The Explanation of Unlikely Events

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The recent discussion of explanation departs from Hempel and Oppenheim's now classic article ([5]). Their treatment of deductive-nomological (D-N) explanation has been extended to inductive-statistical (I-S) explanation. (cf. [4] & [9]). While models of I-S explanation differ in detail, they share an asymmetry in the explanation of likely and unlikely events. The former can be explained, the latter cannot.

Jeffrey ([6]) and Railton ([8]) have argued that this is objectionable. They contend that both likely and unlikely events are equally explicable. I shall argue here that Jeffrey and Railton correctly maintain that the explanatory status of likely and unlikely events is the same. However, I shall argue that both are equally inexplicable.

1. *I-S Explanation*: I-S explanation is modeled after D-N explanation. Both require both covering laws and statements of initial conditions, and that a specified logical relationship obtain between the explanans and the explanandum. The central difference is the type of covering laws at issue. As Rescher put it;

> The pattern of reasoning involved in [I-]S- explanation is, except for the difference in the types of laws, strictly parallel to the pattern of reasoning involved in D-[N] explanations. ([9], p. 46)

In D-N explanation, all covering laws are universal ones. In I-S explanation, at least one of the covering laws is essentially statistical in nature. Hence, the relationship between the explanans and the explanandum cannot be one of deductive validity. Rather, the explanans confers some specified degree of probability on the explanandum. Three models have been proposed which vary in the degree of probability required. Those models can be characterized as follows. Let the explanans consist of the covering law-(s), L, and statements of initial conditions, C. Let E be the explanadum.

(1a) Hempelian I-S (H-I-S) Explanations; (L,C) is an H-I-S explanation of E iff p(E, L&C)=1-e, where e is a small number. ([4]), p. 381-383)

(1b) Strong I-S (S-I-S) Explanation: (L,C) is an S-I-S explanation of E iff p(E, L7C)>1/2. ([9]), p. 45)

(1c) Weak I-S (W-I-S) Explanation: (L,C) is a W-I-S explanation of E iff p(E, L&C)>p(E', L&C) for all E' such that p(E', L&C)>0. ([9], p. 45)

The use of terms 'strong' and 'weak' in (1b) and (1c) respectively betrays the roots of I-S explanation in D-N explanation because these I-S explanations are evaluated in terms of how closely they approximate D-N explanation; the closer p(E, L&C) is to one, the better the explanation. Thus, any H-I-S explanation is better than any S-I-S or W-I-S explanation, and any S-I-S explanation is better than any W-I-S explanation. This approach to the evaluation of I-S explanations is explicitly embraced by Rescher and Skyrms in their discussion of explanatory "strength" and "power." ([10], p. 124-128)

As Railton points out ([8], pp. 212-213), even Jeffrey who explicitly states that "the strength of a statistical explanation. . . is not given by the degree of confirmation" the explanans bestows on the explanandum ultimately succumbs to the temptation to measure I-S explanations against D-N explanations. ([6], pp 105-106). This approach to I-S explanation is objectionable for several reasons.

First, if explanations are "stronger," "more powerful," or in any other sense better if they confer a higher degree of probability on the explanandum, then it follows that any D-N explanation is better than any I-S explanation since it confers a probability of one on its explanandum. This is surely implausible.

Second, as Rescher points out, in some cases I-S explanation of any kind is uniformly impossible. Consider a discrete state Markow chain consisting of three states S1, S2, S3 such that the transitions from any state to any other state are equiprobable. In this case "no-state-occurence is explicable even in the sense of [W-I-]S. . . explanation" and *a fortiori* of S-I-S and H-I-S explanation. ([9], p. 54)

There is surely something amiss with an account which has this consequence. We know everything there is to know, yet we are utterly unable to explain anything. According to Rescher, we must accept this consequence because in such cases "we cannot answer the question 'Why did X happen?'" ([9], p. 54) This brings me to my third argument against I-S explanations.

Third, no I-S explanation provides an answer to the central explanatory question 'Why did A occur rather than B?'. This is true not only of the above case, but of all I-S explanations including those which make the explanandum virtually certain. Consider a case where a given state, S1, can be followed only by two other states, S2 and S3: one highly probable, p(S2, S1)=0.99; the other highly improbable p(S3, S1)=0.01. According to the proponents of I-S explanation, the occurrence of S2 can be explained; that of S3 cannot. But if the laws governing the system are really statistical in nature, then there is no reason why the one state occurs rather than the other.

