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Gary Blum

University of Nebraska at Omaha

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HYPOTHESIS IN BRITISH METHODOLOGICAL THOUGHT:
NEWTON TO WHEWELL

GARY BLUM

Department of Religion and Philosophy
University of Nebraska at Omaha 68132

In this paper I wish to trace the gradual breaking away from the powerful influence of Isaac Newton's views on the admissibility of hypotheses in "experimental philosophy," mainly as this break occurred in the writing of 19th century methodologists in Great Britain.

First, let us consider Newton's notion of *hypothesis*. The term is used in many different ways in Newton's various writings (I. B. Cohen, in *Franklin & Newton*, has distinguished at least 9 different senses of the word). But two major considerations are relatively clear: Newton called his science "experimental philosophy" in order to contrast it with the "hypothetical philosophy" of the Cartesians, and, secondly, hypotheses are contrasted by Newton with phenomena or things derived from phenomena. Newton's famous remark "*Hypotheses non fingo*" occurs in this passage from the General Scholium of the *Principia*: "Hitherto I have not been able to discover the cause of those properties of gravity from phenomena and I frame no hypotheses. For whatever is not deduced from the phenomena is to be called a hypothesis; and thpotheses, whether metaphysical or physical, whether of occult qualities or mechanical, have no place in experimental philosophy." (Thayer, 1953:45). But this quotation is not entirely typical of Newton. In the first edition of the *Principia* he labeled at least 9 propositions as Hypotheses (these included what in later editions were called the Rules of Reasoning and the Phenomena), and he is quoted elsewhere as saying that in his own philosophy "... hypotheses have no place, unless as conjectures or questions proposed to be examined by experiments." (Cohen, 1962:388).

Thus it seems that we can mark out three important senses of hypothesis:

- 1) One meaning is that of an axiom or postulate in the system (either methodological or physical). Examples: In Book 3 of the *Principia* (3rd edition) (Hyp. 1.) "The centre of the system of the world is immovable"; Book 3 of *Principia* (1st edition) (Hyp. 1) "We are to admit no more causes of natural things, than such as are both true and sufficient to explain their appearances." (Koyre, 1968:29-30). These propositions are plausible assumptions to be accepted, without further proof.
- 2) A second meaning is related to "conjectures or questions proposed to be examined by experiments." Evidently these propositions are

empirically testable. Some of Newton's Queries in the *Opticks* were intended to fall into this class. Although testable they have *not yet been* tested.

- 3) A third sense of the term includes those hypotheses which lack the kind of empirical testability of those hypotheses captured by the second use of the term. In a letter to Cotes, Newton defines this third class as follows: "The word *hypothesis* is here used by me to signify only such a proposition as is not a phenomena or deduced from any phenomena but assumed or supposed without any experimental proof." (Koyre, 1968:38). From remarks and examples given by Newton, he seems to want to include in this category not only those propositions assumed without experimental proof, i.e., those constructed on a non-phenomenal basis; but also those which can be falsified by the evidence. The basic fault in both of these cases is that the hypotheses were not deduced from phenomena.

Descartes, who seems to be the target of many of Newton's methodological restrictions, fails on both of the counts mentioned in (3) in the case of his theory of vortices. First of all, the leading principles of that theory were not suggested by phenomena, but by Descartes' metaphysical views, and thus they were, to Newton, initially implausible; secondly, that theory's implications seemed to contradict empirical fact.

Another important subclass of hypotheses not derived from phenomena is marked out in this revealing passage from a draft of the 3rd Book of the *Principia*:

"The argument of induction taken from experiments and the observations of the senses on which experimental philosophy is founded cannot apply to hypothetical or metaphysical entities which are not phenomena except through hypotheses: therefore, nothing which is determined about bodies by means of induction in this book refers to those entities. Here it is a question only of sensible things and their parts because the argument of induction concerns these alone." (Newton, MS).

This passage clearly indicates that inductive reasoning cannot extend to anything beyond the phenomenal. Thus, those hypotheses that refer to non-phenomenal entities are considered to be *not* deduced from phenomena, and inductive conclusions cannot apply to these entities.

It seems, then, that when Newton excludes from experimental philosophy those hypotheses not derived or deduced from phenomena, he is excluding at least three types of hypotheses: (1) those derived from first principles which are metaphysical or non-physical; (2) those whose implications are falsified by empirical facts; (3) those referring to non-phenomenal entities, and to which entities inductive conclusions cannot be applied.

