Chapter 14

Science and Epistemology

In this chapter first we will bring our story more or less up-to-date, and second we will round out some issues concerning the concepts of knowledge and justification; that is, belief, knowledge, evidence and degrees of justification, reliabilism, coherentism and foundationalism, and the tripartite definition of knowledge (knowledge as justified true belief).

14.1 An uneasy relationship

In the last chapter we looked at Kant's views on our knowledge of the *a priori*; space and time, as applications of the concepts of geometry and number that we bring to bear in experience, and certain high-level concepts—principally that of cause and effect—that are not derived from experience but are brought to bear by us in making sense of our experience.

This approach goes together with the idea that philosophy is prior to natural science, that thinking about thought itself, isolating what is *a priori*, is the first source of knowledge. On this view philosophy generates the conceptual scheme used by other disciplines, so natural science has to wait on and follow on from the discoveries of philosophers. The last great proponent of this view was G.W.F. Hegel (1770–1831), whose three volume *Encyclopaedia of the Philosophical Sciences*, devoted to logic (the study of forms of thinking, the *a priori*), and its applications (the philosophy of nature and the philosophy of mind), was intended to provide a comprehensive philosophical foundation for all subsidiary disciplines, including natural science. But even in Hegel's lifetime such an approach was increasingly untenable and as the nineteenth and the twentieth centuries progressed the star of natural science rose, eclipsing that of philosophy. So in this section I will briefly bring our story up-to-date as a backdrop to the topics we will look at in the rest of this chapter. First, we will look at two major developments in the nineteenth century that undermined Kant's conception of *a priori* knowledge, concerned with geometry and number.

Geometry

Kant's argument, as we have seen, is that we perceive space in terms of Euclidean geometry because Euclidean geometry is, so to speak, hard-wired into our minds. This is the basis of Kant's account of the necessity and universal applicability of geometry; these follow automatically from the idea that in making sense of the spatial arrangements of things in the world around us we bring Euclidean geometry to bear.

In the nineteenth century, though, non-Euclidean geometries were developed, principally by Riemann and Lobachevsky. Imagine you are standing at the North Pole. You walk due south until you get to the equator—about 6200 miles—and turn left through 90°, and walk a further 6200 miles. Now turn left again through 90° and walk due North, again about 6200 miles, until you are back at the North Pole. Your original path is 90° to you, so you have walked three straight lines, come back to the point you started at—just as if you had walked a triangle—yet the included angles add up to 270°. How can this be? The reason is that the earth is not flat, it is a sphere, so applying geometry on the surface of the earth over any significant distance involves non-Euclidean geometry (geometries in which the included angles of a triangle add up to more than, or less, than 180°, on surfaces that are either convex or concave).

A similar effect occurs with parallel lines. Euclid's geometry includes the *parallel postulate*, that given a line L and a point x not on L, exactly one line can be drawn through x that never meets L, however much we extend the two lines. But this does not work on a curved surface. Two lines either converge, in which case they touch sooner or later, or they diverge, in which case they may eventually loop back on one another.

The crunch comes with Einstein's theory of relativity. This shows that space is not conceptually distinct from time, and that space-time is curved (5.3). But this does not prove that Kant was wrong. It could be that we can only perceive space in terms of Euclidean geometry because while the range of our perceptual apparatus, unaided, is enormous—we can, after all, "see" stars light years away (we see the light emitted from them years ago)—our capacity to discriminate is not nearly so great. To "see" the red shift effect we have to use sophisticated experimental techniques and apply sophisticated theoretical methods. Perhaps, then, we perceive what there is in terms of Euclidean geometry, and apply theoretical techniques to make appropriate adjustments. Nevertheless we have some reason to be wary of making *a priori* claims about Euclidean geometry.

Further, this suggests that the Kantian project of identifying what is necessary and *a priori* as aspects of judgements contributed by us is possibly misguided. Kant devised this approach as a bulwark against Humean scepticism, which he associates with empiricism. If non-Euclidean geometry furnishes grounds for rejecting Kant's approach, and if pragmatically the success of modern science undermines the grounds for scepticism, then perhaps we can reasonably adopt empiricism. This question will be taken up later in the present chapter.

Number

As we also saw, Kant associates number with time, with our ability to count; as someone might count under their breath 1, 2, 3, and so on, so Kant suggests that we are aware of number. Many events might happen in the time it takes me to count to one thousand, and these events will all have a temporal ordering, an ordering I can ascribe numbers to.

The development that matters here in the nineteenth century was that of axiomatisation. In the case of number the axioms are those set out by the Italian mathematician Guiseppe Peano in 1899:

1. 0 is a number.
2. The immediate successor of a number is a number.
3. 0 is not the immediate successor of any number.
4. No two numbers have the same immediate successor.
5. Any property belonging to 0, and also to the immediate successor of every number that has the property, belongs to all numbers (principle of mathematical induction).

