Principles of scientific method

Notes on Lectures by Dr K.R. Popper given at the University of Otago, 22–26 May 1945

Lecture 1. The hypothetico-deductive method

All science has a distinctive character, which may be summarised as follows:

1. All scientific statements retain their hypothetical character (hypotheticism). They are always hypotheses. Certainty is not, and cannot be, the aim of science.
2. Deductivism – the so-called inductive method is a kind of optical illusion. It looks like induction, but never is.
3. Testing of theories. Doctrine concerning the way we test our theories. (see Lecture 2).

Methodology of science

From John Stuart Mill onward, the problem has been approached by attempting to analyse: 'How is it that physics is so successful?', and applying the answers to backward sciences [sic], such as psychology and the social sciences, and to a lesser extent the biological sciences. Mill took over views from Bacon and others that the methods of science were fundamentally inductive (inductivism). Mill's law of causality is a generalisation from multifarious observations (see note below).

With the method of deduction one starts with original ideas of unclear origin, i.e. general hypotheses, and then tries to prove these hypotheses. The hypothesis is provisional. When established by some kind of proof, it becomes a theory. However, you never get beyond the stage of a hypothesis. The last word may be said on some scientific problem, but, if it is said, we cannot know it; hence, the whole distinction between theory and hypothesis breaks down, i.e. all theories are hypotheses and never more.

But the reverse is not the case. All hypotheses are not theoretical. Hypotheses are of two kinds – (a) general or universal, as in science (these could be called theories), (b) special or individual, e.g. a medical diagnosis.

To sum up: The aim of science is not certainty. It is a human effort and in consequence shares human imperfection.

Prejudices in the way of acceptance of hypotheticism

1. Mill's – 'If you don't get certainty in science, where do you get it?'. This is Science with a capital S, i.e. 'Science says …', of the popular conception. It is, however, adopting a magical attitude to science, just as is done with a medicine man, both ancient and modern!

It is important to realise the significance of this attitude. Great scientists realise how little they know – the humility of the really great. There is no scientific knowledge in the general sense of the word 'knowledge'. We speak of knowledge in ordinary life as something we can be sure of. It is the higher standards that science applies which reduce 'scientific knowledge' to the hypothesis. The term 'body-of-scientific-knowledge' (for example, as in a textbook) is a misnomer – it is not a body and is not really knowledge.

2. The empirical prejudice – 'I believe only what is evidenced by my senses'.
3. Rationalistic prejudice – 'I believe only what can be proved to me'.

The last two together lead off Mill's point of view – which is inductivism. 'I believe only what can be proved on the basis of observation'. It is wrong to take them as a basis of scientific method. Before beginning to observe we must have a problem, i.e. a statement of a hypothetical character, otherwise the observations are uninteresting and unrelatable. One can, therefore, never isolate the observations as such, for then one has not the basis of the hypothesis on which they are superimposed. The rationalistic prejudice – 3 above – can be discarded as one can't prove anything scientifically.

The character of scientific method is rather that of situational logic, i.e. it resembles the character of the situation of a man dodging traffic – we are in a strange world, dodging in and out according to circumstances. An alternative analogy is that of a man finding his way through a forest in a dark night, pressing forward, bumping up against trees, moving round and past them to encounter more obstacles, etc.

Note

(Extracts from *The Poverty of Historicism III*, by K.R. Popper, 1936.)

Mill describes the law of causality as follows: 'An individual fact is said to be explained by pointing out its cause, that is, by stating the law or laws …… of which its production is an instance. Thus a conflagration is explained when it is proved to have arisen from a spark falling into a heap of combustibles …'

I suggest that to give a causal explanation of a certain specific event means deducing a statement describing this event from two kinds of premises, viz. from some universal laws, and from some singular or specific statements which we may call the specific initial conditions. For example, we can say that we have given a causal explanation of the breaking of a certain thread, if we find that this thread could carry a weight of only one pound, and that a weight of two pounds was put on it. If we analyse this causal explanation, we find that two different constituents are involved. (1) We assume some hypotheses of the character of universal laws of nature; in this case, perhaps: 'Whenever a certain thread undergoes a tension exceeding a certain minimum characteristic for that particular thread, it will break." (2) We assume some specific statements (the initial conditions) pertaining to the particular event in question; in this case, we may have two statements: 'For this thread, the characteristic minimum tension at which it is liable to break is equal to one pound weight' and, 'The weight put on this thread was a two pound weight'. Thus we have two different kinds of statements which together yield a complete causal explanation: (1) universal statements of the character of natural laws, and

(2) specific statements pertaining to the special case in question, the initial conditions.

Now, from the universal laws (1), we can deduce with the help of the initial conditions (2) the following specific statement (3): 'This thread will break'. This conclusion (3) we may also call a specific prognosis. The initial conditions (or more precisely, the situations described by them) are usually spoken of as the cause of the event described by the prognosis; so we say that the putting of a weight of two pounds on a thread capable of carrying only one pound was the cause of the breaking.

Such a causal explanation will be, of course, scientifically acceptable only if the universal laws are well tested and confirmed, and if we have also some independent evidence of the cause described by the initial conditions.

Before proceeding to analyse the causal explanation of regularities or laws, it may be remarked that several things emerge from our analysis of the explanation of singular events. One is that we can never speak of cause and effect in an absolute way, but that an event is a cause of another event – its effect – relative to some universal law. However, these universal laws are very often so trivial (as in our example) that as a rule we take them for granted, instead of making conscious use of them. A second point is that the use of a theory for predicting some specific event is just another aspect of its use for explaining such an event. And since we test a theory by comparing the events predicted with those actually observed, our analysis also shows how theories can be tested. Whether we use a theory for the purpose of explanation, of prediction, or of testing, depends on our interest, and on which statements we consider as given or unproblematic and which need testing, etc.

If we now compare our explanation of causal explanation with Mill's, we see that in Mill's discussion of the causal explanation of singular events, there is no clear distinction between (1) the universal laws and (2) the specific initial conditions. This is largely due to Mill's lack of clarity in his use of the term 'cause', by which he means sometimes singular events, and sometimes universal laws.