Verification: The use of empirical data, observation, test, or experiment to confirm the truth or rational justification of a hypothesis. Scientific beliefs must be evaluated and supported by empirical data. What does this require? Two concepts are fundamental in discussing scientific method: truth and justification (warrant). A hypothesis is true if it corresponds to the way the world is. Justification has to do with the grounds we have for believing a given statement to be true. A hypothesis is rationally warranted if a body of evidence and inference has been provided in support of it. Ideally, the fact that a statement is rationally warranted ought to make it likely that the statement is true. (This treatment makes apparent the relevance of Baysian theory to scientific inference. The questions have to do with the transmission of rational credibility from one body of beliefs to another.) Philosophers have introduced several concepts and theories on the basis of which to analyze the logical and inferential relations between empirical data and scientific hypotheses, including observation, falsifiability, confirmation, and experimental method. One of the most important consequences of this extended and complex debate is the conclusion that theories cannot be "verified", but they can be "confirmed," "warranted," or "falsified."

The general question of scientific inference can be formulated in these terms: Given a body of evidence E and a hypothesis or theory T, how do we measure the warrant of T given E? Are there logical grounds for answering this question? (This does not define the full task for a theory of scientific method, because scientific method should also give us some guidance concerning the problem of discovering a relevant body of evidence.) It is rare for a scientific hypothesis to be amenable to direct and certain confirmation along these lines: given E, H is certainly true. That is, it is rare that there is a finite body of observations that suffice to establish the truth of a given scientific hypothesis. This is so for two reasons: First, because scientific hypotheses normally refer to entities, mechanisms, or processes that are not directly observable; and second, because hypotheses and theories normally make universal claims (laws) that go beyond any finite body of observations. Instead, verification normally takes the form of indirect inductive or hypothetico-deductive support for the hypothesis: given E, H is likely to be true.

Suppose that H deductively implies O and that the body of evidence E contains "not O". In this case E falsifies H. On these assumptions, the body of evidence contains observations that demonstrate that H is false. (For example, suppose the hypothesis H deductively entails that the metal will melt when heated to 500 degrees Centigrade. We perform the experiment; the metal does not melt; and we conclude that H is false.) Suppose now that H implies a series of observations $O_1, O_2, ..., O_n$ and that E contains $\{O_I\}$. (That is, some of the observational consequences of the theory are found to be true.) Does E confirm H, and to what extent? This is the fundamental question of inductive logic and scientific method. What constitutes a significant test and confirmation to the theory? Several logical points are important. No finite list of observations exhaustively confirms a theory with universal generalizations; and different types of additional evidence have very different incremental effects on the credibility of the theory. E.g. additional observations of the same type have less epistemic weight than an additional unexpected observation.

What is an observation? This has been a main source of controversy in the philosophy of science, in that it has long been recognized that there is no sharp and permanent distinction between observation and theory. Virtually all scientific observations are theory-laden. But the essential idea is that an empirical observation is a scientific belief with a relatively direct relationship between the evidence of the senses and the truth conditions of the statement, based on reliable techniques of data collection to which we can attach high rational credibility. Here, for example, we are to consider direct sensory observation, observation using instrumentation, interviews, records of price data, etc. Most are not "direct" or "certain". But they are relatively unburdened by currently controversial theories. This description suggests an approach to empirical confirmation that can be described as the "bootstrapping" method, where the credibility of some beliefs is enhanced by assigning provisional credibility to others; we then return to re-assess the provisional beliefs based on the wider set of theoretical beliefs.

Several general approaches to empirical evaluation of scientific hypotheses have been offered in the past century. First is the idea, most deeply explored by Carl Hempel, that we should draw out the deductive consequences of a theory; evaluate the truth of some of those consequences using observation and instrumentation; and assign a degree of warrant to the theory based on the volume of its confirmed observational consequences. This approach constitutes the hypothetico-deductive theory of confirmation, and it represents the logical basis for the experimental method. Second is the idea, advanced by Karl Popper, that the scientific method works primarily through diligent and serious efforts to refute scientific hypotheses. The researcher needs to identify the most unlikely predictive consequences of the hypothesis and make every effort to show that these predictions are not upheld—thereby "falsifying" the theory in question. Only when a theory or hypothesis has withstood serious and varied tests along these lines do we have a rational basis for believing the theory. The two approaches are logically similar, in that they attempt to assign a degree of empirical warrant to a hypothesis based on the truth or falsity of its deductive consequences. But the underlying assumptions about how confirmation and testing proceed are quite different. Confirmation theory largely assumes that degree of warrant increases through the gradual accumulation of true consequences; whereas falsifiability theory assumes that warrant increases only as a result of our failure to refute the hypothesis in question. Both approaches have generated a large volume of critical discussion. Critical reflection upon classical confirmation theory notes that it is difficult or impossible to provide a purely formal specification of the set of deductive consequences of a theory that serve to enhance the warrant of the theory. Further discussions of the theory of falsifiability have noted that anomalies are too easy to find in the development of scientific theories, and have attempted to offer a more historically adequate account of scientific belief based on a theory of "scientific research programmes" (Lakatos 1978).

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