

2

Logic Plus Empiricism

2.1 The Empiricist Tradition

The first approach to science that we will examine is a revolutionary form of empiricism that appeared in the early part of the twentieth century, flourished for a time, was transformed and moderated under the pressure of objections, and then slowly became extinct. The earlier version of the view is called “logical positivism,” and the later, moderate form is more usually called “logical empiricism.” There is variation in terminology here; “logical empiricism” is sometimes used for the whole movement, early and late. Although we will be looking at fossils in this chapter, these remnants of the past are of great importance in understanding where we are now.

Before discussing logical positivism, it will be helpful to go even further back and say something about the empiricist tradition in general. In the first chapter I said that empiricism is often summarized with the claim that the only source of knowledge is experience. This idea goes back a long way, but the most famous stage of empiricist thought 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 often 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. This view of the mind is not implied by the more basic empiricist idea that experience is the source of knowledge, but for many years such a view was common within empiricism.

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 about the world. This problem has two aspects. One aspect we can call *external world skepticism*: how can we ever know anything about the real world that lies behind the flow of sensations? The

second aspect, made vivid by David Hume, is *inductive skepticism*: why do we have reason to think that the patterns in past experience will also hold in the future?

Empiricism has often shown a surprising willingness to throw in the towel on the issue of external world skepticism. (Hume threw in the towel on both kinds of skepticism, but that is unusual.) Many empiricists have been willing to say 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 within empiricism, and their oddity was treated with nonchalance. John Stuart Mill, an 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, 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. This is partly because they 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 so easy to set up an empiricist view that entirely avoids the bad influence of this picture.

In discussions of the history of philosophy, it is common to talk of a showdown in the seventeenth and eighteenth centuries between "the rationalists" and "the empiricists." Rationalists like Descartes and 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 experience and preexisting mental structures that we use to *make sense* of experience. Key concepts like space, time, and causation cannot be derived from experience, because a person must *already* have these concepts in order to use experience to learn

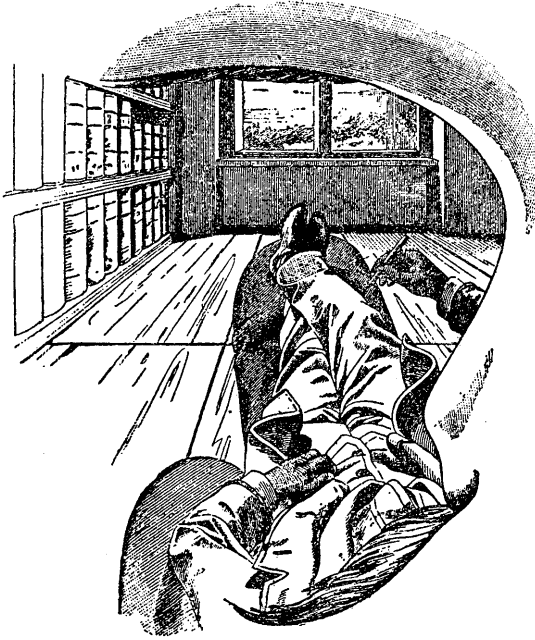


Fig. 2.1

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

about the world. Kant also held that mathematics gives us real knowledge of the world but does not require experience for its justification.

Empiricists must indeed avoid overly simple pictures of how experience affects belief. The mind does not passively receive the imprint of facts. The active and creative role of the mind must be recognized. The trick is to avoid this problem while still remaining true to basic empiricist principles.

As I said above, 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 called “rationalist” in the twentieth century were often forms of empiricism; the term was often used in a broad way, to indicate a confidence in the power of human reason.

So much for the long history of debate. Despite various problems, empiricism has been a very 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 times). David Hume, John Stuart Mill, and Bertrand Russell are examples of this tendency. Of the three elements of my generalization, religion is the one that has the most counter-examples. Berkeley was a bishop, for example, and Bas van Fraassen, one of the most influential living empiricist philosophers, is also religious. 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. The logical positivists definitely fit this pattern.

2.2 The Vienna Circle

Logical positivism was a 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. This group has become known as the *Vienna Circle*.

The Vienna Circle was established by Moritz Schlick and Otto Neurath. It was based, as you might expect, in Vienna, Austria. From the early days through to the end, a central intellectual figure was Rudolf Carnap. Carnap seems to have been the kind of person whose presence inspired awe even in other highly successful philosophers.

