A Theory of Wonder

Evolution, Brain and the Radical Nature of Science

by

Gonzalo Munévar
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Dedicated to the memory of Paul K. Feyerabend and in honor of the celebration of his 100th birthday on January 13, 2024

"A Theory of Wonder" is a wonderful book. Professor Munévar, an original philosopher of science, challenges logical empiricism, falsificationism (critical rationalism), scientific realism, Bohr's epistemology, and the philosophy of science of Kuhn, Feyerabend and Lakatos. Thus he creatively explores the evolutionary relativism: a novel and "dynamic" philosophy of science on the basis of evolutionary biology and neuroscience with a focus on living organisms. By contrast, the old and "static" philosophies of science are almost entirely based on physics that focuses on inanimate objects. The author provides a biologically based theory of relative truth, and thereby holds that truth is relative to a frame of reference, and that success explains truth, not the other way around. Creative and germinal is his view of science: "Science as Part of Nature", and "Science as Radical Knowledge". In sum, this thought-provoking work brings forth a new field in philosophy of science. In order to develop and complete this new field, further inputs from philosophers and scientists are much needed.

Yuanlin Guo
Professor of Philosophy
Center for Science, Technology and Society
Tianjin University, China

Gonzalo Munévar's "Theory of Wonder" provides a detailed, well organized journey through the controversies animating 20th century philosophy of science between those looking for a logic of science that captures its method, and those such as Thomas Kuhn and Paul Feyerabend who take the history of scientific practice seriously. Munévar makes this history come alive for scientists and intelligent laypersons, rather than just professional academic philosophers. It is a sophisticated and very engaging account on both a personal and professional level. He presents an innovative exploration of an alternative for the 21st century in which a naturalistic perspective on biological evolution and cognitive neuroscience can shape our understanding of scientific inquiry. His clever arguments and his scholarship reflect a broad interdisciplinary understand of science and its history.

He punctuates his lively discussion with a large variety of scientific examples and observations that show a masterful command of the literature and a well-focused analysis and criticism—a tour de force. Munévar holds that science is an extension of our sense of wonder, but holds that the nature of science described by much of 20th-century academic philosophy of science actually baffled practicing scientist and blunted their curiosity. He offers instead a new, optimistic vision of the field in which science is seen as part of nature, and the nature of science can only be adequately understood if the insights of science

itself (particularly evolutionary biology and cognitive neuroscience) are taken into account. This is a large task, but Munévar makes an admirable start in doing so.

The book should be especially valuable to an international audience drawn to the work of Paul Feyerabend as we approach the centenary of his birth. Feyerabend was Munévar's mentor and friend, who shaped his view of science and launched him on the path that has led to it.

David W. Paulsen
Professor emeritus
The Evergreen State College

Mr. Munévar's manuscript addresses what can be considered the main issue that arises about science from a philosophical reflection, that is, what is the nature of science. The philosophy of science as an autonomous discipline originated around this question and other more specific ones that derive from it at the end of the 19th century and developed more systematically throughout the last century and the last two decades.

Understanding what scientific progress consists of and explaining its success are two central specific questions about the nature of science. The most dominant answers to these two questions have been, respectively, that scientific progress lies in the application of the scientific method and that the success of science is due to discovering the truth about the world, that is, it achieves a true knowledge of how this is, regardless of our state of knowledge and our cognitive abilities.

The manuscript focuses on these two problems, that of progress (scientific method) and that of success (scientific realism), taking them from the answers given in the first half of the 20th century to the most current proposals, and to finally expose and argue the personal solutions given to these by Munévar. This is done masterfully, exposing each of the main points of view precisely and clearly and how they are overcome among themselves: inductivism present in positivists or logical empiricists, falsification in its various variants (radical, Popper and Lakatos), and the historicist turn favored mainly by Kuhn and Feyerabend. As for the original solutions that Munévar proposes, these are based on the findings of the historicist school (so that Munévar recognizes the intellectual debt that he owes to Feyerabend), but it goes further by enriching this historical perspective with the scientific one that considers evolutionary biology and neuroscience in the context of evolution. Munévar calls "evolutionary relativism" to the solution he proposes, to the point of view he develops, because science seen from history and evolutionary biology cannot be understood as a cumulative or progressive process in which a conception or point of view is consolidated, but rather as a process in which science undergoes drastic changes

and in which different conceptions of the world can be given that can be equally correct, and even so it is possible to speak of progress in science.

