Chapter 2

Empiricism

2.1 *The Empiricist Tradition*

Empiricism is a family of ideas that have probably shaped philosophical thinking about science more than any other. In addition, a particular version of empiricism that arose early in the twentieth century set in motion the sequence of debates I will describe chronologically in the first half of this book.

In the opening chapter I said that empiricism is often summarized with the claim that the only source of knowledge is experience. This idea has a long history, but the most important stage in the development of empiricist philosophy was in the seventeenth and eighteenth centuries, with the work of John Locke, George Berkeley, and David Hume. These "classical" forms of empiricism were based upon theories about the mind and how it works. Their view of the mind is sometimes called "sensationalist." Sensations, like patches of color and sounds, appear in the mind and are all the mind has access to. The role of thought is to track and respond to patterns in these sensations. Using a phrase that was unknown then, but useful anyway, we could say that classical empiricism saw the mind largely as a pattern-recognition device.

Both during these classical discussions and more recently, a problem for empiricism has been a tendency to lapse into *skepticism*, the idea that we cannot know anything, or can only know much less than is usually supposed, about the world and its workings. There are many kinds of skepticism, but two are especially important here. One is *external world skepticism*, which questions whether we can ever know anything about a physical world that might lie behind the flow of sensations we receive. The second form, made vivid by Hume, is *inductive skepticism*: why do we have reason to think that the patterns found in past experience will also hold in the future?

Empiricists have often shown a surprising willingness to throw in the towel when faced with external world skepticism. (Hume threw in the towel on both kinds, but that is unusual.) Quite a few empiricists have said that they don't care about the possibility that there might be real things lying behind the flow of sensations. It's only the sensations that we have any dealings with. Maybe it makes no sense even to try to think about objects lying behind sensations—perhaps our concept of "the world" is just a concept of a patterned collection of sensations. This view is sometimes called "phenomenalism." During the nineteenth century, phenomenalist views were quite popular, and their oddity was treated with nonchalance. John Stuart Mill, a leading English philosopher and political theorist, once said that matter may be defined as "a Permanent Possibility of Sensation" (1865, 183). Ernst Mach, an Austrian physicist and philosopher who influenced many people, including Einstein, illustrated his phenomenalist view by drawing a picture of the world as it appeared through his left eye (see fig. 2.1; the shape in the lower right part of the image is his elegant mustache). All that exists is a collection of observer-relative sensory phenomena like these.

I hope phenomenalism looks strange to you, despite its eminent proponents. It is a strange idea. But empiricists have often found themselves backing into views like this, and when they arrive they sometimes say they feel at home there. This is partly because empiricists have often tended to think of the mind as confined behind a "veil of ideas" or sensations. The mind has no access to anything outside the veil. Many philosophers, including me, agree that this picture of the mind is a mistake. But it is not easy to set up an empiricist view that entirely avoids the influence of this picture.

In discussions of the history of philosophy, it is common to talk of a battle in the seventeenth and eighteenth centuries between the "rationalists" and the "empiricists." Rationalists such as Descartes and G. W. Leibniz believed that pure reasoning can be a route to knowledge that does not depend on experience. Mathematics seemed to be a compelling example of this kind of knowledge. Empiricists like Locke and Hume insisted that experience is our only way of finding out what the world is like. In the late eighteenth century, a sophisticated intermediate position was developed by the German philosopher Immanuel Kant. Kant argued that all our thinking involves a subtle interaction between sensory experience and preexisting mental structures that we use to make sense of experience. Concepts such as space, time, and causation cannot be derived from experience, because a person must already have

