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EXPLANATION AND THEORY EVALUATION

ABSTRACT. It is claimed that Kuipers' approach to explanation opens the possibility for a further refinement of his own refined HD method for the evaluation of theories. One severe problem for the HD method, refined or not, is theory-ladeness. Given that experimental results are theory-laden, the comparative evaluation of alternative hypotheses is always relative to background knowledge. This difficulty can be avoided by supplementing HD considerations with the principle of inference to the best explanation. The authors sketch a program for doing this. The general idea plays on some similarities between Kuipers' account of explanation and Lipton's. The former, however, is considered more flexible than the latter, which makes it even more attractive for the purpose under consideration.

In his numerous writings Theo Kuipers promotes a revised, or refined, hypothetico-deductive (HD, for short) method of theory evaluation. The core idea, which can be viewed as an elaboration and sophistication of Lakatos' account, is that the method is not intended to serve merely as a means of error elimination. Instead, it is supposed to serve, in the first place, as a method for the comparative evaluation of theories and hypotheses in terms of their relative successes and failures. The refined HD method, so conceived, is truth-conducive in the sense that it gets closer to the truth with less and less flawed theories, rather than discarding false theories in search of a/the true one. Attractive though this may be, the HD method suffers from one serious problem. Theory-ladenness makes falsification background-knowledge relative. Even if Kuipers does acknowledge the limitations of the HD method, including those that arise from theory-ladenness, he seems to underestimate the fact that the comparative evaluation of alternative hypotheses is always relative to background knowledge. This relativity leads to a version of the Duhem problem: in the face of negative empirical results, there is always a choice whether to reject a hypothesis under test or, alternatively, to revise the present system of background knowledge so as to maintain the allegedly falsified hypothesis.

This version of the Duhem problem has never been satisfactorily solved by the most prominent proponents of the HD method. It is for this reason that Karl Popper was accused of having been an "irrational rationalist" (Newton-

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Smith), a "contemporary irrationalist" (Stove), or, most moderately, a "conventionalist" (Brown). Lakatos, replacing background knowledge with the hard core of a scientific research program, comes quite close to a solution. Nevertheless, his conception of postponed rationality is not fully immune to Feyerabend's challenge: how long are we to wait for the decision to be made between alternatives? Watkins' and Zahar's search for the justification of Popper's basic statements with so-called 0-level statements – autopsychological reports or descriptions of noemata, respectively – represents a highly dubious switch towards internalist foundationalism. Kuipers' version, as far as the Duhem problem is concerned, seems to follow Laudan's pattern of estimating the relative problem-solving efficiency of alternative systems of theories or hypotheses. Unfortunately, in doing this, Kuipers does not take the opportunity to use some important insights of his own, which can open new prospects for the theory of scientific method.

What we have in mind here are Kuipers' ingenious remarks about explanation. He points to many aspects of scientific endeavor that are not dealt with by Hempel's law-covering account. To make up for this, Kuipers offers a novel account of explanation: explanation by specification. However, this new approach to explanation is neglected in the refined HD evaluation since, due to the symmetry between prediction and explanation, what are considered successes and failures of a theory or hypothesis are precisely the explanatory successes and failures in Hempel's defective sense of explanation. This amounts to saying that whether or not a theory or hypothesis can be used to give some explanation by specification does not contribute to its cognitive value. Such a view is dangerously close to van Fraassen's constructive empiricism. Thus, the converse seems more attractive for those who, like Kuipers and the present authors, declare their commitment to realism. Consequently, we here try to indicate how the scope of explanatory applications of a theory, in terms of Kuipers' account of explanation, is relevant for its evaluation. We discuss at some length only one kind of explanation by specification, namely explanation by causal specification, and make rather programmatic remarks concerning explanations by intentional and functional specification as characterized by Kuipers.

