Epistemic and Ontic Theories of Explanation and Confirmation

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Abstract

This paper reviews some recent work on issues connecting the theories of scientific explanation and confirmation. Beginning with Harman and Hempel and continuing with Salmon, Miller, Pennock and Ruben, I consider different explications of the explanatory relation that could be used in an Inference to the Best Explanation (I.B.E.) confirmation theory. Causal theories of explanation are currently the most promising and I discuss the strengths of an I.B.E. theory based upon an objective “ontic” view of explanation like Salmon’s over an “epistemic” causal view such as Miller’s. Finally I show how a causal theorist can address two purported weaknesses of the causal approaches that arise from Humean and Sellarsian arguments.

Introduction

One important theory of confirmation holds that a datum, A, is evidentially relevant for finding out about some hypothesized empirical fact, X, whereas another datum, B, is not because the former but not the latter would be explained by X. This notion of evidence forms the basis of the confirmation theory that is now often called “Inference to the best explanation” (hereafter, “I.B.E. confirmation”). This paper will explore a few elements of the general proposal to explicate evidence in terms of explanation, and review some recent literature that is relevant to the issue, beginning with Harman and Hempel and continuing with Salmon, Miller, Pennock and Ruben. I will not address the question of what might make one explanation “best,” but instead will focus upon the prior problem of what makes something an explanation in the first place, and consider different explications of the explanatory relation that could be used in an I.B.E. confirmation theory. I will look most closely at causal theories of explanation and discuss some potential strengths and weaknesses of an I.B.E. confirmation relation based upon an objective “ontic” view of explanation like
Salmon's in contrast to an epistemic causal view such as Miller's.

**Harman's I.B.E. View**

We owe the phrase "the inference to the best explanation" to Gilbert Harman who coined it in his influential article of the same title. The general idea is that "one infers, from the premise that a given hypothesis would provide a 'better' explanation for the evidence than would any other hypothesis, to the conclusion that the hypothesis is true." (Harman 1965, p. 89) One finds earlier articulations of this idea in the views of Pierce, Descartes and Aristotle, to name just a few of the precursors. Other variations of I.B.E. confirmation also have been developed recently by Achinstein (1983), Miller (1987) and Lipton (1991).

Although Harman acknowledged the problem of how to determine which of competing hypotheses was a "better" explanation, he did not say anything about how to solve it except for a passing reference to standard considerations of simplicity, plausibility, scope and ad hocness. This is an understandable omission since his main concern in the article was to show that the proposed non-demonstrative inferences of another theory of confirmation, enumerative induction, are warranted only insofar as they are instances of I.B.E. confirmation. A more serious omission is that neither did he say anything about what constitutes the basic relation of explanation. This omission does not mean that Harman's account is without basis, for the I.B.E. confirmation proponent may appeal directly to intuitions that favor the idea that evidential relevance should be explicated in terms of explanatory relevance. We do readily infer to some hypothesized state of affairs, H, once we see that H would explain or account for the pattern of data we have observed, given our pre-theoretic notions of explanation. Harman mentions several examples of this sort—a detective infers that the identity of the killer is B because that would account for the facts of the case, or a scientist infers that atoms exist since that would account for a variety of data. However, we should recognize that the notion of "accounting for" in these examples is not an analysis of explanation. Even someone sympathetic to the I.B.E. account should expect an explanation of the key relation.

**Hempel on Explanation & Confirmation**

The first systematic philosophical theory of scientific explanation was developed by Carl Hempel (1964; 1965a). Hempel also developed his own theory of confirmation that was not an I.B.E. account, but he was certainly sympathetic to features of that approach, for he pointed out explicitly that there is an important conceptual connection between confirmation and explanation in science that suggested their theoretical structures ought to dovetail. "An adequate definition of confirmation," he wrote, "will have to do justice to the way in which empirical hypotheses function in theoretical scientific contexts such as explanations..." (Hempel 1965b p. 13) So, what happens if one were to take Hempel's analysis of explanation and use it to explicate the evidence relation for an I.B.E. account of confirmation?