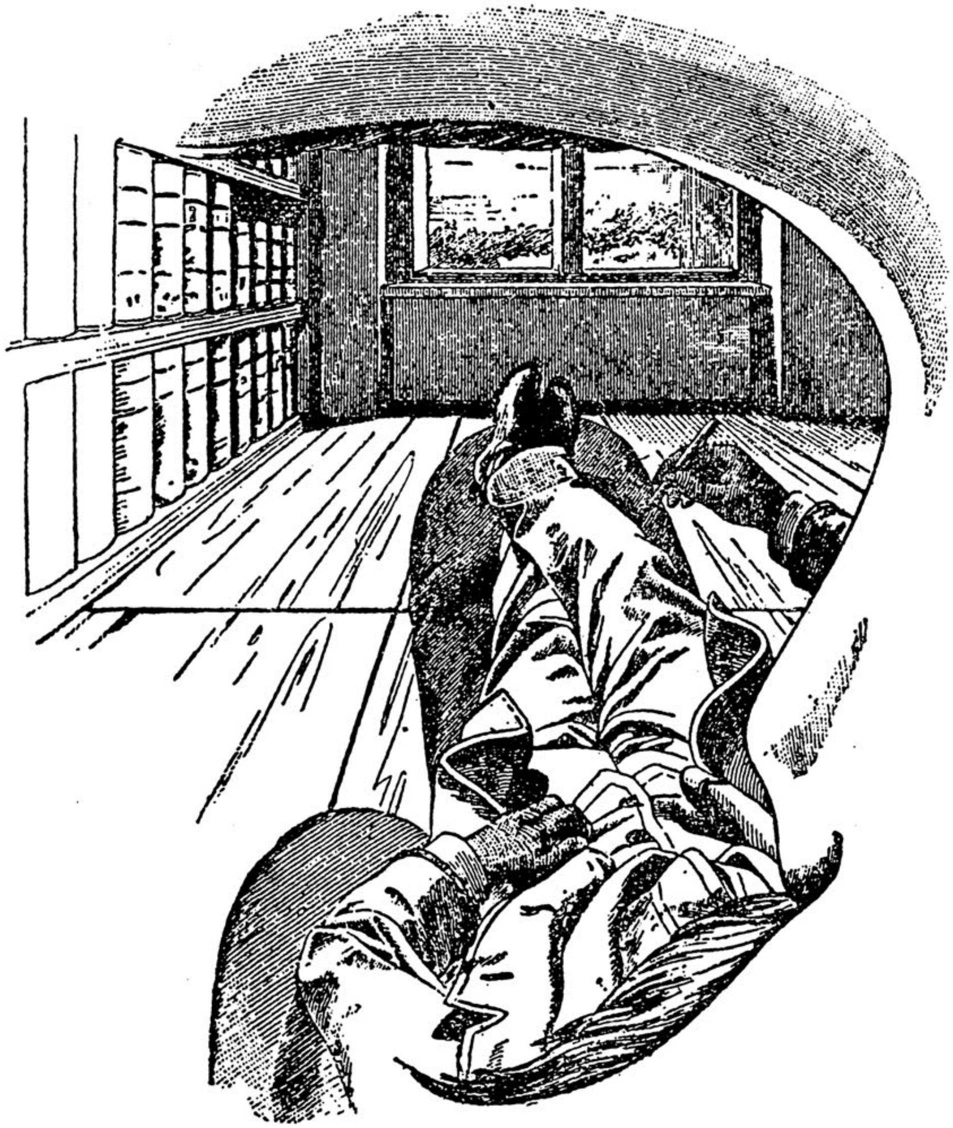

Figure 2.1. "The assertion, then, is correct that the world consists only of our sensations." (Mach 1897, 10)

these concepts in order to use experience to learn about the world. Kant also held that mathematics gives us genuine knowledge but does not require experience for its justification.

As I said earlier, in the history of philosophy the term "rationalism" is often used for a view that opposes empiricism. In the more recent discussions of science that we are concerned with here, however, the term is generally not used in that way. (This can be a source of confusion; see the glossary.) The views referred to as rationalist in the twentieth century were often also forms of empiricism; the term "rationalism" was often used in a broad way, to indicate confidence in the power of human reason.

Despite various problems, empiricism has been an attractive set of ideas for many philosophers. Empiricism has often also had a particular kind of impact on discussions outside of philosophy. Making a sweeping generalization, it is fair to say that the empiricist tradition has tended to be (1) pro-science, (2) worldly rather than religious, and (3) politically moderate or liberal (though these political labels can be hard to apply across centuries). Hume, Mill, and Bertrand Russell are examples of all three parts of this tendency. Of the three elements of my generalization, religion is the one that has the most exceptions—Berkeley was a bishop, for example. But on the whole it is fair to say that empiricist ideas have tended to be the allies of a practical, scientific, down-to-earth outlook on life.

2.2 *The Vienna Circle*

A new form of empiricism developed in Europe after World War I. The movement was established by a group of people who were scientifically oriented and who disliked much of what was happening in philosophy. They also thought they could avoid many of the problems with traditional forms of empiricism. This group has become known as the "Vienna Circle" (though their own name for the group paid homage to Mach, who did the drawing that appears as fig. 2.1). The Vienna Circle was established by Moritz Schlick and Otto Neurath. It was based, as you might expect, in Vienna, Austria. Another member of the group who was central to the development of its ideas was Rudolf Carnap.

The usual name for the view the Vienna Circle developed is "logical positivism." (The term "positivism" derives from the nineteenth-century scientific philosophy of Auguste Comte.) The view is sometimes called "logical empiricism" instead, though other people use this pair of terms to mark a distinction within the movement, saying "logical positivism" for an earlier, more extreme form of the view and "logical empiricism" for a later, more moderate version. I will follow that usage.

It is worth spending some time describing the unusual intellectual and historical context in which logical positivism developed. In particular, it is worth paying attention to what the logical positivists were against. The logical positivists were inspired by developments in science in the early years of the twentieth century, especially the work of Einstein. They also thought that developments in logic, mathematics, and the philosophy of language had shown a way to put together a new kind of philosophy. Some traditional problems would be solved by this approach, while others would be rejected as meaningless. Logical positivist views about language were influenced by the early ideas of Ludwig Wittgenstein ([1922] 1988). Wittgenstein was an enigmatic, charismatic, and eccentric philosopher of logic and language who was not an empiricist at all. Some would say that the positivists adapted Wittgenstein's ideas, others that they misinterpreted him.

Though they admired some philosophers, the logical positivists were distressed with much of what had been going on in philosophy. In the years after Immanuel Kant's death in 1804, philosophy had seen the rise of a number of systems of thought that the logical positivists found pretentious, obscure, dogmatic, and politically harmful. A central villain was G. W. F. Hegel, who had a huge influence on nineteenth-century thought. Hegel was famous for his work on the relation between philosophy and history. He thought that human history as a whole was a process in which a "world spirit" gradually reached consciousness of itself. For Hegel, individuals are less important than the state as a whole, especially the role of the state in the grand march of historical progress. These ideas were often taken to support nationalism. Hegel's was an "idealist" philosophy, since it held that reality is in some sense spiritual or mental. But this is not a view in which each person's reality is made up in some way by that person's ideas. Rather, a single reality *as a whole* is said to have a spiritual or rational character. This view is sometimes called "absolute idealism."

Hegel's influence bloomed and then receded in continental Europe. As it receded in continental Europe, in the later nineteenth century, it bloomed in England and America. Absolute idealism is a good example of what logical positivism was against. Sometimes the positivists would disparagingly dissect especially obscure passages from this literature. Hans Reichenbach (who was not part of the original Vienna Circle but was a close ally) began his book *The Rise of Scientific Philosophy* (1951) with a quote from Hegel's most famous work on philosophy and history: "Reason is substance, as well as infinite power, its own infinite material underlying all the natural and spiritual life; as also the infinite form, that which sets the material in motion." Reichenbach lamented that if you are a philosophy student, you might initially think it is your fault that you do not understand Hegel's impressive-looking words. You will then work away until finally it seems undeniable to you that reason, indeed, really is substance, as well as infinite power. . . . Reichenbach, in contrast, says it is Hegel's fault that the passage seems to make no sense. Whatever factual meaning the claim might be intended to convey has been smothered with misused language. The absolute idealist emperor has no clothes, and we all need to realize this and not be intimidated by elaborate words.