1. Explanation by Causal Specification

As far as explanation by causal specification is concerned, the explanation-seeking question has the form:

(1) Why did an event *b* occur to system *a*?

where *b* is assumed to be an *abnormal* event or factor for *a*. The concept of "abnormality" is not explicated in general terms; an unexpected death of a patient, a car accident, a fire, etc. are paradigmatic examples here. A question of the form (1) is then construed as:

(2) What was the cause of (abnormal) event *b* that occurred to system *a*?

A possible answer to (2) (and thus to (1)) has the form of:

(3) Event *b* occurred to system *a* due to cause *x*.

whereas the presupposition of (2) is:

(4) Event *b* occurred to system *a* due to some specific cause.

The meaning of a sentence of the form (3) is characterized by the following meaning postulate:

MP1: Event *b* occurred to system *a* due to cause *x* if and only if:

(4.1) event *b* occurred to system *a*,

(4.2) event *x* occurred to system *a* and *x* is an abnormal factor (event, intervention, condition) for *a*,

(4.3) there are factors f_1, …, f_n such that f_1, …, f_n are normal factors/conditions for *a* and "if *x* and f_1 and …. and f_n, then event *b* occurs to system *a*" is a causal law in the strict sense[1],

(4.4) *x* was causally effective for the occurrence of *b* to *a*.

To provide a causal explanation by specification is to formulate and verify a certain answer of the form (3) to the explanation-seeking question (1). Formulating an answer amounts to specifying a certain substitution-instance for *x* in (3), whereas the verification of the answer is tantamount to the verification of the corresponding substitution-instances of (4.2), (4.3) and (4.4). The term 'verification' is understood here in a very general, pragmatic sense; in particular, it does not presuppose irrevocability. Kuipers characterizes the schematic train of thought which may lead to a verified answer to the explanation-seeking question. One can show that all argumentative steps involved in such a train of thought are valid inferences, either standard or erotetic (cf. Kuipers and Wiśniewski 1994). Roughly, the process of searching for an explanation by causal specification starts with a verified hypothesis of the form "event *b* occurred to system *a*," where *b* is conceived as abnormal for *a*. Then – by the so-called principle of specific causality – the presupposition (4) of question (2) is arrived at. This presupposition is a hypothesis, however.

[1] That is, an experimental law in the sense of Nagel (1961): the factors *x*, f_1, …., f_n are space-and-time contiguous and there exists a time-asymmetry between *x* and *b*, i.e. *x* precedes *b*.

Presupposition (4) gives rise to question (2). An answer to question (2) is then proposed as a hypothesis to be tested. Of course, question (2) has many possible answers, which are substitution-instances of (3); from among them a certain one is chosen, as Kuipers puts it, "by idea." From the erotetic point of view, this step amounts to arriving at a yes-no question of the form "Is it the case that event *b* occurred to system *a* due to cause *c*?", where *c* comes "by idea." Then, on the basis of the meaning postulate MP1, one comes to a conjunctive question, the constituents of which result from (4.2), (4.3) and (4.4) by substituting *c* for *x*. Next the following question is asked:

(5) Is it the case that event *c* occurred to system *a* and *c* is an abnormal event for *a*?

If the affirmative answer to (5) is verified, the following question will be asked:

(6) Are there factors $f_1, \ldots, f_n$ such that $f_1, \ldots, f_n$ are normal factors/conditions for *a* and "if *c* and f_1 and …. and f_n, then event *b* occurs to system *a*" is a causal law in the strict sense?

If the affirmative answer to (6) is verified, the next question will be:

(7) Was *c* causally effective for the occurrence of *b* to *a*?

If the affirmative answer to (7) is verified, then – by the affirmative answers to (5) and (6) together with meaning postulate MP1 – one arrives at the following answer to (2) (and thus to (1)):

(8) Event *b* occurred to system *a* due to cause *c*.

The answer (8) is now a verified hypothesis and an explanation by causal specification. Since (8) logically entails (4), from now on (4) can be regarded as a verified hypothesis too. If, however, a negative answer to any of the questions (5), (6) or (7) is verified, or no clear results are available, the inquirer has to repeat the procedure with respect to a certain (possible) cause *d*, which, again, is taken "by idea." The process goes on until the actual specific cause is found. Nevertheless, there is no guarantee that such a cause will be found.