Instead of thinking of numbers as things, axiomatisation enables us to think of them in terms of a set of rules. These rules define the permissible manipulations of symbols, that is, they define not *things* but *structures*. A line of clothes pegs on a washing line is as good a model of the beginning sequence of the natural numbers as saying one, two, three, and so on, out loud, and does not require any reference to a thinking being. On this view mathematics is about structures, not things, and mathematical knowledge is knowledge of rules for manipulating these structures, not knowledge of things. For example:

A two-legged duck has two legs.

is a tautology, because the subject ("a two-legged duck") already contains the predicate ("has two legs"). Similarly:

$$2 + 2 = 4$$

is a tautology, as a meaning of "4" is "2+2" (other "meanings" are 2^2, $5 - 1$, and so on). In a post office you might find a letter-sorting machine; you put a pile of letters into the hopper, it scans the postcodes, and outputs the letters into a series of pigeon holes. Barring malfunctions the output is the same as the input, only it is sorted (a structure has been imposed upon it). The underlying idea is that arithmetic, and mathematics generally, is a colossal collection of tautologies that adds no content; it is a collection of techniques for ordering and arranging whatever content it is applied to.

As with non-Euclidean geometry, we have grounds for discarding Kant's approach. The necessity of mathematics does not arise from its realisation in the rational faculty, imposed by us in making judgements about the world. Rather it reflects the idea of mathematics as a contentless collection of structures, a set of techniques that acts as a bridge between sets of propositions; from an initial plan to build a bridge over a river, perhaps, to a finished scheme fully calculated and optimised to cope with weather conditions and traffic loads.

Furthermore these developments, coupled with the fallout from the development of quantum mechanics in the 1920s, undermined the idea of theory of knowledge as a subject distinct from natural science, let alone prior to it. If theory of knowledge is about how we form accurate, reliable beliefs about what there is—beliefs that are appropriately justified, are true—as science (I'll drop the "natural" from hereon) is the most successful enterprise going in this area, perhaps theory of knowledge should be refocussed as a descriptive study of scientists about their work.

Reliabilism

Here is an example of this sort of approach. If a dark speck moves close enough to a frog, it will shoot out its tongue, catch it and eat it. A frog has to eat, so frogs that survive will be those that are most effective at discriminating and catching passing insects. If a frog catches an insect, its belief-forming mechanism ("that's edible and within range") has generated the answer "true". If it fails (it was not an insect but a speck of soot, it was not in range) then it's belief-forming mechanism has generated an error (a falsehood). A frog that is consistently wrong will not live for long and probably will not reproduce, so over time it is likely that frogs will manifest more accurate belief-forming mechanisms.

Successful frogs will be those with a reliable belief-forming process when it comes to food. This is known as **reliabilism**, and it applies in similar ways to people. Those who are effective in achieving what they set out to do are likely to be more successful, all else being equal. Their beliefs are justified because they are generated by reliable belief-forming mechanisms. So if we want to study knowledge, perhaps we should study the belief-forming processes of successful people. In this way the theory of knowledge would become a branch of psychology, in which we study successful people, in order to extrapolate principles that underlie their success and to see how we can teach these principles to others. We would, of course, also look at the less successful as an example of how not to go about things.

While reliabilism has some attractive and plausible aspects, it does not obviously have much to say as to *why* a belief-forming process is reliable. A clairvoyant might be reliable but there is no obvious reason why they are reliable. Someone who is a reliable guide to wine, for example, will be someone who has studied their subject, has a wide experience of tasting and has a sophisticated palette. You would have good reason to trust such a person's judgement in their field, to think that their judgments are likely to be accurate and consistent. But this seems to sever the link between knowledge and evidence, because if somebody is reliable then they just are reliable; that they are reliable is its own justification. This is why reliabilism is called a "non-justificatory" approach in theory of knowledge. We will look more closely at such relationships between concepts in 14.5.

14.2 Verificationism and evidence

Before the emergence of epistemology as a descriptive enterprise, it was profoundly influenced in the 1920s by *logical empiricism* (the label "logical empiricism" is now more generally used than "logical positivism"). The most influential proponents of this approach comprised the *Vienna Circle*, a group mainly of scientists with philosophical interests. Logical empiricism combined the approach to the *a priori* sketched above, that the *a priori* is a collection of tautologous principles that can be used for ordering or structuring data given in experience, that is, what is given *a posteriori*. Combining the latter with the former yields, so they argued, properly scientific knowledge about the world and about ourselves (the task of a properly scientific psychology).