Another philosopher who came to seem an especially important rival to logical positivism was Martin Heidegger. A moment ago I gave a quick summary of Hegel's ideas. It is much harder to do that for Heidegger, especially for his most influential work, *Being and Time* (1927). Heidegger is sometimes categorized as an existentialist. Perhaps he is the most famously difficult and obscure philosopher who has ever lived (so far). I will borrow the summary reluctantly given by Thomas Sheehan in the entry for Heidegger in the *Routledge Encyclopedia of Philosophy* (1998): "He argues that mortality is our defining moment, that we are thrown into limited worlds of sense shaped by our being-towards-death, and that finite meaning is all the reality we get." Perhaps this does not get us all the way to a straightforward summary. Simplifying even more, Heidegger held that we must understand our lives as based, first and foremost, upon practical coping with the world rather than knowledge of it. All our experience is affected by the awareness that we are traveling toward death. The best thing we can do in this situation is stare it in the face and live an "authentic" life.

The emphasis on practical coping in Heidegger's view, and the resulting contrasts with more traditional philosophies, are quite interesting. He criticizes attempts to explain features of human life by fitting them into a picture governed by our scientific knowledge. But Heidegger combined these ideas with tremendously convoluted discussions of Being and—notoriously—the nature of "Nothing." Heidegger also had one point in common with some (though not all) absolute idealists: his opposition to liberal democratic political ideas.

Heidegger was seen as an important rival by the logical positivists. Carnap gave humorous logical dissections of Heidegger's discussions of Nothing in his lectures. Logical positivism was a plea for Enlightenment values, in opposition to mysticism, Romanticism, and nationalism. The positivists championed reason over the obscure, the logical over the intuitive. The logical positivists were also internationalists, and liked the idea of a universal and precise language that everyone could use to communicate clearly. Otto Neurath was the member of the group with the strongest political and social interests. He and various others in the group could be described as democratic socialists. They also had a keen interest in some movements in art and architecture at the time, such as the Bauhaus movement. They saw this work as assisting the development of a scientific, internationalist, and progressive outlook on society.

The Vienna Circle flourished from the mid-1920s to the mid-1930s. Logical positivist ideas were imported into England by A. J. Ayer in *Language, Truth, and Logic* (1936), a vivid and readable book that conveys the excitement of the time. Under the influence of logical positivism and the philosophy of G. E. Moore and Bertrand Russell, English philosophy abandoned absolute idealism and returned to a more empiricist emphasis.

In continental Europe the story turned out differently. For we have now, remember, reached the 1930s. The development of logical positivism ran straight into the rise of Adolf Hitler.

Many of the Vienna Circle had socialist leanings, some were Jewish, and there were certainly no Nazis. So the logical positivists were persecuted by the Nazis, to varying degrees. The Nazis encouraged and made use of pro-German, anti-liberal philosophers, who also tended to be obscure and mystical. Martin Heidegger joined the Nazi party in 1933 and remained a member throughout the war. Many logical positivists fled Europe, especially to the United States. Schlick, unfortunately, did not. He was murdered by a psychopathic former student in 1936. (At his trial, the student said that Schlick's philosophy had undermined his moral restraints.) The logical positivists who did make it to the United States were responsible for a great flowering of American philosophy in the years after World War II. These include Rudolf Carnap, Hans Reichenbach, Carl Hempel, and Herbert Feigl. In the United States, the strident voice of logical positivists was moderated. This was partly because of criticisms of their ideas—criticisms from the side of those who shared their general outlook. But the moderation was no doubt due in part to the different intellectual and political climate in the United States. Austria and Germany in the 1930s had been an unusually intense environment for doing philosophy.

2.3 *Central Ideas of Logical Positivism*

Earlier empiricist views were based on views about the mind and perception. Logical positivism, in contrast, was based in large part on theories about language—especially about what language can and can't express. Perhaps their central idea was the *verifiability theory of meaning*.

Here is how the theory was often put: the meaning of a sentence consists in its method of verification. That formulation might sound strange (it always has to me). Here is a formulation that sounds more natural: knowing the meaning of a sentence is knowing how to verify it. And here is a key application of the principle: if a sentence has no possible method of verification, it has no meaning.

By "verification," the positivists meant verification by means of observation. Observation in all these discussions is construed broadly, to include many kinds of sensory experience. And "verifiability" is not the best word for what they meant. A better word would be "testability." This is because testing is an attempt to work out whether something is true or false, and that is what the positivists had in mind. The term "verifiable" generally only applies when you are able to show that something is true. It would have been better to call the theory "the testability theory of meaning." Sometimes the logical positivists did use that phrase, but the more standard name is "verifiability theory," or just "verificationism."

Verificationism is a strong empiricist principle; experience is the source of meaning when we speak and write, as well as the only source of knowledge. Note that verifiability here refers to verifiability in principle, not in practice. There was some dispute about which hard-to-verify claims are really verifiable in principle. It is also important that conclusive verification or testing was not required. There just had to be the possibility of finding observational evidence that would count for or against the proposition in question. In addition, the verifiability theory was only supposed to apply to a particular kind of meaning, the kind seen when a person is trying to state something about the world—rather than issue a command, or express an emotional response, for example. This was sometimes called "factual meaning."

In the early days of logical positivism, the claim was that in principle one could translate all factually meaningful sentences into other sentences that referred only to possible observations and the patterns connecting them. This program of translation was soon abandoned as too extreme. But the verifiability theory was retained after the program of translation had been dropped. The logical positivists used the verifiability principle as a philosophical weapon. Scientific discussion, and most everyday discussion, consists of verifiable and hence meaningful claims. Some other parts of language are not even intended to have factual meaning, so they fail the verifiability test but in a harmless way. Included here are poetic language, expressions of emotion, and so on. But there are also parts of language that are supposed to have factual meaning—are supposed to say something about the world—and fail to do so. For the logical positivists, this includes most traditional philosophy, much of ethics, and theology as well.

At this point you might be wondering about that long-standing problem for empiricist views: mathematical statements. To describe the logical positivist response to this problem I need to introduce a second part of their view of language. This is the distinction between *analytic* and *synthetic* sentences.