Munévar's work, while in principle it is aimed at specialists in philosophy of science, given the general problem with which it deals and the way it exposes itself, it may also be of importance for philosophers in general, concerned with the central problems of epistemology. Even because of the centrality of the philosophical problems dealt in the work, I consider that this could be a good tool in university courses, specialized and introductory on philosophy, and much better in philosophy of science.

I believe that the main impact that the work could have lies in the original idea that it displays to understand the nature of science, the evolutionary relativism. Although it is a controversial thesis, as the author himself acknowledges, the exposition and the justification made are clear and precise, supported by arguments from the history of science and evolutionary biology, including elements of neuroscience. Besides, it seems to me that the work could also be welcomed by specialists and a wider audience, cultured, because of the way it is written, starting from the historical context of the problem up to its current state. Although technical, all this with a clear and precise language is accompanied by illustrations that are very appropriate to the subject matter, which allows non-specialists to follow the line of argument.

Germán Guerrero Pino
Professor, Department of Philosophy
Universidad del Valle, Colombia

Gonzalo Munévar is an internationally recognised philosopher of science and among the most important interpreters of the work of Paul Feyerabend, a philosopher of science renowned for encouraging a deep sense of wonder at our abundant reality. He is superbly placed to offer a powerful reflection on the nature of wonder - a complex concept and experience with, I think, a deep role in human life. Munévar argues that the sciences, properly understood, can enrich our sense of wonder - a theme rooted not only in his work on Feyerabend but his recent research in neuroscience and space exploration. Perhaps more than any other sciences, they are apt to evoke a sense of wonder. Munévar is certainly unique in being capable of philosophical reflection on both human consciousness and the cosmos.

Dr. Ian Kidd
Professor, Department of Philosophy
University of Nottingham

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ACKNOWLEDGEMENTS

Over several decades many people have made contributions to help me develop the ideas presented in this book. Already in graduate school, I had invaluable conversations with Paul Feyerabend and Carl Hempel. It was Hempel, whose teaching assistant I was, who inspired some of the figures in Chapter 2 against induction. Indeed, I owe much gratitude to the many artists who have contributed drawings to the manuscript. Beginning with unnamed staff members of the University of Nebraska at Omaha research office; continuing, many years later, with Nicole Ankeny, at Lawrence Technological University; with Leonardo Falaschini, from Cambridge, and finally with my former student Ruoyu Huang. Then there are all those students who reacted to earlier versions of the manuscript. Students in graduate seminars at the University of Washington in Seattle and at the University of California at Irvine, as well as advanced undergraduates at several schools, including the University of Nebraska at Omaha, Evergreen, and Lawrence Technological University. Their many questions have provided useful guideposts. As for my writing the final draft of the book, I am very grateful for their computer help to my colleague, Dr. Matthew Cole, and to my former student Phillip McMurray, who has gone well beyond the call of duty in improving the appearance of the manuscript by formatting the text and images of the book. And last, I also wish to mention the many improvements owed to the proofreading and encouraging comments from my wife, Dr. Susan Greenshields. I do apologize to all those not acknowledged here because of the failings of my memory.

PREFACE

About a year ago, I walked around the beautiful campus of the University of California at Berkeley. Inevitably my steps took me to the manicured lawns by the Campanile, to the green grass where a long time ago I sat with other students, term after term, in Paul K. Feyerabend's graduate seminar. It was the early seventies, when Feyerabend was slowly putting together the manuscript of his greatest work, *Against Method*, the culmination of the revolution in philosophy of science that he and Thomas Kuhn had begun in 1962.