Among the examples of explanation by causal specification, Kuipers mentions (SiS, p. 123) the explanation of childbed fever as caused by "cadaveric matter." The well-known story of Semmelweis' discovery reported by Hempel (1966) was later retold by Lipton (1990) in a way that reinforces Kuipers' suggestion of the superiority of specific causal explanation over explanation by subsumption. In his version, Lipton argues that Semmelweis' discovery is an illustration of the way in which the principle of inference to the best explanation provides us with a better guide than the falsificationist method. Semmelweis is said to have rejected some hypotheses without even trying to falsify them, just because of their failure to give the desired explanation of the dramatic difference in mortality rates of two maternity divisions of his hospital. Among them, there was the perfectly plausible hypothesis to the effect that the membership of a higher social class, due to better nutrition, makes people more resistant to illness. This hypothesis was rejected simply because there were no considerable differences in the social composition of the two divisions. Nevertheless, the hypothesis might well have been true: the mortality rate among the members of a higher social class might have been lower than that in the rest of the population. This, however, was not even investigated just because the hypothesis under consideration appeared irrelevant to Semmelweis' explanatory endeavor. The guiding principle of Semmelweis' investigation was the search for a causally effective factor that made the difference.

In Lipton's account, explanation is an answer to a contrastive why-question, i.e. a question of the form "Why *P* rather than *Q*?" A plausible answer has to point to a factor in the causal history of *P* that has no counterpart in the causal history of non-*Q*. The concept of counterpart may be somewhat vague, but there is no need to elaborate upon it in the present context. Apparent differences notwithstanding, there are some affinities between Lipton's and Kuipers' proposals. First, the explanatory factor, let us call it *Z*, is causal. Second, in so far as the question "Why *P* rather than *Q*?" is (often but of course not always) motivated by a feeling of surprise, *P* can be considered as an event that has occurred unexpectedly as compared to the expected *Q*. Consequently, *Z* is in a sense *abnormal*, for it is precisely the factor whose occurrence has prevented the "normal" *Q* from having happened. In contrast, the shared members (up to the relation of "being a counterpart") of causal histories of *P* and *Q* can be called "normal" causal factors.

Whether or not Lipton's account of contrastive explanation and Kuipers' account of specific causal explanation are equivalent, we are not in a position to decide. Much depends on possible further explication of the concept of "abnormality." Nevertheless, the similarities between the two permit us to pursue Lipton's idea about the justificatory role of explanation, reformulated so that it can be applied to Kuipers' account. The reformulation in question is that explanatory successes and failures, in the sense of explanation by specification, count more for the purposes of theory evaluation than empirical successes and failures in the sense of the HD method, refined or not.

One may argue that, just as falsification is relative to background knowledge, so too is explanation by causal specification. This is so because the normal/abnormal distinction is pragmatic, i.e. it depends on context and, in particular, background knowledge. This, however, gives the explanatory power considerations priority over the conventional use of the HD method. As has already been stated, the HD method suffers from a version of the Duhem problem – the problem of choice, in the face of negative evidence, between the rejection of the hypothesis under test or a suitable revision of the background knowledge so that the hypothesis in question can be saved. This problem is much more easily solved when one is confronted with failures to give a specific causal explanation.

Failure of this kind suggests that the effective abnormal cause has not yet been discovered, or that there is more than one abnormal cause in operation, or that instead of an abnormal cause it is an abnormal joint occurrence of normal causes which is effective. Consequently, three different lines of research are open. The first one is rather straightforward and can be pursued as long as there is a hope of finding the cause "by idea." The two others are more complex, for they involve a hypothesis about the interaction of some causes. Such a hypothesis may go far beyond the currently accepted background knowledge, even if the causes in question are identifiable within its framework.