Some sentences are true or false simply in virtue of the meaning of the words within them, regardless of how the world happens to be; these are analytic. A synthetic sentence is true or false in virtue of both the meaning of the words in the sentence and how the world actually is. "All bachelors are unmarried" is a standard example of an analytically true sentence. "All bachelors are bald" is an example of a synthetic sentence, in this case a false one. Analytic truths are, in a sense, empty truths, with no factual content. Their truth has a kind of necessity, but only because they are empty. Analytic sentences are not supposed to be covered by the verifiability theory of meaning; they are another example of sentences with a different kind of meaning that is not "factual."

This distinction had been around, in various forms, since at least the eighteenth century. The terminology "analytic/synthetic" was introduced by Kant. Although the distinction itself looks uncontroversial, it can be made to do real philosophical work. Here is some of that work: the logical positivists claimed that all of mathematics and logic is analytic. For logical positivism, mathematical propositions do not describe the world; they merely record our decision to use symbols in a particular way. Synthetic claims about the world can be expressed using mathematical terms, such as when it is claimed that Jupiter has seventy-nine moons. But proofs and investigations within mathematics itself are analytic. This might seem unlikely, because some statements and proofs in mathematics are so surprising and certainly look significant. For example, there are infinitely many prime numbers—that claim does not look empty at all. But the logical positivists insisted that once we break down any mathematical proof into small steps, each step will be trivial and unsurprising.

Earlier philosophers in the rationalist tradition had claimed that some things can be known a priori, this means known *independently of experience*. Logical positivism held that the only things that seem to be knowable a priori are analytic and hence empty of factual content. A remarkable episode in the history of science is important here. For many centuries, the geometry of the ancient Greek mathematician Euclid was regarded as a shining example of real and certain knowledge. (Euclid, incidentally, also proved that there are infinitely many prime numbers.) Immanuel Kant, inspired by the immensely successful application of Euclidean geometry to nature in Newtonian physics, claimed that Euclid's geometry (along with the rest of mathematics) is both synthetic and knowable a priori. In the nineteenth century, mathematicians worked out some alternative geometrical systems to Euclid's, but they did so as a mathematical exercise, not as an attempt to describe how lines, angles, and shapes work in the actual world. Early in the twentieth century, however, Einstein's revolutionary work in physics showed that a non-Euclidean geometry *is* true of our world. The logical positivists were very impressed by this development, and it guided their analysis of mathematical knowledge. The positivists insisted that pure mathematics is analytic, and they broke geometry into two parts. One part is purely mathematical, analytic, and says nothing about the world. It merely describes possible geometrical systems. The other part of geometry is a set of synthetic claims about which geometrical system applies to our world.

Another part of their view of language—a part that brings us closer to issues about science—is a distinction they made between *observational* and *theoretical* language. There was uncertainty about exactly how to set up this distinction. Usually it was seen as a distinction applied to individual terms. "Red" is in the observational part of language, and "electron" is in the theoretical part. There was also a related distinction at the level of sentences. "The rod in front of me is glowing red" is observational, while "Helium atoms each contain two electrons" is theoretical. A more important question was where to draw the line. Schlick thought that only terms referring to sensations were observational; everything else was theoretical. Here Schlick stayed close to traditional empiricism. Neurath thought this was a mistake and argued that many terms referring to ordinary physical objects are in the observational part of language. For Neurath, scientific testing must not be understood in a way that makes it private to the individual. Only observation statements about physical objects can be the basis of public or "intersubjective" testing.

Carnap came to think that there are lots of acceptable ways of marking out a distinction between the observational and theoretical parts of language; one can use whichever is convenient for the purposes at hand. This was the start of a more general move that Carnap made toward a view based on the "tolerance" of alternative linguistic frameworks.

This analysis of language provided the background ideas for the logical positivist philosophy of science. Science was seen as a more complex and sophisticated version of the same sort of thinking, reasoning, and problem-solving that we find in everyday life, and completely unlike the meaningless blather of traditional philosophy.

Though traditional philosophy was seen as largely a waste of time, the logical positivists did think there were some real tasks for philosophers to do. These tasks were mostly concerned with logic. They saw logic as the main tool for philosophy, including philosophical discussion of science. The most useful thing that philosophers can do is give logical analyses of how language, mathematics, and science work.

Here we should distinguish between two kinds of logic (this discussion will be continued in chapter 3). Logic in general is the attempt to give an abstract theory of what makes some arguments compelling and reliable. Deductive logic is the most familiar kind of logic, and it describes patterns of argument that transmit truth with certainty. These are arguments with the feature that if the premises of the argument are true, the conclusion must be true. Impressive developments in deductive logic had been under way since the late nineteenth century and were still going on at the time of the Vienna Circle.

The logical positivists also believed in a second kind of logic, a kind that was (and is) much more controversial. This is *inductive* logic. Inductive logic was supposed to be a theory of arguments that provide support for their conclusions but do not give the kind of guarantee found in deductive logic.

From the logical positivist point of view, developing an inductive logic was of great importance. Hardly any of the reasoning about the world that we encounter in everyday life and science carries the kind of guarantee found in deductive logic. Even the best kind of evidence we can find for a scientific theory is not completely decisive. There is always the possibility of error, but that does not stop some claims in science from being supported by evidence. The logical positivists accepted and embraced the fact that error is always possible. Although some critics have misinterpreted them on this point, the logical positivists did not think that science ever reaches absolute certainty.

The logical positivists saw the task of logically analyzing science as sharply distinct from any attempt to understand science in terms of its history or psychology. Those are empirical disciplines, and they involve a different set of questions from those of philosophy. A terminology standardly used to express the separations between different approaches here was introduced by Reichenbach, who distinguished between the "context of discovery" and the "context of justification." That terminology is not very helpful, because it suggests that the distinction has to do with before versus after. It might seem that the point being made is that discovery comes first and justification comes afterward. That is not the point (though the logical positivists were not completely clear on this). The distinction, instead, is between the study of the logical structure of science and the study of all the historical and psychological aspects of science. Logical positivism tended to dismiss the relevance of fields like history and psychology to the philosophy of science. In time, this came to seem a big mistake.