Logical positivism was an extreme, swashbuckling form of empiricism. The term “positivism” derives from the nineteenth-century scientific philosophy of Auguste Comte. In the 1930s Carnap suggested that they change the name of their movement from “logical positivism” to “logical empiricism.” This change should not be taken to suggest that the later stages in the movement were “more empiricist” than the earlier stages. The opposite is true. In my discussion I will use the term “logical positivism” for the intense, earlier version of their ideas, and “logical empiricism” for the later, more moderate version. Although Carnap suggested the name change in the mid-1930s, the time during which logical positivist ideas changed most markedly was after World War II. I will spend some time in this section describing the unusual intellectual and historical context in which logical positivism developed. In particular, it is easier to understand logical positivism if we pay 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 empiricist phi-

losophy that would settle, once and for all, the problems that philosophy had been concerned with. Some problems would be solved, and other problems 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 did admire some philosophers, the logical positivists were distressed with much of what had been going on in philosophy. In the years after 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. One key villain was G. W. F. Hegel, who worked in the early nineteenth century and 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 taken to support strong forms of 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 who 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 a philosophy student, on first reading this passage, would usually think that it was *his* fault—the student's fault—that he did not understand it. The student would then work away until it finally seemed obvious that Reason was substance, as well as infinite power. . . . For Reichenbach, it is entirely *Hegel's* fault that the passage seems to make no sense. It seems to make no sense because whatever

factual meaning the claim might be intended to convey has been smothered with misused language.

People sometimes describe the history of this period as if it was a pitched battle between logical positivism and absolute idealism. That is not how things went. In the early twentieth century, there were many kinds of philosophy jostling and wrangling in Europe. There was a “back to Kant” movement going on (as there seems to be now; perhaps this will happen every hundred years). Another philosopher who came to seem an especially important rival to logical positivism was Martin Heidegger.

Earlier I gave a quick summary of Hegel’s ideas. It is much harder to do that for Heidegger. Heidegger is sometimes categorized as an existentialist. Perhaps he is the most famously difficult and obscure philosopher who has ever lived. 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.” 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. And the best thing we can do in this situation is stare it in the face and live an “authentic” life.

This picture of life might seem to make some sense (especially on a bad day). But Heidegger combined his descriptions of how it feels to live in the world with abstract metaphysical speculation; especially notorious are his discussions of 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 a key rival by the logical positivists. Carnap gave humorous logical dissections of Heidegger’s discussions of Nothing in his lectures. Interestingly, recent work has shown that Carnap and Heidegger understood each other better than was once supposed (Friedman 2000).

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 they 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 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 practical outlook on society (Galison 1990).

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 its traditional empiricist emphasis, an emphasis it has retained (more or less) ever since.

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. In contrast to the logical positivists, 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 deranged former student in 1936. 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. Partly this was because of criticisms of their ideas—criticisms from the side of those who shared their general outlook. But the moderation was no doubt partly due 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

Logical positivist views about science and knowledge were based on a general theory of language; we need to start here, before moving to the views about science. This theory of language featured two main ideas, the *analytic-synthetic distinction* and the *verifiability theory of meaning*.

The analytic-synthetic distinction will probably strike you as bland and obvious, at least at first. Some sentences are true or false simply in virtue of their meaning, 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 sentence *and* how the world actually is. “All bachelors are unmarried”

is the 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.

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 one crucial piece of work the logical positivists saw for it: they claimed that all of mathematics and logic is analytic. This made it possible for them to deal with mathematical knowledge within an empiricist framework. For logical positivism, mathematical propositions do not describe the world; they merely record our conventional decision to use symbols in a particular way. Synthetic claims about the world can be expressed using mathematical language, such as when it is claimed that there are nine planets in the solar system. But proofs and investigations within mathematics itself are analytic. This might seem strange because some proofs in mathematics are very surprising. The logical positivists insisted that once we break down such a 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. Immanuel Kant, inspired by the immensely successful application of Euclidean geometry to nature in Newtonian physics, even claimed that Euclid’s geometry (along with the rest of mathematics) is both synthetic and knowable a priori. In the nineteenth century, mathematicians did work out 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 enormously 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.

I turn now to the other main idea in the logical positivist theory of language, the *verifiability theory of meaning*. This theory applies only to sentences that are not analytic, and it involves a specific kind of “meaning,” the kind involved when someone is trying to say something about the world. 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” here, the positivists meant verification *by means of observation*. Observation in all these discussions is construed broadly, to include all 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 only source of meaning, 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 the early days of logical positivism, the idea was that in principle one could *translate* all sentences with factual meaning into sentences that referred only to sensations and the patterns connecting them. This program of translation was fairly quickly abandoned as too extreme. But the verifiability theory was retained after the program of translation had been dropped.