Hempel's core model of explanation—the Deductive-Nomological (D-N) model—holds that an explanandum statement is explained by virtue of being logically implied by explanans statements that include a true law statement and statements of initial conditions. That is, the relation of explanation is a special type of deductive relation among sentences in a logical language. On this explication of explanation, the I.B.E. confirmation relation will thus also be a deductive relation among sentences. Indeed, the theory we get turns out to approximate the familiar Hypothetico-Deductive (H-D) Method, which holds that one confirms a hypothesis, H, by finding that data statements logically deducible from it (together with background information, such as initial conditions) are true. Harman may have had something like this tacitly in mind, for he says that I.B.E. confirmation corresponds approximately to the method of hypothesis.1 In retrospect, however, we see that this approach is a dead-end for the I.B.E. theorist, because philosophers have since identified serious problems in both Hempel's theory of explanation and in the H-D Method—the logical relations at the heart of these theories licensed as explanations and evidence hypotheses and data that were clearly recognized as irrelevant to one another, leading to a variety of now well-known paradoxes.2

**Salmon on subjective vs. objective relations**

So why can't an I.B.E. theorist simply rely upon a pre-theoretic concept of explanation? One problem is that our ordinary use of the concept is much looser than the scientific. For example, one pre-theoretic notion about explanation is that something explains because it overcomes a certain kind of psychological uneasiness; we are "satisfied" by a good explanation. Wesley Salmon properly rejects this psychological model of scientific explanation, arguing that such a subjective view is at odds with reasonable requirements...
that scientific explanation rest upon true explanatory bases that are grounded in scientific fact. There should be an objective relationship between the explanatory facts and the fact-to-be-explained. Referring to one of the explanatory relevance paradoxes, Salmon argues:

> [e]ven if a person were perfectly content with an ‘explanation’ of the occurrence of storms in terms of falling barometric readings, we should still say that the behavior of the barometer fails objectively to explain such facts. (Salmon 1984 p. 13)

Furthermore, people may feel dissatisfied with legitimate scientific explanations as well as satisfied with defective ones. Salmon maintains that such considerations favor his alternative causal approach to explanation, because it avoids the relevance paradoxes and because it has an objective relation built in. We will examine Salmon’s theory of explanation shortly, but here let us just note that the same arguments that Salmon gives against the psychological view of scientific explanation also tell against the counterpart in confirmation theory. Surely that someone simply feels psychologically convinced that the monoliths of Stonehenge confirm the hypothesis that ancient astronauts visited the earth, as Erik von Danikan would have us believe, does not make it objectively so. The maid’s fingerprints on the gun are not evidence that the butler fired the shot, no matter that someone perversely happens to feel that they are.

Similar problems stemming from the subjectivity of psychological states can appear even in technically defined confirmation theories. For example, some Hypothetico-Deductivists tried to supplement their deductive confirmation relation with a requirement that the prediction from the hypothesis be surprising, another psychological property. However, psychics have occasionally had their surprising predictions come true, and unless we want to allow the possibility of crystal ball gazing as evidence on this ground, it seems as though we must give up the subjective basis for confirmation and insist that the confirmation relation, like the explanatory relation, be objective.

