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A Critique of the "Standard Conception" of Scientific Theories and Scientific Explanation

Tomáš Kunca

"This construal ... does not claim simply to be descriptive of the explanation actually offered in empirical science; for - to mention but one reason - there is no sufficiently clear generally accepted understanding as to what counts as a scientific explanation. The construal here set forth is, rather, in the nature of an explication, which is intended to replace a familiar but vague and ambigous notion by a more precisely characterized and systematically fruitful and illuminating one. Actually, our expliacatory analysis has not even led to a full definition of a precise "explicatum" - concept of scientific explanation; it purports only to make explicit some especially important aspects of such a concept."

C.G. Hempel

Scientific explanation has been under discussion for more than three decades in both general and special methodologies of science, in particular in the methodologies of natural and social sciences. The original formulation of the problem as expounded by C.G. Hempel has become a richly exploited target of criticism as well as a springboard for revealing still new aspects of this procedure. Should the contemporary standpoint be a) to improve upon Hempel´s covering-law models (as results of his explicatory analysis of the concept of scientific explanation in empirical science) or b) look for new formal models of scientific explanation, then, in Professor

Achinstein´s words we would be playing "a new variation on the old theme" and as he puts it "each that variation is simply an invitation to philosophical sharpshooters to hit the mark with fresh counterexamples."1)

All this, however, does not seem to me to invalidate the necessity to establish or reject the meaningfulness of scientific explanation as a research problem in its own right within the general methodology of science. This involves stating the conditions under which the formulation of the problem is meaningful, choosing the ways of resolving the problem and envisaging the nature of the resulting theory. We would have to take into account its relevance to the special sciences, assess the insight it can yield into creation and objectification of contemporary science as well as its validity from the descriptive and standardising angles. In view of the fact that methodological theories based on different philosophical (epistemological) assumptions from those under scrutiny formulate their own versions of scientific explanation analysis, an effort to find a more generally acceptable version of the theory of explanation seems worthwhile.

It may seem equally justified to reject such a programme on the strength of pronouncing the problem of scientific explanation too artificial and implicitly reproducing a series of assumptions underlying logical empircism.

One possible direction to take when evaluating the meaningfulness of the problem of scientific explanation in the methodology of science is to re-examine Hempel´s analytical conception (explicatory analysis of the concept of scientific explanation in empirical science) in the light of his self-criticism of the nineteen-seventies. Thus the original assumptions underpinning Hempel´s construal could be brought into limelight.

The first step in our attempt to propose a re-examination of Hempel°s analytical conception (explicatory analysis of the concept of scientific explanation in empirical science) in the light of his self-criticism of the nineteen-seventies consist in presentation of Hempel scientific explantion construal. Counstrual should be presented in the context relevant to examinitation of theoretical links between Hempel´s covering-law hypothesis and (self)criticism of his "Standard Conception" of scientific theories.

Hempel´s formulation of the problem of scientific explanation and its theoretical links to "Standard Conception" of scientific theories are at least implicitly stated in his essay on "Theoretician´s Dilemma"2). Of special importance are passages dealing with the systematising function of empirical science which should reveal the core of the force of empirical science which allows it to go beyond common sense. At the same time conditions will be stated under which it is meaningful to formulate the idea of subsumability of whatever is to be explained under general laws or theoretical principles (covering-law hypothesis).

Scientific systematisation comprising explanatory procedures, prediction and post diction typically demands the employment of general laws or theoretical principles of either strictly universal or in statistical form.

"These general laws have function of establishing systematic connections among empirical facts in such a way that with their help some empirical occurences may be inferred, by way of explanation, prediction, or post diction, from other such occurrences."3)

In other words:

"Scientific systematisation is ultimately aimed at establishing explanatory and predictive order among the bewildering complex "data" of our experience, the phenomena that can be directly observed."4)

Moreover, there is an assumption stated that scientific systematisation, i.e. scientific explanation, prediction and post diction all have the same logical character:

"they show that the fact under consideration can be inferred from certain other facts by means of specified general laws." 5

This type of argument is by Hempel schematised for the simplest case as a deductive inference of the following form:

*C*1, *C*2...*C*k

*L*1, *L*2...*L*r

(1.1) _____

E

Here, *C*1, *C*2...*C*k are statements of particular occurrences (e.g. of the positions and momenta of certain celestial bodies at a specified time), and *L*1, *L*2,...*L*r are general laws (e.g., those of Newtonian mechanics); finally, *E* is a sentence stating whatever is being explained, predicted, or postdicted. And the argument has its intended force only of its conclusion, *E*, follows deductively from premises.6)

This systematization can take on - precisely in dependence on the character of the general laws and theoretical principles - either a deductive or an iductive form. It is important to emphasize that Hempel distinguishes two fundamental levels: the level of empirical generalization and the level of theory formation. As he himself puts it:

"It is a remarkable fact, therefore, that the greatest advances in scientific systematization (this includes explanation - T.K.) have not been accomplished by means of laws referring *observables*, i.e. to things and events which are ascertainable by direct observation, but rather by means of laws that speak of various *hypothetical*, or *theoretical*, *entities*, i.e. presumptive objects which cannot be perceived or directly observed by us."7)

Above presented request for scientific explanation to search for systematic connections between empirical facts holding on the levels of empirical generalization and theory formation is meaningful within the framework of the linguistic (analytical) approach to empirical science as worked out by late logical empiricism. Empirical science then acquires the form of a set of sentences of different types and functions. This leads Hempel to the conclusion that the vocabulary of the empirical science consists of two layers: logical and extralogical. The

extralogical layer in turn comprises a subset of observational terms and another of theoretical terms. Here arises the question crucial not only for Hempel´s philosophy of science as a whole but also to the problem of scientific explanation: *How can systematic connection among empirical facts be achieved on the basis of theory, of sentences containing theoretical terms?* The answer to this was made by the setting up of the so called "Standard Conception" of scientific theories which brings along the meaning problem for theoretical terms.

Hempel´s construal of "Standard Conception" of scientific theories can be summarized as follows:

1. Assumption of non-observable entities serves the purpose of systematization: it provides connections among observables in the form of laws containing theoretical terms, and this detour via the domain of hypothetical entities offers certain advantages.8)

2. Scientific theory may be, formally, considered as a set of sentences expressed in terms of specific vocabulary.9)

3. Theory will always be thought of as formulated within linguistic framework of clearly specified logical structure, which determines, in particular, the rules of deductive inference.10)

4. Deductive system can function as a theory only if it has been given an interpretation by reference to empirical phenomena.11)

5. We may think of such interpretation as being effected by the specification of a set of interpretative sentences.12)

What follows from the preceding account for our inquiry into assumptions behind the formulation of the problem of scientific explanation in empirical science by Hempel? Precisely the conclusion that Hempel´s hypothesis about explanation functioning as systematizing connection presupposes the acceptance of "Standard Conception" of scientific theories. The explanatory connections among statements couched in observational terms are then in theoretically-based explanations mediated by interpretative sentences in the logical structure of scientific systematization is borne out by Hempel in numerous examples.

The second step in our attempt to propose a re-examination of Hempel´s analytical conception (explicatory analysis of the concept of scientific explanation in empirical science) in the light of his (self)criticism of the nineteen-seventies consist in presentation of Hempel´s (self)criticism of the validity of the "Standard Conception" ("Standard Construal") of scientific theories.

In the nineteen-seventies C.G. Hempel critically examined many aspects and assumptions of the "Standard Conception" ("Standard Construal") of scientific theories. There is evidence that Hempel directs the critique at himself:

"I have myself relied on the standard construal in several earlier studies, but I have now to consider it misleading in certain philosophically significant respects."13)

Thus it seems justified to talk about (self)criticism and admire Hempel´s scholarly and personal stature. For our purpose it is convenient to present C. Moulines´ summarization of Hempel´s (self)critical argument:

A. A linguistic approach to the problem of theoretical terms implies that the meaning of these terms in given empirical theory *T* should be rendered through a special class of sentences.

   (B) These sentences can be only *T´*s axioms or *T´*s bridge principles to some antecedently available vocabulary...

B. But this use of *T´*s axioms or bridge principles would make *T* true by convention.

(D) Since *T* is an empirical theory, it cannot be true by convention.

Conclusions:

Therefore,

[1] the linguistic approach to the problem of theoretical terms is fundamentally wrong;

[2] in particular, there are no interpretative sentences for theoretical terms;

[3] hence, there is no point in sharply distinguishing between axioms and bridge principles;

[4] finally, then, there is no problem of theoretical terms. 14)

The crucial point here is just linguistic approach to theoretical terms, the idea of linguistic determination of theoretical terms through interpretative sentences. As Moulines points out - Hempel thinks, that this idea comes from misled and untenable extrapolation of metamathematical theory analysis of the Hilbertean type to the philosophy of empirical science.15)

The third and final step in our re-examination of Hempel´s analytical treatment of the problem of scientific explanation in the field of empirical science is an inference of potential consequences of his (self)criticism for the analytical approach to the problem of scientific explanation itself.

Hempel´s (self)criticism contains an explicit critique of the extrapolation of metamathematical theory analyses of Hilbertean type to the philosophy and methodology of empirical science. The idea of searching for explicative concepts of explanation has its source precisely in the recognition of the possibility of such extrapolation. There is strong evidence supporting our statement:

"As is made clear by our discussions, these models (covering-law models of

explanations - T.K.) are not meant to describe how working scientists actually

formulate their explanatory accounts. Their purpose is rather to indicate in reasonably

precise terms the logical structure and the rationale of various ways in which

empirical science answers explanation-seeking why-questions. The construction of

our models therefore involves some measure of abstraction and of logical

schematization. In these respects, our concepts of explanation resemble the

concept, or concepts, of mathematical proof (within a given mathematical theory)

as construed in meta- mathematics."15)

Therefore, we can talk about implicit criticism of the formulation of the explanatory problem which looks for the explicative concept similar in function for explanations occurring in empirical sciences to the concept of proof in metamathematics which has the same function in relation to mathematics.