The verifiability principle was used by the logical positivists as a philosophical weapon. Scientific discussion, and most everyday discussion, consists of verifiable and hence meaningful claims. Some other parts of language are clearly not intended to have factual meaning, so they fail the verifiability test but do so in a harmless way. Included 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—but which *fail* to do so. For the logical positivists, this includes most traditional philosophy, much of ethics, and theology as well!

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

So let us now look at the logical positivists' picture of science and of the role of philosophy in a scientific worldview. Next we should turn to another distinction they made, between "observational" language and "theoretical" language. There was uncertainty about how exactly to set this distinction up. 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 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 terms referring to many 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 "inter-subjective" testing.

The issue became a constant topic of discussion. In time, 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 could 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.

We now need to look at logical positivist views about logic. For logical positivism, *logic is the main tool for philosophy*, including philosophical discussion of science. In fact, just about the only useful thing that philosophers can do is give logical analyses of how language, mathematics, and science work.

Here we should distinguish 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 arguments and evidence that we confront in everyday life and science carry the kind of guarantees 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 Hans Reichenbach. Reichenbach distinguished between the “context of discovery” and the “context of justification.” That terminology is not helpful, because it suggests that the distinction has to do with “before and after.” It might seem that the point being made is that discovery comes first and justification comes afterward. That is not the point being made (though the logical positivists were not completely clear on this). The key distinction is between the study of the logical structure of science and the study of historical and psychological aspects of science.

So logical positivism tended to dismiss the relevance of fields like history and psychology to the philosophy of science. In time this came to be regarded as 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 traditional philosophy has tried to find such a route, it has lapsed into meaninglessness.

The interpretation of logical positivism I have just given is a standard one. There is controversy about how to interpret the aims and doctrines of the movement, however. Some recent writers have argued that there is less of a link between logical positivism and traditional empiricism than the standard interpretation claims (Friedman 1999). But in the sense of empiricism used in this book, there is definitely a strong link. We see that in the Schlick quote given in the previous paragraph.

During the early twentieth century, there were various other strong versions of empiricism being developed as well. One was *operationalism*, which was developed 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 (motivated especially by the lessons of Einstein's theory of relativity) 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-worshippers. Their strongly pro-science stance has even 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 often extremely 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 (who exemplifies these themes especially well). Neurath 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 which 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 they were subject to many challenges. One set of problems was internal to the program. For example, 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.) 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. That topic will be covered in the next chapter.

Other criticisms were directed not at the details but at the most basic ideas of the movement. The criticism that I will focus on here is one of these, and its most famous presentation is in a paper sometimes regarded as the most important in all of twentieth-century philosophy: W. V. Quine’s “Two Dogmas of Empiricism” (1953).

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 that 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 idea 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 of other observers, and so on. So whenever you think of yourself as testing a single idea, what you are really testing is a long, complicated *conjunction* of statements; 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 failure of 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 seems to have some 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.

Holist arguments had a huge effect on the philosophy of science in the middle of the twentieth century. 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” (1953, 41). Logical positivism 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, writing in 1943: “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 much earlier French physicist and philosopher, as someone who had argued for holism about testing. (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 of this, 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. Quine, in contrast, 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 analyticity was intended to treat some claims as *immune to revision*, and he argued that in fact no statement is immune to revision. But Carnap had already decided 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. Let us now look at some central ideas of logical empiricism, the later, less aggressive stage of the movement.

2.5 Logical Empiricism

Let's see how things looked in the years after World War II. Schlick is dead, and other remnants of the Vienna Circle are safely housed in American universities—Carnap at Chicago, Hempel at Pittsburgh and then Princeton, Reichenbach at UCLA (via Turkey), Feigl at Minnesota. Many of the same people are involved, but the work is 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. The analytic-synthetic distinction had not been rejected, but it was regarded as questionable. The logical empiricists felt the pressure of Quine's arguments. The verifiability theory, which had been so scythe-like in its early forms, was replaced by a *holistic empiricist theory of meaning*. Theories were seen as abstract structures that connect many hypotheses together. These structures are connected, as wholes, to the observable realm, but each *bit* of a theory—each claim or hypothesis or concept—does not have some specific set of observations associated with it. A theoretical term (like “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, Herbert 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 form 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 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-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