To take another example, according to an early form of Bayesian confirmation theory, evidence is a function of change in degree of belief and this could vary in whatever way one felt because probability was interpreted as subjective degree of belief. Many people’s probability assignments are simply inconsistent, and this meant that the Subjectivist Bayesian could confirm beliefs with irrelevant data such as in the cases mentioned above. To correct this, most Bayesians rejected the Subjectivist interpretation in favor of the Personalist interpretation, which still holds that probabilities are degrees of belief, but adds the constraint that a person’s degrees of belief be consistent with the probability calculus. Bayesians have offered elaborate arguments in support of this requirement, showing that one would always be subject to a “Dutch Book” bet if one were to revise one’s beliefs in a way that departed from the probability calculus. However, even specifying an “Ideal Bayesian Agent” in this way may not solve all the problems stemming from a subjective psychological approach, for one may maintain consistency with the probability calculus not by revising one’s beliefs by conditionalizing in the standard way on Bayes’ theorem, but also by simply adjusting the values of the factors in some other way to preserve consistency. Because of this, even Personalist Bayesians may have to allow the possibility of such perverse “confirmations” as seen above, which is one reason why other Bayesians, such as Salmon, insist upon some objective interpretation of the probability calculus. In any case, Bayesianism falls short in another way from the perspective of an I.B.E. confirmation theorist, because it does not have an integrated theory of explanation.

**Causal Theories of Confirmation**

I have argued elsewhere (Pennock 1991) that a causal explication of the confirmation relation can avoid the well-known paradoxes having to do with evidential relevance. Given that a causal account of explanation appears to solve the explanatory relevance paradoxes, adopting a causal theory of evidence has the added virtue that causal relations then provide a common framework for both theories of confirmation and explanation, as Hempel said should be required. Linking of this sort is expected by and indeed is necessary for an I.B.E. confirmation theory, though the idea that the link is causal is relatively new. Richard Miller was the first to develop a causal I.B.E. confirmation theory, in his ground-breaking 1987 book *Fact and Method*.

Miller proposes that confirmation is:

> (Definition MC) "... the fair causal comparison of a hypothesis with its current rivals. A hypothesis is confirmed just in case its approximate truth, and the basic falsehood of its rivals, is entailed by the best causal account of the history of data-gathering and theorizing out of which the data arose." (Miller 1987 p. 155)
The explanatory requirement of I.B.E. confirmation enters this definition in that a “causal account” for him is an explanation, and he proposes that an explanation is:

(Definition ME) "...an adequate description of underlying causes helping to bring about the phenomenon to be explained." (Miller 1987 p. 60)

Both the above definitions are tightly packed and Miller carefully spells out in the book what he means by each of the key terms. Miller’s approach opens a promising way forward for confirmation theory, but this is not the place for a critical examination of the details of his view. Here I simply want to note our agreement on the causal linking of confirmation and explanation and our disagreement about how best to understand the nature of the link. In Salmon’s terminology, Miller’s account of confirmation is “epistemic” while I recommend an approach that is “ontic.” Epistemic theories view explanation (or confirmation) as a type of argument; that is, relations among statements, typically in some formal language, constitute the explanatory (or evidential) relations. Hempel’s Deductive-Nomological model is an epistemic theory of explanation and the Hypothetico-Deductive Method is an epistemic theory of confirmation. An ontic approach, on the other hand, holds that explanatory (or evidential) relations are not primarily linguistic or logical relations, but rather are relations in the world.

Comparing Salmon & Miller

We can elucidate the difference between epistemic and ontic approaches by comparing Miller’s theory of explanation with Salmon’s, which was put forward in *Scientific Explanation and the Causal Structure of the World* (1984). According to Salmon, scientific explanations have two tiers. The first tier involves a subsumption of the explanandum under appropriate statistical relevance relations. Statistical relevance does not provide an explanation, however, without the second tier in which those statistical relations are explained in terms of causal relations. The essential explanatory work takes place in this second tier, and it is at this level that Salmon’s theory departs from the epistemic approach and becomes an ontic theory. There are several preliminary formulations of the causal approach, but the most precise version says that:

(Definition SE): “To provide an explanation of a particular event is to identify the cause and, in many cases at least, to exhibit the causal relation between this cause and the event-to-be-explained.” (Salmon 1984 pp. 121-22)

On the surface Salmon’s and Miller’s definitions look much the same, but the difference comes out in the details. Besides the terms “identify” and “exhibit” in definition SE, Salmon elsewhere uses terms such as “show,” “fit,” “place,” and “display” to elucidate what the explainer does, but such display is not itself the explanation according to him. Miller, on the other hand, in definition ME, says that the explanation is the “description.” The difference is significant; for Salmon, an event is explained by something in the world (a cause), whereas for Miller a phenomenon is explained by something in language (a description of a cause).