An explanation by causal specification may also fail when the explanation-seeking question and/or the operative questions may be sound, but unanswerable by means of a theory and/or background knowledge. For example, the theory and/or background knowledge may offer no candidate for "the cause" of the phenomenon in question (think of an empirically-oriented medieval medical doctor who tries to explain why the inhabitants of a certain village survived the "black death" epidemic whereas all the inhabitants of a village situated nearby died) or may offer no candidate to which there are no decisive objections (think of a contemporary medical doctor who observes the rapid recovery from cancer of a patient who has just visited Lourdes). In situations like these, a revision of background knowledge is needed to reopen a set of possible "ideas" for the candidate causes.

Thus a prolonged explanatory failure exerts pressure to make attempts to revise background knowledge. Indeed, assuming the account under discussion, it is plausible to claim that an explanatory failure even permits one to draw some hints about possible revisions, provided that some non-explanatory coincidences are established. The story of Semmelweis' discovery is a good example. In the maternity division with the higher mortality rate, in contrast to the other, the nursing duties were performed by medical students. This coincidence was not explanatory, however, since it was not causal. An attempted explanation "by idea" was that students dealt carelessly with patients. Investigation demonstrated the opposite. No new "idea" had come about until another coincidence was discovered. Semmelweis' colleague, doctor Koletschka, cut his finger with a scalpel and soon died of childbed fever. Before the accident, the scalpel was used in the prosectorium, where the students were regularly instructed; they attended patients only after their classes. This coincidence of two coincidences gave rise to the "idea" of transmission of a hypothetical "cadaveric matter" – the supposed cause of childbed fever – both by Koletschka's scalpel and students' hands. Clearly, Semmelweis' conclusion – that washing one's hands carefully before attending patients may help – represents a substantial revision of background knowledge.

On the other hand, even if the phenomenon in question occurred due to some specific cause and the set of conceptual possibilities offered by the theory and/or background knowledge is wide enough to offer serious candidates without substantial revisions, an attempt to provide an explanation by causal specification may fail since, in order to verify a hypothesis of the form (8), one has to answer the corresponding questions of the form (5), (6), and (7), and they are usually difficult questions. In particular, in order to answer question (6) one has to point to a certain empirical law (a question about the existence of a law can be answered only by referring to an example of an appropriate law). The required law can already belong to the theory or background knowledge, but it may also be that it yet has to be derived and/or empirically verified. Nevertheless, the theory and/or the background knowledge that we are working with may be insufficient, and may be resistant to relevant empirical extensions. Providing a successful explanation by causal specification is a difficult enterprise and therefore its success seems to present a good argument for a positive evaluation of the theory in question.

So far, we have assumed that an attempt to provide an explanation by causal specification is made by means of a single theory and the associated background knowledge. But in the case of abnormal events scientists often work with rival theories. If a given theory suggests a successful explanation by causal specification of a certain abnormal event, whereas its rival does not, one may say that the former gains superiority over the latter. Sometimes the event in question is not conceived as abnormal when viewed in the light of a rival theory, and can be explained by subsumption by means of that theory. In such cases the latter seems to gain superiority over the former.

One doubt may arise. It is stated that "an explanation by causal specification implies the possibility of providing an explanation by causal subsumption if the particular causal law is explicitly known" (SiS, pp. 125-6). This may imply that explanation by causal specification, given its heuristic value, plays a significant role in the context of discovery, but is not particularly significant in the context of justification. Once an explanation of this sort is found, it can be transformed into an explanation of the Hempelian pattern, and Hempelian-like explanatory successes are simply successes in terms of the HD method of evaluation. In such cases, however, there is a clear epistemic gain in comparison with mere subsumption, namely the identification of a causal factor. On the other hand, not every HD success is a success in giving a specific causal explanation.

Nevertheless, one may ask why an identification of a causal factor – leaving aside its heuristic value – provides us with more knowledge than the discovery of a law, whether causal or not. Or what mentioning the cause responsible for the regularity in question adds to the cognitive value of the law that expresses this regularity. Is it not the case – a positivist might ask – that the whole value of science is exhausted in discovering laws that describe regularities in nature, and that everything going beyond this is irrelevant?