Let us put all these ideas together and look at the picture of science that results. Logical positivism was a revolutionary, uncompromising version of empiricism, based largely on a theory of language. The aim of science—and the aim of everyday thought and problem-solving as well—is to track and anticipate patterns in experience. As Schlick once put it, "what every scientist seeks, and seeks alone, are . . . the rules which govern the connection of experiences, and by which alone they can be predicted" (1932–33, 44). We can make rational predictions about future experiences by attending to patterns in past experience, but we never get a guarantee. We could always be wrong. There is no alternative route to knowledge besides experience; when philosophy has tried to find such a route, it has lapsed into meaninglessness.

During the early twentieth century, other versions of empiricism were being developed as well. One was *operationalism*, which was introduced by a physicist, Percy Bridgman (1927). Operationalism held that scientists should use language in such a way that all theoretical terms are tied closely to direct observational tests. This is akin to logical positivism, but it was expressed more as a proposed tightening up of scientific language than as an analysis of how all science already works.

In the latter part of the twentieth century, an image of the logical positivists developed in which they were seen as stodgy, conservative, unimaginative science worshipers. Their pro-science stance has been seen as antidemocratic, or aligned with repressive political ideas. This is very unfair, given their actual political interests and activities. Later we will see how ideas about the relation between science and politics changed through the twentieth century in a way that made this interpretation possible. The accusation of stodginess is another matter; the logical positivists' writings were indeed often dry and technical. Still, even the driest of their ideas were part of a remarkable program that aimed at a massive, transdisciplinary, intellectual housecleaning. And their version of empiricism was organized around an ideal of intellectual flexibility as a mark of science and rationality. We see this in a famous metaphor used by Neurath. He said that in our attempts to learn about the world and improve our ideas, we are "like sailors who have to rebuild their ship on the open sea." The sailors replace pieces of their ship plank by plank, in a way that eventually results in major changes, but is constrained by the need to keep the ship afloat during the process.

2.4 *Problems and Changes*

Logical positivist ideas were always in a state of flux and were subject to many challenges. One set of problems was internal to the program. There was considerable difficulty in getting a good formulation of the verifiability principle. It turned out to be hard to formulate the principle in a way that would exclude all the obscure traditional philosophy but include all of science. Some of these problems were almost comically simple. For example, if "Metals expand when heated" is testable, then

"Metals expand when heated and the Absolute Spirit is perfect" is also testable. If we could empirically show the first part of the claim to be false, then the whole claim would be shown false, because of the logic of statements containing "and." (If *A* is false, then *A&B* must be false too, no matter what *B* is.) Patching this hole led to new problems elsewhere; the whole project was quite frustrating (Hempel 1965, chap. 4). The attempt to develop an inductive logic also ran into serious trouble, a topic that will be covered in the next chapter.

Other criticisms were directed not at the details but at more fundamental ideas. I will spend some time on one of these, a criticism presented in an article that had a huge influence on philosophy in the middle of the twentieth century: W. V. Quine's "Two Dogmas of Empiricism" (1951a).

Quine argued for a *holistic* theory of testing, and he used this to motivate a holistic theory of meaning as well. In describing the view, first I should say something about holism in general. Many areas of philosophy contain views that are described using the term "holism." A holist argues that you cannot understand a particular thing without looking at its place in a larger whole. In the case we are concerned with here, holism about testing says we cannot test a single hypothesis or sentence in isolation. Instead, we can only test complex networks of claims and assumptions. This is because only a complex network of claims and assumptions makes definite predictions about what we should observe.

Let us look more closely at the claim that individual claims about the world cannot be tested in isolation. The idea is that in order to test one claim, you need to make assumptions about many other things. Often these will be assumptions about measuring instruments, the circumstances of observation, the reliability of records and other observers, and so on. Whenever you think of yourself as testing a single idea, what you are really testing is a long, complicated *conjunction* of statements (*p & q & r & . . .*); it is the whole conjunction that gives you a definite prediction. If a test has an unexpected result, then something in that conjunction is false, but the test itself does not tell you where the error is.

For example, suppose you want to test the hypothesis that high air pressure is associated with fair, stable weather. You make a series of observations, and what you seem to find is that high pressure is instead associated with unstable weather. It is natural to suspect that your original hypothesis was wrong, but there are other possibilities as well. It might be that your barometer does not give reliable measurements of air pressure. There might also be something wrong with the observations made (by you or others) of the weather conditions themselves. The unexpected observations are telling you that something is wrong, but the problem might lie with one of your background assumptions, not with the hypothesis you were trying to test.

Some parts of this argument are convincing. It is true that only a network of claims and assumptions, not a single hypothesis alone, tells us what we should expect to observe. The failure of a prediction will always have a range of possible explanations. In that sense, testing is indeed holistic. But this leaves open the possibility that we might often have good reasons to lay the blame for a failed prediction at one place rather than another. In practice, science often seems to have effective ways of working out where to lay the blame. Giving a philosophical theory of these decisions is a difficult task, but the mere fact that failed predictions always have a range of possible explanations does not settle the holism debate.

These holist arguments were very influential, though. Quine, who sprinkled his writings with deft analogies and dry humor, argued that mainstream empiricism had been committed to a badly simplistic view of testing. We must accept, as Quine said in a famous metaphor, that our theories "face the tribunal of sense-experience . . . as a corporate body" (1951a, 38). In simpler language, from another paper: "Science is a unified structure, and in principle it is the structure as a whole, and not its component statements one by one, that experience confirms or shows to be imperfect" (1951b, 72). Logical positivism, he said, must be replaced with a holistic version of empiricism. But there is a puzzle here. The logical positivists already accepted that testing is holistic in the sense described above. Here is Herbert Feigl: "No scientific assumption is testable in complete isolation. Only whole complexes of inter-related hypotheses can be put to the test" (1943, 16). Carnap had been saying the same thing (1937, 318). We can even find statements like this in Ayer's *Language, Truth, and Logic* (1936).

Quine did recognize Pierre Duhem, a French physicist and philosopher, as someone who had argued for holism about testing before him. (Holism about testing is often called the "Duhem-Quine thesis.") But how could it be argued that logical positivists had dogmatically missed this important fact, when they repeatedly expressed it in print? Regardless, many philosophers agreed with Quine that logical positivism had made a bad mistake about testing in science.