Standing there, in the very spot where we used to sit around him over forty years ago, I could almost feel his presence, the force of his incomparable personality again. I begin this book with these very personal remarks, because this book is the culmination of a very long personal journey, regardless of how intellectual it might have also been. And in both the personal and intellectual aspects of the journey, Feyerabend had a great influence, not by having me become his "follower"—he would have found the thought repulsive—but by challenging my ideas while encouraging me to develop my own thoughts.

Feyerabend was born in Vienna in 1924. During World War II, three Russian bullets left him crippled for the rest of his life (he called himself a cripple and would make fun of euphemisms like "handicapped"). After the war, he recovered enough to study physics and astronomy at the University of Vienna. In those days, Vienna was still a city of geniuses. Feyerabend had a great voice, good enough to sing at the Vienna Opera House, and at one time Bertolt Brecht asked him to be his assistant. Feyerabend also met Konrad Lorenz, who also asked him to be his assistant. Although it was obvious that he had many talents, he ended writing his doctoral thesis in philosophy, under Victor Kraft. After meeting Ludwig Wittgenstein, Feyerabend made arrangements to work with him in Cambridge, but Wittgenstein's death forced him to end up as Karl Popper's assistant instead. All those Viennese figures influenced the young Feyerabend significantly, and in the long run, that influence played an important role in the intellectual revolution that he forged with Kuhn in the sixties and seventies.

I met him in Berkeley in early 1973, during the second year of my doctoral studies. I showed up in his seminar, thinking that I would just sit in it—being cautious just in case the many students who dreaded his critical mind were right. "What will be topic of your presentation?" he asked me after he sat down. "I am just sitting in," I answered. "If you want to stay you will have to give a presentation," he insisted. "But all my ideas are bizarre," I said. "Par for the

course," he answered, taking his schedule book out. "When are you going to present them?"

During my presentation, weeks later, I experienced in my own flesh how disconcerting his criticism could be – something I would have wished on my worst enemy, or on myself if I had really believed that criticism was the main source of progress. Feyerabend questioned everything; he would argue against, and even make fun of what appeared to be obvious claims. In a conversation with him no idea could be taken for granted. That day I was as critical of his remarks as he was of mine, but left the classroom fearing that I had made a fool of myself. Afterwards, however, he was very friendly and invited me to lunch at the Golden Bear, an outdoor restaurant on campus. That would be the first of many meals, not only at the Golden Bear, but at many other restaurants in the San Francisco Bay area and in Europe; meals in which his perceptive comments would jump from philosophy and science to music, or art, or theater, and back to philosophy again; the first of many discussions in which we would talk about women and make fun of each other.

Feyerabend was as mesmerizing in conversation as he was during his lectures. It was difficult then to notice his metal crutch or the constant pain and bad health that he had to overcome during his adult life. Before the great fame, or notoriety, that *Against Method* brought him, he was already an intellectual giant. Standing in the grass by the Campanile a year ago, I vividly remembered his animated face, his contagious laughter, and that extraordinarily sharp mind that delighted his students, his colleagues, his friends – a mind worthy of the greatest admiration.

Someone wrote in the famous journal *Nature* that Feyerabend was the worst enemy of science. But, on the contrary, what Feyerabend did was demonstrate how complex and human science can and should be. Of his many contributions, perhaps the most important is that there is no method or rule that can capture the nature of science. Even the most excellent idea about the practice of science must allow for exceptions. And when we examine the history of science, we discover not only that the great scientists violated the so-called "empirical method," in all its main incarnations, but they had to violate it, for otherwise the great accomplishments by which we know them today would not have come to pass.

Some intellectuals, particularly analytic philosophers in the English speaking world, felt that Feyerabend was insane, or at best, the court jester in philosophy of science. But many people around the world who have read his works, published in many languages, have thought very highly of those works. Over the years, I had doctoral students and post-docs from Europe, China and Africa come to work with me on Feyerabend. I felt honored to be able to guide them. Not that I refrained from criticizing him; surely no less than when I used to sit

across a restaurant table from him, or on the grass at Berkeley, with the Campanile looming large behind him.