This difference between the ontic and epistemic views is even more pronounced once one plugs the theories of explanation into the I.B.E. account of confirmation. For Miller confirmation is an argument and the key evidential relations are deductive. Recall definition MC which states that a hypothesis is confirmed just in case its approximate truth is “entailed” by the best causal account of the data; this only makes sense because the explanation is a linguistic object. Though the specifics differ, this is the same sort of epistemic relation that we saw in Hempel’s model of explanation and in an I.B.E. confirmation theory based upon his model—that is, the relations that determined explanatory and evidential relevance were taken to be formal relations in the given logic. On the other hand, if one makes use of an ontic theory of explanation like Salmon’s in an I.B.E. confirmation theory, then evidence turns out not to be something in language, but rather something in the world. So, for example, we would say that the smoke (rather than the description thereof) is evidence of a fire because it is explained by (caused by) the fire. Given that Salmon’s causal approach is currently the most promising and most developed theory of explanation, making use of his theory would be a good strategy for an I.B.E. theorist.

Of course, an I.B.E. confirmation theory that adopts an ontic view of the explanation relation will have the strengths of that approach but also will have to deal with its weaknesses. Let us now turn to two of the most common worries about the causal approach.
Humean Problem for Causal Approaches?

An obvious difficulty for the ontic view is the need to provide an adequate understanding of causal relations in the face of the Humean challenge to concepts of causation. Salmon has tackled this problem in his book and in subsequent articles. The theory of causation he presents involves a shift from an event ontology to a process ontology. The notion of a process is a primitive in Salmon’s system and so is defined by example; baseballs traveling from a bat toward a window, traveling beams of light, cloud shadows moving across a landscape, waves and persisting material objects are all processes, in contrast to events such as the ball’s hitting the window, the activation of a photocell by the light beam, or a sneeze. Processes are further characterized as the sort of thing that would be represented in a space-time diagram as a line, rather than a point (which represents an event). There are two types of processes: “causal processes” and “pseudo processes” (though the latter type would more accurately be termed “non-causal processes” or “pseudo-causal processes” since they are true processes). Causal processes are characterized as being:

...self-determined and not parasitic upon other causal influences. A causal process is one that transmits energy, as well as information and causal influence. (Salmon 1984 p. 146)

All of the above features are a result of the property of causal processes of transmitting their own structure. Pseudo-processes, on the other hand, cannot transmit their own structure, but are “parasitic” upon causal processes. How can one differentiate causal processes from pseudo-processes?

In his original treatment, drawing upon an idea suggested by Reichenbach, Salmon proposed that causal processes are distinguished from pseudo-processes by their “ability to transmit a mark.” A mark is a change in “structure” that is “introduced” into a causal process at a local “interaction” with another causal process (i.e. at an “intersection” of their causal lines) and it would then persist unless there were further intervention; only causal processes can transmit marks. To say that a mark is “transmitted” or “propagated,” say from point A to point B, is simply to say that it is at the intervening point at the intervening instants.11 These elements combine to form the Principle of Propagation of Causal Influence, which states that “a process that transmits its own structure is capable of propagating a causal influence from one space-time locale to another.” (Salmon 1984 p. 155) It is this principle with which Salmon answers the Humean problem of how to get from cause to effect. He writes:

The propagation of causal influence by means of causal processes constitutes, I believe, the mysterious connection between cause and effect which Hume sought. (Salmon 1984 p. 155)

Hume’s problem arose from thinking in terms of an event ontology of points instead of a process ontology of lines; it made sense for Hume to question by what “hidden power” one could transmit causal influence from one distinct event-point to the “next,” but the problem loses much of its force if one takes the basic ontic entity to be line-like and accepts the “At-At” theory.