Logical empiricism begins with the "Verification Principle" (**verificationism**). This is Ayer's version:

> We say that a sentence is factually significant to any given person, if, and only if, he knows how to verify the proposition which it purports to express—that is, if he knows what observations would lead him, under certain conditions, to accept the proposition as being true, or to reject it as being false. (*Language, Truth and Logic*, p.16)

The connection of truth-value with observation is significant. By **proposition** is meant, more and less, what a sentence says:

the sentences "Snow is white" and "La neige est blanche" say *that snow is white* so, since we are interested in the things themselves, it is propositions we are interested in. Here is a programmatic statement of logical empiricism's central doctrines from Rudolf Carnap, one of the leaders of the Vienna Circle:

> What, then, is the method of verification of a proposition? Here we have to distinguish between two kinds of verification: direct and indirect. If the question is about a proposition which asserts something about a present perception, e.g. "now I see a red square on a blue ground", then the proposition can be tested directly by my present perception. If at present I do see a red square on a blue ground, the proposition is directly verified by this seeing; if I do not see that, it is disproved. To be sure, there are still some serious problems in connection with direct verification. We will however not touch on them here, but give our attention to the question of *indirect* verification, which is more important for our purposes. A proposition P which is not directly verifiable can only be verified by direct verification of propositions deduced from P together with other already verified propositions.
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> Let us take the proposition P_1: "This key is made of iron." There are many ways of verifying this proposition; e.g.: I place the key near a magnet; then I perceive that the key is attracted. Here the deduction is made in this way:
>
> *Premises*:
>
> P_1 "This key is made of iron"; the proposition to be examined.
> P_2 "If an iron thing is placed near a magnet, it is attracted"; this is a physical law, already verified.
> P_3 "This object—a bar—is a magnet"; proposition already verified.
> P_4 "The key is placed near the bar"; this is now directly verified by our observation.
>
> From these four premises we can deduce the conclusion:
>
> $\mathbf{P}_5$ "The key will now be attracted by the bar."

This proposition is a prediction which can be examined by observation. If we look, we either observe the attraction or we do not. In the first case we have found a positive instance, an instance of verification of the proposition P_1 under consideration; in the second case we have a negative instance, an instance of disproof of P_1.

In the first case the examination of the proposition P_1 is not finished. We may repeat the examination by means of a magnet, i.e. we may deduce other propositions similar to P_5 by the help of the same or similar premises as before. After that, or instead of that, we may make an examination by electrical tests, or by mechanical, chemical, or optical tests, etc. If in these further investigations all instances turn out to be positive, the certainty of the proposition P_1 gradually grows. We may soon come to a degree of certainty sufficient for all practical purposes, but *absolute* certainty we can never attain. The number of instances deducible from P_1 by the help of other propositions already verified or directly verifiable is *infinite*. Therefore there is always a possibility of finding in the future a negative instance, however small its probability may be. Thus the proposition P_1 *can never be completely verified*. For this reason it is called an **hypothesis**.

So far we have considered an individual proposition concerning one single thing. If we take a general proposition concerning all things or events at whatever time and place, a so-called natural *law*, it is still clearer that the number of instances is infinite and so the proposition is an hypothesis.

Every assertion P in the wide field of science has this character, that it either asserts something about present perceptions or other experiences, and therefore is verifiable by them, or that propositions about future perceptions are deducible from P together with some other already verified propositions. If a scientist should venture to make an assertion from which no perceptive propositions could be deduced, what should we say to that? Suppose, e.g., he asserts that there is not only a gravitational field having an effect on bodies according to the known laws of gravitation, but also a *levitational field*, and on being asked what sort of

> effect this levitational field has, according to his theory, the answer is that there is no observable effect; in other words, he confesses his inability to give rules according to which we could deduce perceptive propositions from his assertion. In that case our reply is: your assertion is no assertion at all; it does not speak about anything; it is nothing but a series of empty words; it is simply without sense. (Carnap, *Philosophy and Logical Syntax*, Kegan Paul Trench Trubner & Co., 1935, p.10–14)

This is a **foundationalist** approach to knowledge, because it begins with evidence derived from observation and builds on it (using tautologous principles). Logical positivism is, as noted earlier, now called "logical empiricism", because it is a combination of logic (the tautologous ordering/structuring principles we met earlier) and **empiricism** about what is observable, what can be experienced. This is why Carnap denies that any law derived from experience in this way—by induction—can ever be *certain*. Hence Carnap denies, in the spirit of Locke (7.5), and Hume (12.2), that necessary truths can ever be derived from experience alone.

At the end of Chapter 12 we touched on the question of whether scientific method is inherently sceptical. We can now refine this and suggest that we regard the results of scientific investigations as inherently **defeasible**; we are prepared to accept that any scientific theory we hold at present may be revised, and may even be proven false, at some point in the future. If induction and defeasibility are central to scientific methodology, then applying them to scientific enquiries themselves shows that theories held at past times have been revised and/or superseded, suggesting that our present theories may in turn be revised and/or superseded by new theories as yet unthought. It is of course possible that some of our present theories will never be revised or superseded; does that make them *necessary* truths, true everywhere and everywhen? How can we ever know? With this background in place, we will turn to perhaps the biggest debate in twentieth century epistemology, that between **foundationalism** and **coherentism**.