Even if my main philosophical view, evolutionary relativism, which I will discuss in this book, may go well beyond Feyerabend's body of work, he was glad that I went my own way. *A Theory of Wonder* is one more book in a long series of books I have published. It may be the last. As I share it with you, I wish to honor someone who showed me the way no less by his example than by his writing and his teaching.

It is only fair that I devote this preface to Paul K. Feyerabend. After all, he wrote the foreword to my very first book, *Radical Knowledge*.

FOREWORD

by David Lamb

A Theory of Wonder is a tribute to the legendary Paul Feyerabend of whom the author was a student. It outlines philosophy of science as it appeared before Feyerabend and advances to the author's well-developed theory of evolutionary relativism, first outlined in his groundbreaking book, *Radical Knowledge*, in 1981, which argued that since both perception and scientific knowledge depended on the brain, and since evolution could create different kinds of brains (or equivalents of the central nervous system), the notion of grasping the naked truth of the world, so to speak, was unsustainable. This book was followed by his *Evolution and the Naked Truth* in 1998, a collection of essays that elaborated his original ideas. Among those original ideas was the suggestion that Munévar's evolutionary relativism can be seen as overlapping with Feyerabend's principle of proliferation. When seen from an evolution inspired perspective, Munévar's approach leads to a social conception of scientific rationality. These ideas are further developed here in close connection to an insightful account of the revolution in the philosophy of science brought about by Kuhn and Feyerabend, with particular emphasis on Feyerabend.

A Theory of Wonder is also influenced by the large amount of work that Munévar has published, and helped publish, concerning the philosophy of his mentor and PhD Dissertation Director at Berkeley, Paul Feyerabend. He edited highly regarded collections of essays on Feyerabend, such as *Beyond Reason* (Kluwer 1991) and *The Worst Enemy of Science?* (Oxford, 2000, co-edited with John Preston and David Lamb).

Munévar accomplishes two tasks in this contribution to the history and philosophy of science. The first is a critique of twentieth-century philosophy of science, outlining its successes and shortcomings; and the second is the development of the author's own theory of evolutionary relativism. In the early chapters, Munévar critiques the so-called scientific method or received view, where observations are said to support theories and are in some way distinct from them. According to the received view, the scientific method consists in having observation pass judgment on theory, either by supporting it or by rejecting it. Practically every introductory science textbook devotes a good portion of its first chapter to emphasize the importance of the scientific method and to give credit to its inventor, Galileo. But whilst the founder of the scientific method is said to be Galileo, an examination of his science reveals that his

approach actually ran counter to claims regarding the distinction between observation and theory.

Two aspects of the standard empiricist account of the scientific method, inductivism and falsificationism associated with Sir Karl Popper, are covered in the early chapters. Rejecting both aspects of the standard empiricist account of the relationship between observations and theory, both Kuhn and Feyerabend drew attention to the actual history of science rather than appeals to the scientific method. They published their initial versions of a historical approach to the comprehension of science in 1962, thus igniting a revolution in the philosophy of science. Nevertheless, there were major differences in their respective standpoints. According to Kuhn, the basic concepts and practices of a scientific community are located within paradigms, which are held until anomalies build up and force a scientific revolution or paradigm shift. To this end, Kuhn defended dogmatism in his principle of tenacity, holding that a paradigm is held dogmatically as long as it holds the promise that it will prove the best way to conceive of the world until it is overcome by a crisis brought on by anomalies. In contrast, Feyerabend held that rather than dogmatically holding to a paradigm we ought to create more crises, and therefore more fruitful change, in Kuhn's own terms, by providing a mechanism to strengthen the anomalies. To accomplish this goal, science should be organized so as to require the continuous generation of alternatives. This is what Feyerabend called the principle of proliferation.