Salmon has recently offered a revised theory (Salmon 1994) to avoid a few problems that arose for the original formulation. For example, the definition of the principle of mark transmission is counterfactual and was criticized for this by Philip Kitcher (1989) as threatening the empiricist basis of science. Salmon had originally tried to formulate his theory without counterfactuals, but felt forced to introduce the subjunctive formulation to deal with a counterexample from Nancy Cartwright. At the time he argued that the counterfactual treatment was not problematic because science can deal with counterfactual assertions by means of controlled experimentation, but he later agreed that Kitcher’s criticism on this point was worrisome. Another criticism came from P. Dowe (1992) who showed that the original set of definitions involving mark transmission was circular in definitions that referred to “interactions,” and argued that the concept of marking was vague because it relied upon undefined notions such as “structure.” Unlike Kitcher, however, who thinks that causality should be explicated in terms of explanation instead of vice versa, Dowe is a sympathetic critic and proposed some emendations to improve Salmon’s account. Although Salmon still claims that the mark criterion is viable and argues that it could avoid the charges of circularity and vagueness by replacing “interaction” with “intersection” at appropriate points in some definitions and by more careful integration of the concept of an objectively co-defined class, he has decided to abandon the mark criterion in favor of a definition that distinguishes causal processes from pseudo processes by appeal to invariant quantities. (Salmon 1994, p. 308) Salmon’s revised theory, drawing upon Dowe’s alternative framework, avoids circularity and vagueness and, as a bonus, answers Kitcher’s objection
in that it does not require a counterfactual formulation.

Of course, we may yet find that Salmon's revised theory of causation still contains problems. While this would clearly be a blow to causal explications of scientific explanation and evidence, it would also be a problem for other approaches as well because causal hypotheses and causal explanations abound in science and must somehow be accounted for in any philosophy of science. Bertrand Russell once tried to argue that science could do without the notion of cause (Russell 1918), but even he eventually withdrew from that position. Even someone like Kitcher who argues that scientific explanations rest upon considerations of unification, must then go on to show how unification explanations can ground causal explanations. And even a Bayesian confirmation theorist will have to give an account of how causal hypotheses are confirmed. Neither of these projects or any other that deals with science can be considered complete without some account of causation, so all will eventually have to deal with the Humean problem.

**Sellarsian Problem for Causal Approaches?**

A second potential problem for ontic approaches may be termed "Sellarsian," for it involves the difficulty of making the connection between the causal and epistemic realms—in this case between the causal mechanisms in the world that make up the ontic explanatory relation, and the cognitive realm in which explanations are requested and supplied. While there is a perfectly sensible way in which *one fact explains another fact*, which is what the ontic view aims to explicate, there is also this important social aspect of explanation— *scientists explain* or offer an explanation of a fact to convey or achieve understanding of it. This latter sense of explanation is clearly of the epistemic realm. An apparent virtue of the old view of explanation was that, by holding that explanations are arguments and its relata propositions, it seemed that all the elements of the theory were in the epistemic realm. The ontic view, on the other hand, needs some way to connect the key ontic relation of causality to the epistemic context of understanding. Salmon clearly intends to keep one foot in the epistemic realm for he is explicit that understanding is the major goal of scientific explanation, but he provides no connection between the ontic and epistemic realms except by means of the metaphorical bridges of "display," "exhibition" and so on that we mentioned earlier. An ontic theory of confirmation, such as an I.B.E. account that uses Salmon's theory of explanation, of course would have the same difficulty. Putting the Sellarsian

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This, I take to be the insight captured by Wesley Salmon... but neglected by both Peter Achinstein and Carl Hempel, the latter of whom concentrates almost exclusively on the epistemic rather than the metaphysical requirements of explanation. (Ruben 1990, p. 241)