Though the history of the issue is strange, it might be fair to say this: although the logical positivists officially accepted a holistic view about testing, they did not appreciate the significance of the point. The verifiability principle seems to suggest that you can test sentences one at a time. It seems to attach a set of observable outcomes of tests to each sentence in isolation.

Strictly, the positivists generally held that these observations are only associated with a specific hypothesis against a background of other assumptions. But then it seems questionable to associate the test results solely with the hypothesis itself and not the other assumptions. Quine made the consequences of holism about testing very clear. He also drew conclusions about language and meaning; given the link between testing and meaning asserted by logical positivism, holism about testing leads to holism about meaning. And holism about meaning causes problems for many logical positivist ideas.

The version of holism that Quine defended in "Two Dogmas" was an extreme one. It included an attack on the one idea in the previous section that you might have thought was completely safe: the analytic/synthetic distinction. Quine argued that this distinction does not exist; this is another unjustified dogma of empiricism.

Here again, some of Quine's arguments were directed at a version of the analytic/synthetic distinction that the logical positivists no longer held. Quine said that the idea of analytic truth was intended to treat some claims as *immune to revision* (as long as ordinary lapses in reasoning are not an issue), and he argued that actually no statement is immune to revision. But Carnap already accepted that analytic statements can be revised, though they are revised in a special way. A person or community can decide to drop one whole linguistic and logical framework and adopt another. Against the background provided by a given linguistic and logical framework, some statements will be analytic and hence not susceptible to empirical test. But we can always change frameworks. By the time that Quine was writing, Carnap's philosophy was based on a distinction between changes made *within* a linguistic and logical framework, and changes *between* these frameworks.

In another (more convincing) part of his paper, Quine argued that there is no way to make scientific sense of a sharp analytic/synthetic distinction. He connected this point to his holism about testing. For Quine, all our ideas and hypotheses form a single "web of belief," which has contact with experience only as whole. An unexpected observation can prompt us to make a great variety of possible changes to the web. Even sentences that might look analytic can be revised in response to experience in some circumstances. Quine noted that strange results in quantum physics had suggested to some that revisions in logic might be needed.

In this discussion of problems for logical positivism, I have included some discussions that started early and some that took place after World War II, when the movement had begun its U.S.-based transformation. I'll now turn to these later stages of the movement.

2.5 *Logical Empiricism and the Web of Belief*

Let's see how things looked in the years after World War II. Schlick is dead, and other remnants and allies of the Vienna Circle—Carnap, Hempel, Reichenbach, and Feigl—are safely housed in American universities. Many of the same people are involved, but the work is now different. The revolutionary attempt to destroy traditional philosophy has been replaced by a program of careful logical analysis of language and science. Discussion of the contributions that could be made by the scientific worldview to a democratic socialist future have been dropped or greatly muted.

(Despite this, the FBI collected a file on Carnap as a possible communist sympathizer.)

As before, ideas about language guided logical empiricist ideas about science. (Remember that I am using the term "logical empiricism" rather than "logical positivism" for this later phase.) The analytic/synthetic distinction had not been rejected, but it was regarded as questionable. The verifiability theory, which had been so scythe-like in its early forms, was replaced with a *holistic empiricist theory of meaning*. Theories were seen as structures that connect many hypotheses together. These structures are connected, as wholes, to the observable realm, but any *part* of a theory—a claim or hypothesis or concept—does not have some specific set of observations associated with it. A theoretical term, such as "electron" or "gene," derives its meaning from its place in the whole structure and from the structure's connection to the realm of observation.

Late in the logical empiricist era, in 1970, Feigl gave a pictorial representation of what he called the "orthodox view" of theories (see fig. 2.2). A network of theoretical hypotheses ("postulates") is connected by stages to what Feigl calls the "soil" of experience. This anchoring is the source of the network's meaning. Feigl used this picture to describe a single scientific theory. For the more extreme holism of Quine, a person's total set of beliefs forms a single network.

The logical positivist distinction between observational and theoretical parts of language was kept roughly intact. But the idea that observational language describes private sensations had been dropped. The observational base of science was seen as being made up of descriptions of observable physical objects (though Carnap thought it might occasionally be useful to work with a language referring to sensations).

Logical positivist views about the role of logic in philosophy, and about the sharp separation between the logic of science and the historical and psychological side of science, were basically unchanged. A good example of the kind of work done by logical empiricists is provided by their work on explanation in science (see especially Hempel and Oppenheim 1948; Hempel 1965). For Hempel, to explain something is to show how to infer it using a logical argument, where the premises of the argument include at least one statement of a natural law (see chapter 11).