Of considerable interest, and well covered here, is Imre Lakatos's theory of competing research programmes, which involved Lakatos's objective to make Kuhn and Feyerabend's insights cohere into a rational pattern. Lakatos's model of research programme aims to combine Popper's adherence to empirical validity with Kuhn's appreciation for conventional consistency. In essence, his idea is that the proper mix of the principles of tenacity and proliferation leads to the growth of science and would portray the history of science as rational. Lakatos's theory of competing research programmes is covered here in considerable depth, and Munévar argues that the methodology of research programs is not able to overcome Feyerabend's objections because when we look at the actual practice of science, we see that in order to progress scientists sometimes had to violate the most cherished methodological rules—rules as basic as "do not advance hypotheses that conflict with the facts." This is what Copernicus, Galileo, Newton, Einstein and many others had to do, even when they preached otherwise, as in the case of Newton. What is at stake is not the simple-minded point that people of great insight may take shortcuts, but rather that the methodology of science advocated by many philosophers may be incompatible with scientific success.

According to Feyerabend, when scientists consider alternative views, they may change theoretical assumptions, and as a result, also change what counts as

evidence. This was elaborated in *Against Method* and most of Feyerabend's subsequent work. Nevertheless, Munévar takes Feyerabend's insights much further by looking at science through neuroscience in the context of evolutionary biology. In addition to the achievements of the historical school of Feyerabend and Kuhn, Munévar adds an important scientific perspective, arguing that science is produced by biological creatures, so accordingly, biology is applied to investigate the nature of science: evolutionary biology first, and then neuroscience in the context of evolution.

According to Munévar, evolutionary relativism holds that an organism's view of the world depends on its mind, that mind depends on biology, that biology supports a logically impeccable form of relativism, and that success explains truth, not the other way around. This approach is consistent with the history of science and with the science most relevant to understanding the pursuit of knowledge.

The scope and depth of insight make it difficult to think of comparable attempts. The originality of Munévar's findings and his scholarship in the several philosophical and scientific fields he brings to the table make those findings very significant. That significance, furthermore, is likely to have a great impact, for *A Theory of Wonder* is written in a clear language accessible not only to professional philosophers but to students and to those members of the general public curious about the nature of scientific knowledge. It should also appeal greatly to the many people whose interest in Feyerabend is greatly increasing as we approach the celebrations for his Centennial in early 2024.

CHAPTER 1

INTRODUCTION

We take our first steps and the world around us assaults our senses with excitement and fires our imaginations with mystery. As we grow up, an enigmatic universe teases our curiosity, and often infects us for life with an overwhelming sense of wonder. In our civilization that sense of wonder has evoked a systematic response: science. This science of ours studies what intrigues us about nature, and in weaving its wondrous tales, it becomes itself a most fascinating object of study. Science thus becomes itself a source of wonder.

The purpose of this book is to determine the best way science can continue to satisfy our sense of wonder by exploring the world. Now, it is presumably well known that the reason science succeeds is because it follows the scientific method, which consists in having observation pass judgment on theory, either by supporting it or by rejecting it. Practically every introductory science textbook devotes a good portion of its first chapter to emphasize the importance of the scientific method and to give credit to its inventor, Galileo. This view of how scientific knowledge does, and should, work is called "empiricism" (for the priority it gives to experience). If perchance the students who were so introduced to science happen to read what Galileo actually wrote and did, they would be shocked to find out that he instead drives a dagger through the heart of empiricism: He strikes down the distinction between theory and observation.

Now, a most famous description of the scientific method as inductive reasoning was given by Newton in his classic *Principia Mathematica*, in the section titled "Rules for Reasoning in Philosophy." Today it would be called "Rules for Reasoning in Science," but at that time science was still part of philosophy. We will discuss the basic insights and difficulties of induction as the method of science in Chapter 2. And we will pay particular attention to Newton's inductive rules in Chapter 3. Newton spoke of standing on the shoulders of giants, with Galileo particularly in mind. But had Galileo not violated Newton's rules, the Copernican Revolution, which removed the Earth from the center of the universe and placed it in motion, would have failed, and *Principia Mathematica* most likely would have never been written.

In Chapter 3, we will consider the proposal that falsification is the method of science, i.e. that scientists should test their theories against the facts, and if those theories conflict with the facts, then they should be rejected. There are

several problems with this apparently sensible suggestion. The worst is that, if Galileo was right and theory and observation are not naturally distinct, there is no reason to assume that experience (through observation) must always take precedence over theory. Indeed, as we will see, progress in science may require scientists to follow Galileo's example, from time to time, and replace the body of accepted facts with a radically different one. Science would thus be a form of radical knowledge.