Not at all. As Lakatos (1970) has pointed out, laws typically contain the *ceteris paribus* or "other things being equal" clause. Its implicit presence is responsible for all the ambiguities of falsification, since any apparently falsifying instance of a law can be explained away by an auxiliary hypothesis to the effect that a hitherto unknown factor is operating. Consequently, one can never exclude the possibility of a suitable revision of background knowledge that will transform an HD failure of the law under test into an HD success. In contrast, a failure to give a specific causal explanation is more telling, for it amounts to the lack of an identification of *the* abnormal cause operating in a test situation (and possibly suggests that the event in question occurred due to an interplay of many causes, abnormal or otherwise). Thus, a specific explanatory failure is more informative than an HD failure. On the other hand, a specific causal explanatory success provides us with more knowledge than the predictive or descriptive success of a law.

To conclude, specific causal explanatory power considerations should play an important role in theory evaluation. Hence, Kuipers' proposal to replace the principle of inference to the best explanation with the principle of inference to the best theory (ICR, p. 170), should be reconsidered in the light of his own insights concerning causal explanation. Alternatively, his definition of the "best theory" should be reconsidered so as to accommodate the present insights.

2. Other Patterns of Explanation

Apart from specific causal explanation, Kuipers considers intentional and functional explanations by specification. Their logical structure is parallel to the structure of explanation by causal specification (see SiS; see also Kuipers and Wiśniewski 1994). The introduction of other types of explanation by specification develops the prospect of going far beyond Lipton's account of inference to the best explanation. In Lipton's formulation, it is only the reference to the relevant difference in causal histories of the fact under explanation and its contrast which lends explanatory power to an answer to a why-question. Consequently, Lipton does not leave any room for non-causal explanations. This seems an unnecessary and inadequate restriction of his account. Hence, if we are right in suggesting that Kuipers' specific causal explanation is able in principle to do the job of Lipton's contrastive explanation, the other forms of explanation Kuipers considers are able to do some additional job.

One may doubt whether this additional job has anything to do with theory evaluation, for – unlike specific causal explanation – intentional and functional explanations by specification do not involve any "intentional" or "functional" law, apart from the general principles of intentionality (or rationality) and functionality (or evolution). The principles in question, however, are not law-like statements subject to evaluation, possibly in terms of their explanatory power. Rather, they are presupposed in the very concept of intentional or functional explanation, just as the principle of causality is presupposed in the concept of causal explanation. The question of what kind of theory or statements are to be evaluated by invoking successes in providing intentional and functional explanations by specification now arises.

Let us consider intentional explanation first. In this case, the explanation-seeking question has the form:

(1*) Why did agent *a* perform action *b*?

or:

(2*) What was the goal of action *b* performed by agent *a*?

A possible answer to (2*) (and thus to (1*)) has the form of:

(3*) *a* performed action *b* with the intention of approaching goal *z*,

where *z* is to be understood as an external goal, in contrast to an internal one, i.e. the one specified in the description of *b*. For example, the internal goal of "opening the window" is "having the window opened," while its possible external goal can be e.g. "letting some fresh air in."

The presupposition of (2*) is:

(4*) *a* performed *b* intentionally (with the intention of approaching a specificic external goal).

The meaning of a sentence of the form (3*) is characterized by the following postulate:

MP2: *a* performed action *b* with the intention of approaching goal *z* if and only if:

(3*.1) *a* performed action *b*,

(3*.2) *a* desired goal *z*,
(3*.3) *a* believed *b* to be useful to approach *z*,
(3*.4) the belief and desire in question were causally effective for *a*'s having had the plan to perform *b*.

As in the case of causal explanation by specification, to provide an intentional explanation is to provide an answer of the form (3*) to the explanation-seeking question (2*). Due to the structural similarity of the two patterns of explanation, the process of the search for an intentional explanation can be described similarly to that of the search for a causal explanation. Details are omitted.

