wrought by founders of cities, law-givers . . . extirpers of tyrants, and heroes . . . extend but for short times, whereas the work of the inventor . . . is felt everywhere and lasts forever."[4]

Similarly, until the 1800s, European universities had no "scientists." Instead they had at most 4 branches of learning: law, medicine, theology, and philosophy. Philosophy included what we now call scientific, engineering, and humanistic disciplines, something that explains why the advanced degree in all these disciplines is still called the PhD (Doctor of Philosophy). By the 17th century, however, philosophy was divided into *moral philosophy*, the study of the human world, as through politics, economics, ethics, and psychology, and *natural philosophy*, the conceptual/mathematical study of non-human phenomena, as through physics or chemistry. Although in Scotland "natural philosophy" sometimes is still used today to label science departments such as physics, it was the dominant label for science only until Whewell's time. That is why Isaac Newton called his 1687 physics classic "The Mathematical Principles of Natural Philosophy."[5]

Even persons studying "scientia" ("episteme" or knowledge, for Aristotle) did not study science as we know it, but any well-established systematic or causal knowledge, including theology. Although early 20th-century philosophers sometimes followed Aristotle and called ethics "science/scientia,"[6] they were in the minority. By the 19th century most scholars no longer considered academic disciplines like theology to be science.[7] Instead they defined science as grounded in rigorous, observation-based experiment, logic, prediction, and replicability. As these chapters illustrate, however, scientists still disagree on how much, and what kind of, rigor is enough, in order for something to be scientific.

Why did natural philosophy slowly evolve into science? One reason is the rising status of mathematical practitioners or artisans doing "ars" ("techne" in Greek). They became aligned with the elite natural philosophers who were doing scientia. Ars was practical knowledge of how to do something—like building tables or tracking stars—whereas scientia was theoretical knowledge of a demonstrative kind, like metaphysics. Many slaves, laborers, and tradespeople did ars, whereas free men (rarely women) of wealth and leisure did scientia. Once the scientific revolution began in the 16th century, however, the theory-focused natural philosophers rejected Aristotelianism and turned to less theological and more practical, empirical, mathematically based views, such as heliocentrism and atomism. Their new natural philosophy focused on predicting and changing the world, not just contemplating it. Nevertheless natural philosophers such as Nicolaus Copernicus, Galileo Galilei, Johannes Kepler, and Gottfried Leibniz remained theists. Charles Boyle, Isaac Newton, and other scientists explicitly tied their work to theology, partly because they believed scientific phenomena required a designer, God. Newton even claimed that because God maintains the solar system, gravity can hold the planets together. However, when most 19th-century scholars rejected such theologically oriented causal explanations for material phenomena, natural philosophy was fully transformed into science.[8]

## What Is Philosophy of Science?

From Aristotle to Einstein, scientists and philosophers of science have focused both on science, assessing questions *within* some science, and on metascience or philosophy of science, assessing questions *about* or *beyond* science. Although science and philosophy of science are different in content, philosophy of science requires understanding science, and science often requires understanding philosophy of science.

For centuries philosophers have evaluated science, mainly because of their interest in the limits of what one could know. In the 17th and 18th centuries, philosopher John Locke sought foundations for the experimental knowledge developed by the scientists of his day, like Robert Boyle and Isaac Newton. However, philosophy of science as a labeled discipline is relatively new, and Locke's work was not called philosophy of science. Neither was that of philosopher Immanuel Kant in the 18th and 19th centuries, although he studied the conceptual conditions necessary for scientific knowledge. Only in the late 19th century were questions about the nature of science called philosophy of science or "logic of science"—the name that chemist- mathematician-logician Charles Sanders Peirce gave to a course he taught at Harvard in the 1860s. By the 1890s at Harvard, Josiah Royce taught philosophy of science under that label, as did Edgar Singer at the University of Pennsylvania. In 1890 Paul Carus founded *Monist,* a journal whose title page proclaimed it was "devoted to the philosophy of science." In 1934, the journal *Philosophy of Science* began. Emphasizing rigorous analytic philosophy and logic, similar journals arose in the 1930s, including *Erkenntnis* in Germany, *Analysis* in Britain, and *Journal for Symbolic Logic* in the United States. They signaled a new way of doing philosophy, one focused on logical empiricism, the belief that all knowledge could be based either on sensory experience or on mathematical logic and linguistics. Although chapter 9 explains why most philosophers of science today are not logical empiricists, the discipline of philosophy of science emerged from logical empiricism.[9]

Today philosophers of science address both *theoretical* and *practical* questions, although the dominance of the former is one reason for needing this book on practical philosophy of science. Their theoretical questions can be *abstract*—that is, focusing on science generally—or *concrete,* that is, focusing on a specific science. More practical questions concern science having real-world, often welfare-related, consequences. Of course, these 4 categories of questions—theoretical, practical, abstract, concrete—are not mutually exclusive, partly because there are degrees of each and because some categories can be subdivisions of others. For instance, concrete scientific questions can be either practical or theoretical.

Some more *abstract* (about-science-generally) *theoretical* questions include the following:

- If human observation is imperfect and partial, how can one justify empirical claims?
- What are the different types of scientific models and theories?
- How can scientific revolutions occur, if science is supposed to be true?
- Does science require predicting events, finding their causes, or something else?

Some more *concrete* (specific-to-some-science) *theoretical* questions include the following:

- Except for genetics, does biology have any laws of nature?
- Are special and general relativity compatible with Newton's laws?
- Is Copernicus's theory simpler than that of Ptolemy?
- Are economists right that people typically maximize expected utility?

Some more *practical* (welfare-relevant) methodological questions include the following:

- How reliable are long-term projections for the safety of chemical-waste dumps?
- Do different sexes and races have different cognitive abilities?
- How reliable are different models of climate change?
- How might some pollution, developmental toxins, cause heritable epigenetic damages?

## Practical Philosophy of Science

As already noted, most evaluations of scientific method have focused on theoretical rather than practical questions. Despite the practical origins of science, concerns with scientific practice and practical consequences of science have been outside mainstream, English-language philosophy of science—one reason the Society for the Philosophy of Science in Practice began in 2006.[10] The American Philosophical Association began the Committee on Public Philosophy in 2005,[11] and the Public Philosophy Network began in 2010.[12] This book should extend the efforts of these groups, doing practical philosophy of science by illustrating and assessing methodological flaws in welfare-related science—and thus improving science. One of its goals is to help scientists and philosophers of science—because their methods of analysis can be the same—make room for analyzing scientific practices and science-related practical questions that affect us all.

Insofar as practical analyses of science are naturalized—that is, employ the methods of science—they also address empirical questions, such as whether there is a threshold below which low-dose carcinogens cause no harm (chapter 3), or whether Florida-panther habit is restricted to dry upland areas (chapter 10). However, although this book includes naturalized evaluations of science, it has no presuppositions, one way or the other way, about religion or beyond-natural beings. It naturalistically assumes that both scientists and philosophers of science should use naturalistic methods and attempt to explain the natural world in non-supernatural terms. However, it non-naturalistically assumes that history