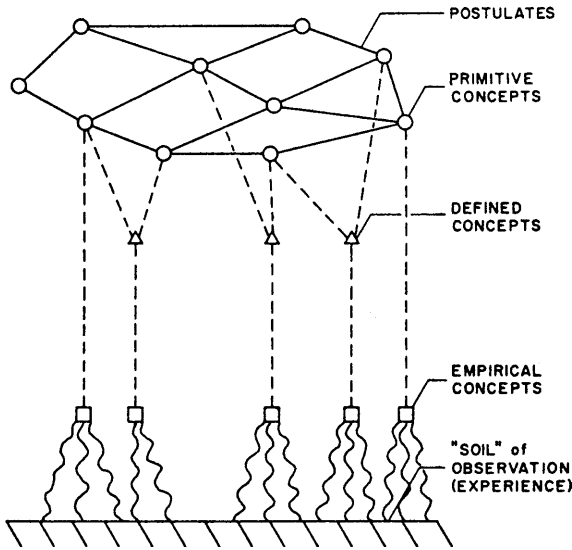


Fig. 2.2

Feigl's picture of the logical empiricist view of theories
(From Feigl 1970; reproduced courtesy
of University of Minnesota Press)

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 13 below). This illustrates the idea, common to logical positivism and logical empiricism, that logic is the main tool of philosophy of science.

We saw that logical positivism held that the sole aim of science is 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. Now, does logical *empiricism* make the same claim? Does logical empiricism claim that scientific language ultimately 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 a paper in 1958 called "The Theoretician's Dilemma," which was the height of logical empiricist agony over the issue. As a fairly traditional 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 like “electron” or “gene,” they act as if they are doing more than tracking complex patterns in the observable realm. But the idea that the logical empiricists were being pushed toward—the idea that scientific theories are aimed at describing unobservable real structures—was hard to put on the table and defend. 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 the traditional empiricist 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 said: “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 constantly 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 electrons, 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.

2.6 On the Fall of Logical Empiricism

Logical empiricist ideas dominated much American philosophy, and they 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 near to extinction. The fall of logical empiricism was due to several factors, all of which I have either introduced in this chapter or will discuss in later chapters. One is the breakdown of the view of language that formed the basis of many logical positivist and logical empiricist ideas. Another is pressure from holist arguments. A third is the frustrating history of attempts to develop an inductive logic (chapter 3). A fourth is the development of a new role for fields like history and psychology in the philosophy of science (chapters 5–7). And eventually there was pressure from scientific realism. But this was only possible after logical empiricism had begun to decline.

Further Reading

For much more on the empiricist tradition in general, see Garrett and Barbanell, *Encyclopedia of Empiricism* (1997).

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 strong, 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.

The *Routledge Encyclopedia of Philosophy* (1998) has an interesting collection of articles, especially in the light of new debates about the history of logical positivism. The article on logical positivism is by Friedman and reflects his somewhat unorthodox reading (de-emphasizing the empiricist tradition). Stadler's entry on the Vienna Circle gives a more traditional view. See also Creath's entry on Carnap. On all these issues, see also the essays in Giere and Richardson 1997.

Peter Galison's "Aufbau/Bauhaus" (1990) is a wonderful account of the artistic, social, and political interests of the logical positivists and the links between these interests and their philosophical ideas. Passmore 1966 is a good and accessible survey of philosophical movements and trends in the late nineteenth and early twentieth centuries, including absolute idealism.

Hempel, *Aspects of Scientific Explanation* (1965), is the definitive statement of logical empiricism. 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).

An attempt to revive some logical positivist ideas has recently begun; see, for example, Elliott Sober's forthcoming book *Learning from Logical Positivism*.

an introduction to the philosophy of science

.....
THEORY AND REALITY
.....

PETER GODFREY-SMITH

The University of Chicago Press / Chicago and London

Peter Godfrey-Smith is associate professor of philosophy and of history and philosophy of science at Stanford University. He is the author of *Complexity and the Function of Mind in Nature*.

The University of Chicago Press, Chicago 60637
The University of Chicago Press, Ltd., London
© 2003 by The University of Chicago
All rights reserved. Published 2003
Printed in the United States of America

1 2 11 10 09 08 07 06 05 04 03 1 2 3 4 5

ISBN: 0-226-30062-5 (cloth)
ISBN: 0-226-30063-3 (paper)

Library of Congress Cataloging-in-Publication Data

Godfrey-Smith, Peter.

Theory and reality : an introduction to the philosophy of science /
Peter Godfrey-Smith.

p. cm. — (Science and its conceptual foundations)

Includes bibliographical references and index.

ISBN 0-226-30062-5 (alk. paper) — ISBN 0-226-30063-3 (pbk. : alk.
paper)

I. Science—Philosophy. I. Title. II. Series.

Q175 .G596 2003

501—dc21

2002155305

© The paper used in this publication meets the minimum requirements of the American National Standard for Information Sciences—Permanence of Paper for Printed Library Materials, ANSI Z39.48-1992.