Note that proscribing the first type of hypotheses amounts to a

restriction on the *source* or *origin* of an hypothesis, and seems to be a kind of confusion of the context of justification and context of discovery. The second type of proscribed hypothesis may pose less of a problem to the concerned methodologist (unless he takes Feyerabend seriously). But the third type of excluded hypothesis amounts to a quite severe restriction on the nature of scientific theories. In effect, it rules out any theory that makes reference to non-phenomenal entities. Obviously Newton violates his own strictures in admitting the existence of the void, of atoms, of aethereal spirit, and of non-mechanical forces. But the expression “hypothesis,” notes Koyre, is like one of those curious terms like “heresy,” that we never apply to ourselves, but only to others. And the others, for Newton, are the Cartesians, Leibniz, and Hooke, to name a few.

Although Newton’s phrase “*Hypotheses non fingo*” was a slogan for many intellectual reformers in and out of science, it seems that the first philosopher in Great Britain to seriously cultivate Newton’s anti-hypothetical views was Thomas Reid (1710-96). Reid was trained in the natural sciences and lectured in physics and mathematics and philosophy at Aberdeen and Glasgow. He lectured on the *Principia* for twelve years, and later, in his two books, *An Inquiry into the Human Mind* (1765) and *Essays on the Intellectual Powers of Man* (1785), he tried to develop a scientific philosophy of mind, or psychology, based on his insights into Newton’s scientific method.

He garnered from Newton a near contempt for hypotheses, theories, or conjectures which were not induced from experiments and observations. This revealing quote from his *Essay on the Intellectual Powers of Man* sums up his attitude:

“... discoveries have always been made by patient observation, by accurate experiments, or by conclusions drawn by strict reasoning from observations and experiments, and such discoveries have always tended to refute, but not to confirm, the theories and hypotheses which ingenious men have invented.

As this is a fact confirmed by the history of philosophy in all past ages, it ought to have taught man, long ago, to treat with contempt hypotheses in every branch of philosophy, and to despair of ever advancing real knowledge that way.” (Laudan, 0000).

Laudan has noted seven kinds of arguments that Reid used to bolster his anti-hypotheticalism and I shall mention them here (taken directly from Laudan, pp. 109-14):

- (1) “As a matter of historical fact, hypotheses and conjectures have not been very productive, and have tended to mislead rather than enlighten us.”
- (2) “The adoption of an hypothesis prejudices the impartiality of the scientist.” If it is *our* creation, we take a vested interest in it and are liable to test it less severely. Also, if an hypothesis is appealing on a

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priori grounds, we are prone to decide the truth and falsity of other empirical propositions by their accord with that hypothesis rather than by testing the hypothesis itself by empirical statements whose truth has been determined independently.

- (3) “The hypothetical method presupposes a greater simplicity in nature than we find there.” We usually select the simplest hypothesis from set of hypotheses that explain phenomena, but the simplest is usually wide of the mark.
- (4) “The use of hypotheses assumes that man’s reason is capable of understanding the works of God.” God’s ingenuity is infinitely superior to ours; thus it is highly unlikely that human conjectures would discover the causes of God’s handiwork.
- (5) “Hypotheses can never be proved by *reductio* methods.” No crucial experiment can show that a particular hypothesis uniquely explains a phenomenon, usually because we cannot enumerate all possible hypotheses.
- (6) “The use of hypotheses usually violates Newton’s first ‘*Regula Philosophandi*’,” which says that no more causes are to be admitted than those which are both true and sufficient to explain the appearances.
- (7) “The hypothetical method substitutes premature theoretical ingenuity for painstaking experimental rigour.” Reid, like many other British inductivists, hoped for a logic of discovery – a set of rules that would allow the devising of scientific laws and theories with less reliance on the need for ingenuity and imagination.

Although Reid, writing in the late 18th century, was probably the first and most vigorous philosophical defender of Newton’s anti-hypotheticalism, British philosophers of logic and scientific method in the 19th century all (including Brown, Herschel, Whewell, Mill, Hamilton, De Morgan, and Jevons) spent some time discussing Newton’s views on scientific method, including hypotheses.

Brown devoted some pages showing that hypotheses are often invented to explain why some phenomenon occurs. The consequence often is that the hypothesis is just as mysterious as the phenomenon it was to explain, thus, leaving two mysteries to be explained where formerly there was one. Brown, however, argues that hypotheses are essential to the first stage of scientific inquiry (but *only* the first stage):

“That hypotheses, in that wide use of the word which implies everthing conjectural, are without use in philosophy it would be absurd to affirm, since every inquiry may, in that wide sense, be said to presuppose them, and must always pre-suppose them if the inquiry have any objects. They are of use, however, not as superseding investigation, but as directing observation to certain objects – not as telling us what we are to believe, but as

pointing out to us what we are to endeavor to ascertain. An hypothesis, in this view, of it, is nothing more than a reason for making one experiment or observation rather than another; and it is evident, that, without some reason of this kind, as experiments and observations are almost infinite, inquiry would be altogether profitless. To make experiments at random is not to *philosophize*: it becomes philosophy, only when the experiments are made with a certain view, and to make them with any particular view, is to suppose the presence of something, the operation of which they will tend either to prove or disprove.” (Brown, 1820:80).