Ruben attempts to follow up this insight in developing his own “Realist theory of explanation” that holds that explanations are made possible by dependency relations that structure the world; one explains a fact by means of another that determines it to be as it is, or upon which it depends. This is clearly an ontic view in Salmon’s sense for Ruben is clear that explanations are not arguments. Ruben’s dependency relations are primarily causal relations, but he also includes identity relations to allow mereological explanations. Then, to bridge the epistemic/ontic gap, Ruben introduces a special notion of an “epistemicized” fact—“ordered sets of ordinary facts and conceptualizations and/or names both of the properties and of the individuals who are constituents of the facts” (Ruben 1990, p. 179)—to serve as the explanatory relata.

Whether or not we accept Ruben’s specific proposal, we can agree that in a hybrid view the ontic element and the epistemic must somehow be complementary. My own view is that in scientific investigation we need the ontic element to provide the ground for epistemic moves, whether they be explanatory or evidential, and that we may connect the two realms by the idea of “licensing.” Our inferences about empirical matters are legitimate only when causal relations license them. For example, I would argue that our core epistemic notion of an explanation is that which makes the explanandum so, and that for empirical matters this means that their explanations are causes. Turning to confirmation, to say that a datum is evidence of some empirical matter is to say that the datum provides information about it, and a datum can be informative of some state of affairs only by virtue of standing in the proper causal relations to it.

It may be that in the end we will find that no hybrid approach is viable and we will be forced to one of the extreme alternatives. Nevertheless, whatever way we eventually find to resolve this issue, the important point for us here is to recognize that the Sellarsian problem applies to epistemic theories of scientific explanation and confirmation as well as to ontic ones, and so is not a special reason to reject the latter.

Conclusion

The main purpose of this paper was to review some recent work on issues connecting the theories of scientific explanation and confirmation. I have been concerned especially to consider the difference between epistemic and ontic approaches to these problems. Causal theories of explanation and confirmation have the virtue of avoiding paradoxes of relevance and showing how these theories can relate in a unified framework as is expected by an I.B.E. account. Furthermore, the Humean and Sellarsian problems are not unique to the causal theories; even if one finds the solutions suggested above to be inadequate, some solution is necessary whatever type of explication of scientific explanation and scientific evidence one adopts. The causal explanations are no worse off than other explications in these respects and are better in other respects, and this makes them worthy of further research.

Notes

1. If this is what Harman had in mind, it would be part of a common confusion that takes the H-D Method to be the same as the Method of Hypothesis, whereas the former is only one type of the latter. I discuss the many historical variations of this view of confirmation in detail in “The Methods of Hypothesis” (forthcoming).

2. To mention just a few of the most famous relevance problems, the D-N model was shown to imply that one could explain the height of a flagpole by the length of its shadow, the occurrence of a past eclipse by present planetary positions, and a coming storm by a falling barometer reading. The H-D method was shown to allow that one could use any data at hand to confirm any arbitrary hypothesis.

3. The explanatory relevance problems mentioned are easily seen to arise from neglecting causal relations; the flagpole causes the shadow but not vice versa, present planetary positions do not cause previous eclipses, and the falling barometer reading and the coming storm are both effects of a common cause.

4. Noted psychic Jeanne Dixon, for example, is fond of pointing out that she predicted the assassination of President Kennedy.

5. Note that the terminology is sometimes applied inconsistently in the literature, and a position may be labeled “Subjectivist” when it is really a Personalist view.

6. These include Hempel’s raven paradox, Goodman’s grue paradox, the problems of irrelevant conjunction and disjunction, and others.

7. I provide a detailed analysis in “Miller’s Causal Comparison Confirmation Theory” (forthcoming).

8. Although I shall continue to discuss I.B.E. confirmation theory in this paper and recommend an ontic

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