In Chapter 4, we will consider a more sophisticated version of falsificationism attributed to Karl Popper, the one 20th Century philosopher of science to meet with general approval within the scientific community. Over much of history, the most prominent philosophers—e.g., Plato, Aristotle, Descartes, Kant—made insightful comments on the nature of science and exerted considerable influence on the directions taken by science. We might say they were the philosophers of science of their day. In today's academic circles, or at least in philosophy departments, it is supposed that just as science constructs theories about the universe, philosophy of science constructs theories about science. Thus, it should seem surprising that the philosophy of science is nowadays far more obscure to the intelligent lay reader than the nature of black holes, while exciting far less curiosity. It may seem even more surprising that trained scientists do not fare better in this respect. What can account for this situation?

Part of the problem is simply that most scientists have been baffled by the linguistic and "logical" concerns of the analytic philosophers who dominated philosophy of science during much of 20th Century, as well as by their impenetrable jargon. But apart from its being unintelligible, logical positivism, the main analytic view, amounted to a dead end as a philosophy of science. Fortunately, it was challenged by thinkers trained in science who paid great attention to the history and practice of science. It was people like Thomas Kuhn and Paul Feyerabend, then, who turned our attention to Galileo's actual views, and who cast very serious doubts on all the most familiar views on method. We could call them and others with similar approaches the historical school. In very revealing remarks, Carl Hempel, one of the most important analytic philosophers of science, pointed out correctly that the historical school of thought "rejects the idea of methodological principles arrived at by purely philosophical analysis" (1978, 292).

The logical school insists on such principles, however, since it is heir to a tradition that holds that the job of philosophy is to determine the foundations of empirical knowledge. In this sense, philosophy is intellectually prior to science (it tells science where it may tread). Thus considerations from the actual practice of science would seem to be of little relevance. In the eyes of the logical school of thought, Hempel continues, "The methodology of science… is concerned solely with certain logical and systematic aspects of science which

form the basis of its soundness and rationality—in abstraction from, and indeed to the exclusion of, the psychological and historical facets of science as a social enterprise" (1978, 291).

It is not surprising that scientists might tend to find this arm-chair theorizing about science rather presumptuous, but the main problem is that the "logical aspects" involved require both the inductive and the deductive "logics" of the analytic philosophers. In Chapter 2 we will learn of the resounding failure of the so-called "inductive logic." And in Chapter 6 we will see that the "deductive logic" of analytic philosophy is based on very bad reasoning and applies neither to science nor to what most human beings would like to call "real life."

But before getting too far ahead of myself, I should mention that in Chapter 5 we will discuss Kuhn's ideas about scientific "paradigms," his distinction between revolutionary and normal science, and his thesis about the incommensurability in the meaning of scientific terms (that the meanings of the same terms might be different in two paradigms). We will also become acquainted with Feyerabend's version of such a thesis. I will also suggest there that the issue of incommensurability need not pertain to meanings at all.

In Chapter 6, we will move on to Feyerabend, the man called an "irrationalist" by a great many philosophers and others who have misread his main works. He has been accused, for example, of claiming that in science "anything goes." What he did say is that, when confronted with the actual practice and history of science, a "rationalist" (the run-of-the-mill philosopher) will conclude in horror that in science "anything goes." But Feyerabend does not agree with such a characterization, let alone recommend it. Much to be recommended, however, is his Principle of Proliferation, as I will point out. In addition, I will present my argument that the "logic" of philosophers is irrelevant to science in crucial ways.

In Chapter 7 we will take a look at the very clever attempt by Imre Lakatos to incorporate several of Kuhn and Feyerabend's main ideas into a system of competing "research programs" that, he hoped, would paint the history of science as rational. For all his cleverness, however, Lakatos' methodology of research programs is not able to overcome Feyerabend's objections.