Brown also marks out the difference between a *theory* and a *hypothesis* a distinction rarely articulated by early methodologists. The difference, he says, is this:

“... we commonly give the name of *hypothesis* to cases, in which we suppose the intervention of some substance, of the existence of which, as present in the phenomenon, we have no direct proof, or of some additional quality of a substance before unobserved – and the name of *theory* to cases, which do not suppose the existence of any substance that is not actually observed, or of any quality that has not been actually observed, but merely the continuance, in certain *new* circumstances, of tendencies observed in other circumstances.” (Brown, 1820:84).

This distinction is similar to Newton’s distinction between hypotheses and propositions induced from phenomena. However, Brown goes on to mitigate the differences between hypotheses, noting that both are open to error (falsification?), though theories are less open to this risk.

John Herschel (1792-1871) was considered to be the most prominent scientist in England when his *Preliminary Discourse on Scientific Method* was published in 1830. This widely read book was quite influential – especially on Mill, who borrowed his famous inductive canons from Herschel’s methods “for the discovery of proximate cause,” and also on Whewell, who cherished Herschel’s friendship above all others. Herschel, it can be said, clearly saw the distinction between the context of discovery and the context of justification. Laws and theories may be arrived at by either of 2 methods or a combination of them:

- (1) by an induction schema (laws of agreement, difference, concomitant variations, residues), which retained the Newtonian spirit of a “deduction from the phenomena.” Or
- (2) by “a *bold hypothesis*”: such as the introduction of the luminiferous aether by T. Young in the wave theory of light.

This latter method is clearly contrary to the Newtonian spirit, since such hypotheses might refer to non-phenomenal entities. But, and this is the important point, as long as such hypotheses about the mode of action or mechanism of non-phenomenal entities lead to testable consequences, the procedure of arriving at scientific propositions by the method of hypotheses is on a par with that of induction. Herschel does not say that the use of

hypotheses is *essential* to the method of science, but clearly held it in esteem. (Agassi, 1969:1-36; Herschel, 1831: 142-65).

A nearly complete liberation from Newton's restrictions on hypotheses is obtained in the writings of William Whewell (1794-1866). His major work in philosophy of science, entitled the *Philosophy of the Inductive Sciences*, is the source of most of his views on the nature of hypotheses.

Whewell clearly thought the formulation and use of hypotheses was *essential* to the method of science: "to form hypotheses, and then to employ much labor and skill in refuting, if they do not succeed in establishing them, is a part of the usual process of inventive minds. Such a proceeding belongs to the rule of genius of discovery, rather than (as has been often taught in modern times) to the *exception*." (Whewell, 1967:56). Further "A facility in devising hypotheses, therefore, is so far from being a fault in the intellectual character of a discoverer, that it is, in truth, a faculty indispensable to his task." (p. 54) Clearly, Whewell had no qualms about gathering hypotheses from metaphysics, as this quote shows: "Physical discoverers have differed from barren speculators not by having *no* metaphysics in their heads, but by having *good* metaphysics in their heads while their adversaries had bad . . ." (Whewell, 1858:vii). Whewell had no qualms about the use of hypotheses referring to non-phenomenal entities such as atoms or the luminiferous aether.

One reason Whewell could be completely relaxed about the admissibility of hypotheses into science is because he saw quite clearly what constituted the test of a sound hypothesis. Certainly, a good hypothesis must explain the class of facts for which it is invented; but an hypothesis achieving what Whewell called a "consilience of inductions" achieves near certitude in his eyes.

A consilience occurs in the following circumstances (Laudan, 1971:371):

- (1) When an hypothesis is capable of explaining two (or more) *known* classes of facts (or laws).
- (2) When an hypothesis can successfully *predict* cases of a kind *different* from those which were contemplated in the formation of the hypothesis.
- (3) When an hypothesis can successfully predict or explain the occurrence of phenomena which, on the basis of our background knowledge, we would not have expected to occur.

Few methodologists would disagree with Whewell on any of these points today.

We have briefly surveyed the relaxing of the Newtonian hard line on hypotheses by later British methodologists. We have not attempted to explain why this loosening took place in Brown, Herschel and Whewell – this would be the subject of a different, longer paper. But, as hinted in our discussion of

Herschel, the necessity for methodologists to account for the advances in non-mechanical sciences such as optics and chemistry, where what we now call "models" were successfully employed, seems to be a relevant factor.

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