We saw that logical positivism held that the sole aim of science is

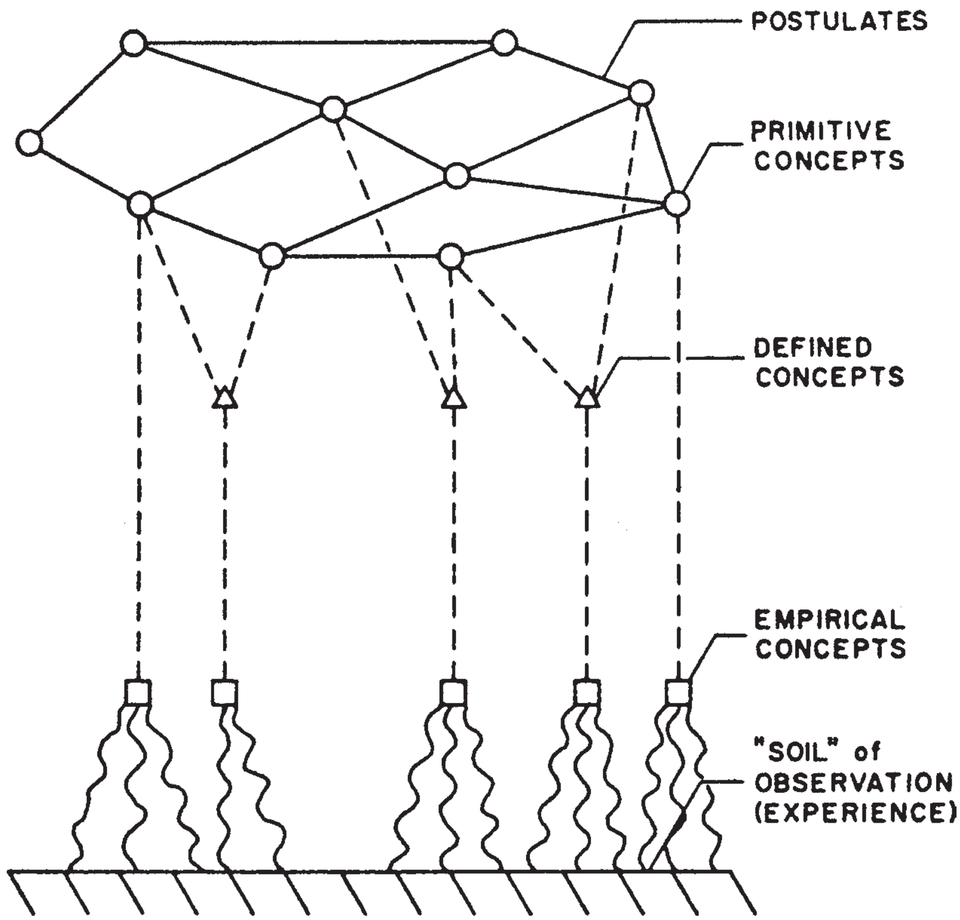

Figure 2.2. Feigl's picture of the logical empiricist view of theories (from Feigl 1970; reproduced courtesy of the University of Minnesota Press)

to track patterns in experience. For logical positivism, when a scientist seems to be trying to describe unobservable structures in the world that give rise to what we see, the scientist must instead be seen as describing the observable world in a special, abstract way. Scientific language is only meaningful insofar as it picks out patterns in the flow of experience. Does logical *empiricism*, the later version of the view, make the same claim? Does logical empiricism claim that scientific language only describes patterns in observables?

The answer is that logical empiricists agonized over this. In their hearts their answer was yes, but this answer seemed to get harder and harder to defend. Carl Hempel wrote an article in 1958 called "The Theoretician's Dilemma" that was the height of logical empiricist agony over the issue. As an empiricist, Hempel was attracted to the idea that the only possible role for those parts of language that seem to refer to unobservable entities is to help us pick out patterns in the observable realm. And if the parts of theories that appear to posit unobservable things are really any good, this "goodness" has to show up in advantages the theory has in its handling of observables. So there is no justification for seeing these parts of scientific language as describing real objects lying beyond experience. But Hempel and the logical empiricists found themselves forced to concede that this view does not make much sense of actual scientific work. When scientists use terms such as "electron" or "gene," they act as if they are doing more than tracking complex patterns in the observable realm. The idea that the logical empiricists were being pushed toward—the idea that scientific theories are aimed at describing unobservable real structures and processes—was hard to put on the table and defend, though. Empiricist philosophy of language seemed implacably opposed to it.

Empiricists were familiar with bad versions of the idea that behind the ordinary world of observables there is a special and superior realm, pure and perfect. This "layered" view of reality seemed to empiricists a source of endless trouble, right from the time of the ancient Greek philosopher Plato, who distinguished the illusory, unstable world of "appearances" from the more perfect and real world of "forms." Empiricists have rightly been determined to avoid this kind of picture. But much of science does appear to be a process in which people hypothesize hidden structures that give rise to observable phenomena. These hidden structures are not pure and perfect, or "more real" than the observable parts of the world, but they do lie behind or beneath observable phenomena. Of course, unobservable structures posited by a theory at one time might well turn out to be observable at a later time. In science, there is no telling what kinds of new access to the hidden parts of the world we might eventually achieve. But still, much of science does seem to proceed by positing entities that are, at the time of the research in question, truly hidden. For the traditional empiricist philosopher, understanding scientific theorizing in a way that posits a layer of observable phenomena and a layer of hidden structure responsible for the phenomena takes us far too close to bad old philosophical views like Plato's. We are too close for comfort, so we must give a different kind of description of how science works.

The result is an insistence that, ultimately, the only thing scientific language can do is describe patterns in the observable realm. In the first published paper that introduced logical positivism, Carnap, Hahn, and Neurath wrote, "In science there are no 'depths'; there is surface everywhere" ([1929] 1973, 306). This is a vivid expression of the empiricist aversion to a view in which the aim of theorizing is to describe hidden levels of structure. Science uses unusual theoretical concepts (which look initially like attempts to refer to hidden things) as a way of discovering and describing subtle patterns in the observable realm. So the logical positivists and the logical empiricists talked continually about *prediction* as the goal of science. Prediction was a substitute for the more obvious-looking—but ultimately forbidden—goal of describing the real hidden structure of the world.

Twentieth-century empiricism made an important mistake here. We can make sense of science only by treating much of it as an attempt to describe hidden structures that give rise to observable phenomena. This is a version of *scientific realism*, an idea that will be discussed later in this book. In science there *are* depths. There is not a simple and fixed distinction between two layers in nature—the empiricists were right to distrust this idea. Instead, there are many layers, or rather a continuum between structures that are more accessible to us and structures that are less accessible. Genes are hidden from us in some ways, but not as hidden as protons, which in turn are not as hidden as quarks. Although there are depths in science, what is deep at one time can come to the surface at later times, and there may be lots of ways of interacting with what is presently deep.

Some people associated with the logical empiricist movement did try to break away from their assumptions about what can be meaningfully spoken about. Herbert Feigl was part of the movement from the early years, and he came to think that a mistake had been made here. Feigl, too, used metaphors of depths and surfaces to describe what was going on. He said the logical positivists were right to emphasize the role of observation in providing evidence for our claims, but they pushed this emphasis so far that they lost sight of the objects that these claims are typically about: "Dazzled by the admittedly tremendous importance of the evidential basis for our knowledge claims, positivists have regrettably neglected the very objects of those knowledge claims. They have myopically flattened them into the surface of evidence" (1958, 98). The word "myopically," whose literal meaning refers to nearsightedness, can be used in a metaphorical way to mean that things are not being seen clearly. But Feigl, cleverly, seems to use the word with something closer to its literal meaning. The positivists, with their eyes fixed on evidence, were not seeing what lies beyond that evidence.