Hemepel´s (self) criticism is explicitly directed at the relevance of formulation of the meaning problem for theoretical terms. Hempel argues precisely against the linguistic approach to the problem of theoretical terms, he denies the existence of the interpretative sentences. However, the expression of the systematizing connections in case of e.g. scientific explanation on the basis of theory - and it is in these that the power of empirical science must manifest itself - presupposes sentences of the type of interpretative sentences.

Therefore, we can justifiably query the validity of Hempel´s construal of scientific systematization and consequently the validity of his explicative concepts of scientific explanation (covering-law models).

As far as consequences I and II are acceptable, then Hempel´s (self)criticism of the "Standard Conception" of scientific theories can be taken for at least as an

implicit (self)criticism of his famous explicative concepts of scientific

explanation (covering-law models). Moreover, conceptions of scientific

explanation treating Hempel´s models as purely formal appears to be misleading in

the light of Hempel´s (self)criticism.

Notes

1) Achinstein (l983), p. vii.

2) Hempel (1970), pp. 173-228.

3) Hempel (l970), p. 177.

4) Hempel (l970), ibid.

5) Hempel (1970), p. 174.

6) Hempel (l970), ibid.

7) Hempel (l970), p. 177.

8) Hempel (l970), p. 182.

9) Hempel (l970), pp. 182-83.

10) Hempel (l970), p. 183.

11) Hempel (l970), ibid.

12) Hempel (l970), ibid.

13) Radner (l970), p. 146.

14) Suppes (l973), pp. 365-69.

15) Suppes (l973), p. 369.

References

1. Achinstein, P.: *The Nature of Scientific Explanation*. New York/Oxford, l983.

2. W.K.Essler, H.Putnam, W.Stegmüller (eds.): *Epistemology, Methodology, and Philosophy of Science.* Dodrecht/Boston, l985.

3. Hempel, C.G.: *Aspects of Scientific Explanation and Other Essays in the*

Philosophy of Science. London/New York, l970 (l965).

4. Hempel, C.G.: "Aspects of Scientific Explanation", in: Hempel (l970), pp.331-496.

5. Hempel, C.G.: "On the “Standard Conception”of Scientific Theories", in: Radner (l970).

6. Hempel, C.G. :"The Meaning of Theoretical Terms: A Critique of the Standard Empiricist Construal", in: Suppes (l973).

7. Hempel, C.G.: "The Theoretician´s Dilemma: A Study in the Logic of Theory Construction", in: Hempel (l970).

8. Moulines, C.U.: "Theoretical Terms and Bridge Principles: A Critique of Hempel´s (Self)Criticism" in: Essler,W.K.(l985).

9. M.Radner, S.Winokur (eds.) *Minnesota Studies in the Philosophy of Science*, *Vol.4*, Minneapolis, l970.

10. P.Suppes, L.Henkin, A.Joja, G.C.Moisil (eds.) *Logic, Methodology, and Philosophy of Science,* Amsterdam/London/New York, l973.

Shrnutí

Stať "Kritika “klasického pojetí” vědeckých teorií a vědecké vysvětlení" se zabývá teoretickými problémy spjatými s explikativní analýzou vědeckého vysvětlení u C.G. Hempela, autora analytických modelů vysvětlení na bázi pokrývajícího zákona ("covering-law models of scientific explanation"), které představují klasickou konstrukci vědeckého vysvětlení ve filosofii a metodologii vědy druhé poloviny 20. století.

Ve stati jsou popsány a doloženy stěžejní momenty Hempelovy analýzy vědeckého vysvětlení, popsána a doložena teoretická vazba konceptu vědeckého vysvětlení a "klasického pojetí" vědeckých teorií, sumarizovány výsledky Hempelovy (sebe) kritiky "klasického pojetí" vědeckých teorií a na závěr vyvozeny možné důsledky této (sebe)kritiky. Relevance důsledků je tematizována zejména v rovině hodnocení explikativní analýzy vědeckého vysvětlení (včetně výsledných modelů vysvětlení pokrývajícím zákonem) samotné.

Ve světle argumentace uvedené ve stati se stává zřejmým, že Hempelova (sebe)kritika "klasického pojetí" vědeckých teorií je při nejmenším implicitní (sebe)kritikou jím navržené explikativní analýzy vědeckého vysvětlení. Pokusy o pojímání Hempelových modelů vysvětlení jako ryze formálních modelů se tak ukazují být problematickými.