In considering a related question of explaining the choice of a particular action among alternatives, Kuipers emphasizes the difference between his and the utilistic approach (SiS, pp. 110-111): the former presupposes that the specific goal of an agent is fixed beforehand, while the latter presupposes that an agent has one general goal of maximizing his expected utility so that the choice of a particular goal is a part of the agent's decision problem. Instead, Kuipers offers a generalization of the pattern of intentional specification, or a second step of intentional specification, to explain the choice of a goal in terms of the agent's approaching, as it were, a second-order goal to be attained with the goal in question. The latter is just substituted for an action in the pattern of explanation by intentional specification. Consequently, to explain why a certain goal *z* was chosen by an agent *a* is to answer the question:

(1**) Why did agent *a* choose goal *z*?

or:

(2**) What was the second-order goal *z** to be attained by *z*?

A possible answer to (2**) (and thus to (1**)) has the form of:

(3**) *a* chose goal *z* with the intention of attaining the second-order goal *z**.

Again, the presupposition of (2**) is:

(4**) *a* chose goal *z* intentionally (with the intention of approaching a specific second-order goal).

The meaning of a sentence of the form (3**) is characterized by the following postulate:

MP1: *a* performed action *b* with the intention of approaching goal *z* if and only if:

(3**.1) *a* (deliberately) chose goal *z*,
(3**.2) *a* desired goal *z**,

(3**.3) *a* believed *z* to be useful to approach *z**,

(3**.4) the belief and desire in question were causally effective in *a*'s having chosen *z*.

This flight from the utilistic approach seems quite reasonable, since the principle of maximizing one's expected utility, as a general "law" of personal behavior, is overidealized. People very rarely, if ever, perform the required calculations. Calculations may possibly be done in specific problem situations, like those in business. In such cases, however, the utility function derives from, e.g., suitable return and risk estimates, without taking into account the utilities of non-profit-oriented actions, or other actions irrelevant to the problem in question. In everyday life even crude estimations are performed only on special occasions, possibly when people ask themselves questions of the sort "Do I really want this-and-that?" Consequently, leaving much space for pragmatic considerations, as Kuipers does, seems to be the right choice.

The conventional utilistic approach presupposes just one general law, which says that people observe the principle of maximizing expected utility. Consequently, utilistic explanatory successes and failures, if they can be used at all, can be used only for the evaluation of this law. In contrast, a more flexible approach can be used to form explanations that involve claims that are more specific. Since in order to provide an explanation by intentional specification one has to verify the belief and desire claims involved, an explanatory success or failure may contribute, e.g., to the evaluation of psychological laws about, say, the preferences or inclinations of people with a certain type of personality; or to the evaluation of anthropological theories about rules of culture, taboos or prescriptions. Thus, the principle of inference to the best explanation, in the sense of intentional explanation by specification, can guide the choice of theories not only of nomothetic, but also of idiographic sciences, the latter being beyond the scope of the HD method.

On the other hand, considering the question of explaining the choice of a particular action among alternatives, Kuipers does make a limited use of the utilistic approach, albeit restricted to a two-element space of possible outcomes: attaining or not attaining the desired goal. Furthermore, in the formula for the calculation of the expected utility of an action, the cost of the action in question is taken into account. This makes room for accounting for various pragmatic factors that can be captured in the cost of an action. Even the principle of maximizing one's expected utility can in a way be re-established, if needed, by defining the cost of an action so that it covers the costs of its side effects. Kuipers' account, then, can be viewed as a generalization of the utilistic approach. And it is precisely this feature that permits the use of intentional explanation by specification in theory evaluation.

Functional explanation by specification, since it displays essentially the same structure, can also provide us with a tool for evaluating theories, e.g., of particular evolutionary scenarios. At present, the authors are not in a position to give a detailed account of the evaluative applications of Kuipers' model of functional explanation. Still, we believe that the search for such an account is a promising program in the philosophy of science.

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