Now, what the historical school shows is that the so-called scientific method does *not* always work. Not that we cannot *prove* that it works, even though it does. But that it does *not* always work. These philosophers argue that we have been taken in by a historical fiction. When we look at the actual practice of science, we see that in order to progress scientists sometimes had to violate the most cherished methodological rules—rules as basic as "do not advance hypotheses that conflict with the facts." This is what Copernicus, Galileo, Newton, Einstein and many others had to do. Even when, as in the case of

Newton, they preached otherwise. What is at stake is not the simpleminded point that people of great insight may take shortcuts, but rather that method may be incompatible with scientific success.

Imagine that a staircase permits hikers to go from the top of a cliff to the beach below. Someone of extraordinary agility—and luck—may dismiss the steps, leap from the top, and land on her feet. But she could have taken the staircase to reach the same destination, albeit in not so spectacular a fashion. What the new philosophy of science claims, though, is that the staircase of method may well keep science from getting to the bottom of things. Such is the lesson that Kuhn, Feyerabend and others have drawn from the most significant episodes of the history of science. Furthermore, in such episodes, it was often the losing side—the one our ahistorical present derides—that put up the good fight for methodological propriety. To traditional empiricist ears it must be at least jarring to hear Galileo say, "There is no limit to my astonishment when I reflect that Aristarchus and Copernicus were able to make reason so to conquer sense that, in defiance of the latter, the former became mistress of their belief" (*Dialogue Concerning the Two Chief World Systems*, 381).

In a war of ideas, it is not uncommon to see the warring factions give way to a completely new vision of the field. And this book may be seen as an attempt to develop such a vision. What is at stake is our understanding of the nature of science. It will make use of the findings of the historical school. But it will add a scientific perspective as well, in Chapters 8-10. Science is produced by biological creatures, so we will apply biology to investigate the nature of science: evolutionary biology first, and then neuroscience in the context of evolution.

One of the issues to be discussed In Chapter 8 concerns the degree to which science can be said to be adaptive. Although that subject has a history of pitfalls, I think that a case can be made along those lines. And it will be seen that the downfall of method actually facilitates, such a case. It will also be seen that when science is taken as a social enterprise, it exhibits certain structural features that permit us to call it rational. Some readers may detect a possible connection with evolutionary epistemology. Indeed, there is. But whereas evolutionary epistemology mostly suggests analogies to evolution, I argue not that science is like nature, but that it is part of nature. Along the way, we will realize that thinking of science as a cumulative, progressive process, as suggested by some historians of science and some scientific realists, is undermined both by history and by evolutionary considerations about the nature of science.

In Chapter 9, we will discuss the realist argument that the success of science can make sense only if we assume that science discovers the truth about the world. We will see, however, that a proper application of evolutionary biology,

in combination with neuroscience, defeats realism and leads to the realization that science is not only open to radical transformation, as history indicates, but that it should be so. That will be an important topic of this chapter and the next. This chapter will pay particular attention to how distortion and exaggeration may often lead us to more successful interactions with the world than veridical perceptions would.

In Chapter 10, we will consider that there might exist "brains" with structures very different from ours, but which may nonetheless serve those other species as well as our kind of brain serves our own species. It would then be highly arbitrary to insist that whatever science our brains develop best resembles the God's Eye point of view. It is clear that different species often do experience the world differently. Those different ways of experiencing the world, including conceiving of the world, are relative to what we may call frames of reference determined by biology. And we may speak of a "complementarity," at least potentially, that is in some way reminiscent of Niels Bohr's epistemology. This evolutionary relativism is the last nail in the coffin of realism, at the level of science. The chapter will then expose the reasoning blunders in the best-regarded objections against relativism. And it will also suggest a reasonable theory of relative truth. Furthermore, instead of leading to a view of science as irrational, thinking of science as radical knowledge, as biology and the history of science suggest, makes us recognize that drastic changes may occur at any level of our scientific enterprise and yield scientific progress.

When all is said and done, this book will settle for a new and optimistic vision of science. I hope that scientists and intelligent lay readers, who have been left out of the proceedings for too long, will wish to join this journey to understand the organized response to our sense of wonder.

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