I think that quite a few empiricists in the middle of the twentieth century would have liked to decisively abandon the idea that all we can ultimately do in science is describe patterns in our experience, or our observational evidence. But this would have meant going completely against the empiricist ideas about meaning and testing that had energized the movement and had seemed such an advance in the early years. And it seemed very hard to come up with a better view about how scientific language works and what kind of meaning a theory has. This still seems hard today.

2.6 *Experience, Experiment, and Action*

Logical empiricist ideas dominated much of American philosophy and were very influential elsewhere in the English-speaking world and in some parts of Europe in the middle of the twentieth century. But by the mid-1960s the view was definitely under threat, and by the middle or late 1970s logical empiricism was close to extinction. How the decline occurred is described in the next few chapters.

At the end of this chapter on empiricism, though, I want to introduce one more theme that will come up in several contexts in this book. I'll do so with a quote from the twentieth-century physicist Richard Feynman.

> The principle of science, the definition, almost, is the following: *The test of all knowledge is experiment*. Experiment is the *sole judge* of scientific "truth."

This is from *The Feynman Lectures on Physics*, a text written for a famous course he taught in the 1960s. In some ways, what Feynman says is similar to what empiricist philosophers like to say, but in one way it looks different. Experiment, he says, is what matters. Not observation or experience, but experiment. And he says that experiment is the sole judge in science.

This is a surprising thing to say. It seems that some observations come from experiments and some do not, and those that do not have sometimes been very important in science. Astronomy is a field where careful observation has been done for many centuries, but not a lot of experiment. And astronomy was perhaps the first of all sciences to reach an advanced state, making impressive predictions by the seventeenth century and certainly the eighteenth. In 1705 Edmund Halley used Newton's theory, along with past records, to predict that a comet would return in 1758. It did exactly that (though it was a close call, arriving on Christmas Day). This was rightly seen as a triumph. It would be hard to view early modern astronomy as a deficient science. (Darwin's work on the theory of evolution, and evolutionary biology for many years after, was also not greatly based on experiment, though Darwin did experiments in other areas. "Experimental evolution" is a fairly new subfield of biology, though an important one.)

In the case of astronomy, you might reply that there have, in fact, been experiments for a long time. We often think of an experiment as setting up an arrangement to see what will happen (when I add this chemical to this other chemical, and so on). But perhaps what is basic to experiment is just having an organized plan where you will do *something*—go through some procedure—and observe the results in a particular way. This might include pointing a telescope at the sky every night at a particular time.

Alternatively, Feynman might think that any science has to head toward experiment as much as possible, even if some progress is possible without it. That is a possibility to consider, though it seems different from what Feynman said.

This whole issue—the relation between observation and experiment—was for a long time largely ignored by empiricist philosophers. In some ways, this is symptomatic of something even bigger. The role of action, and the ways we deliberately transform the world around us by doing things, building things, and so on, was also neglected, not just in philosophical writing about science but in much empiricist philosophy generally. This is not only true of the old figures from many centuries ago; it is also true of Quine, the empiricist who criticized the dogmas of others and defended his web-of-belief view. When Quine talks about what we use our web of belief for, he emphasizes prediction—anticipating what will happen. He hardly ever talks about using our beliefs to work out how to act.

Action is important here in at least two ways. First, much of the point of learning about the world is working out what to do—what material to build bridges out of, how to purify water for drinking. Also, when you act you often change your own experience. This is true both in everyday cases—when you unwrap a box, walk down the street, or turn on the lights—and in more complicated cases, when we build a particle accelerator that can create observations that would never otherwise be possible. There are many questions to think about here. What distinguishes experiment from other activities? The important issue is not so much to work out what counts as "experiment," in the usual sense of this term, but to work out which, if any, of the more active forms of observation make a difference to knowledge and investigation. Is it always good for a science to head to down the road toward experiment, or experiment of some particular kind? If so, why?

Further Reading and Notes

Schlick's "Positivism and Realism" (1932–33) and Feigl's "Logical Empiricism" (1943) are good statements of logical positivism by original members of the Vienna Circle. (Feigl uses the term "logical empiricism," but his paper describes a fairly undiluted version of the view.) Ayer's

Language, Truth, and Logic (1936) is readable, vivid, and exciting. Some see it as a distortion of logical positivist ideas. Reichenbach's *The Rise of Scientific Philosophy* (1951), which I discuss in section 2.2, is very good although Reichenbach was not part of the Vienna Circle itself.

Classics of the empiricist tradition include Locke's *An Essay Concerning Human Understanding* (1690), Berkeley's *Three Dialogues between Hylas and Philonous* (1713), and Hume's *An Enquiry Concerning Human Understanding* (1748 [1999]), all of which are available in free online editions. Reichenbach's Hegel quote is from *The Philosophy of History* ([1824] 1956). Neurath's boat metaphor ("sailors who have to rebuild their ship on the open sea") appears in his "Anti-Spengler" (1921). Neurath is discussed in detail in Cartwright et al. (1996). There are many collections of articles about the logical positivists (/empiricists) now, including Giere and Richardson (1996). Galison's "Aufbau/Bauhaus" (1990) is a fascinating account of the artistic, social, and political interests of the logical positivists and the links between these interests and their philosophical ideas.

The logical positivists were inspired by Einstein, and in some ways he repaid the compliment. His paper "On the Method of Theoretical Physics" (1934) expresses ideas quite close to theirs.

Hempel's *Aspects of Scientific Explanation* (1965) is the most influential statement of the later, moderate "logical empiricist" view. His *Philosophy of Natural Science* (1966) is the easy version. Carnap's later lectures have been published as *Introduction to the Philosophy of Science* (1995). The Feynman quote is from the first page of Feynman, Leighton, and Sands (1963–65), chapter 1.