It is true that we would expect S2 to follow S1 99 times more frequently than S3. But the fact that S2 follows S1 much more frequently than S3 does not provide a reason why S2 occurred rather than S3. If the laws are both indeterministic and fundamental, then there is according to those laws no reason why one state occurs

rather than the other. They occur by chance. With Jeffrey, I suggest that "here knowledge *why* splits clearly away from knowledge *that*." ([6], p. 109)

The anamoulous nature of I-S explanation is further illustrated by "the fact that when the improbable chances to happen, we give the same sort of account" as when the probable happens. ([6], p. 110) It therefore seems reasonable to view the explanatory status of that account as the same in both cases as Jeffrey and Railton suggest. However, they view the account as equally explanatory in both cases. Because Railton's account is the fuller and more recent of the two, I shall deal with it in what follows.

2. *D-N-P Explanation*: Railton's account of deductive-nomo-logical probabilistic explanation (D-N-P explanation) follows Jeffrey's on two important points. First, with Jeffrey ([6], p. 109) he maintains that statistical explanations are not inferences ([18], pp. 216-217) Second, he follows Jeffrey in maintaining that statistical explanation aims at

> understanding the process which had the outcome. . . it consists of a statement that the process was a stochastic one, following such-and-such a law. ([6], p. 109)

Railton introduces the following "scheme for probabilistic explanations of particular chance facts by nomic subsumption."

(2a) "A law of essentially probabilistic form" (2b) is derived from our theory "complete with an account of how the law applies to the indeterministic process in question."

(2b) The law is of the form "At any time, anything that is F has probability p to be G."

(2c) "Next we adduce the relevant fact(s) about the case at hand, e: 'e is F at time t_0'."

(2d) From 2b and 2c "we draw the obvious conclusion. . . 'e has probability p to be G at time t_0'."

(2e) "To which we add parenthetically, and according to how things turn out; . . . 'e did/did not become G at t_0'." ([8], pp. 217-218)

Railton's D-N-P explanation has two deductive steps. First an essentially statistical law (2b) is deduced from a relevant theory. Second, a statement of the probability of the explanandum (2d) is deduced from an explanans consisting of the statistical law (2b) and relevant initial conditions (2c). According to Railton the first step provides an account of the "indeterministic mechanism" and insures the "nomological status" of the statistical law. The second step makes the indeterministic theory and law relevant to the particular (chance) event to be explained. According to Railton, these two deductive arguments carry "almost all the explanatory burden in probabilistic explanation." ([8], p. 217)

But the inference to this point "gives a D-N explanation only of the fact that . . . [the explanandum] had such and such a probability." ([8], p. 214) To complete the explanation, Railton adds a "parenthetic addendum" to the effect that the explanandum did occur.

> The parenthetic addendum fills this gap in the account, and communicates information that is relevant to the casual origin of the explanandum by telling us it came about by the realization of a particular physical possibility. ([8], p. 217)

The distinctive elements of Railton's D-N-P explanation are his use of this "parenthetic addendum" and his demand that the covering law be deduced from some theory. Neither seems to me to be appropriate. I address them in turn.

The first thing which must be said about parenthetic addendum is that its role is quite unclear. This is due to two things. First, Railton says little about its role. Second, his distinction between explanatory arguments and explanatory accounts is unclear.

He suggests in the case of alpha-decay that once we have derived the covering law from quantum mechanics, derived the probability of alpha-decay from the covering law and shown the parenthetic addendum to be true; then we have said everything that can be said about alph-decay. ([8], p. 216) That may well be the case, but how does the addition of the parenthetic addendum advance the cause of explanation? In traditional terms, Railton's parenthetic addendum is just the explanandum. If so, then there is nothing exceptional about establishing its truth. The dominant, and I suggest correct, view is that the explanandum must be known to be true independently of the explanans. (This, of course, must be the case for unlikely events.) Further, it is difficult to see how the explanandum itself can have explanatory value unless we allow either partial or total self-explanation.

The suggestion that the parenthetic addendum provides information concerning the "casual origin of the explanandum by telling us it came about as the realization of a particular physical possibility" ([8], p. 217) is equally unsatisfactory. Since the parenthetic addendum *is* the explanation, *prima facia* it provides no further information concerning its own causal origin. Further in a genuinely statistical case the explanandum *has no* casual origin; it happens by chance.

Railton also suggests that "the parenthetic addendum. . . furnishes a non-probabilistic premise from which to begin" accounts of other things. ([8], p. 217) Since the parenthetic addendum is the explanandum and is known to be the case independently of its explanation, of course it is available to fill that role. But that is the case whether it has a D-N-P explanation or not.

Overall, Railton's discussion casts little light on the role of the parenthetic addendum. This difficulty is compounded by the lack of clarity concerning his distinction between explanatory arguments and accounts.

The second distinctive element of Railton's account is his demand that explanations include a theoretical derivation of the covering law. This is his criterion of lawlikeness. ([8], p. 215) However, his requirement is not just that the covering law meet that criteria. Rather, he requires both the theory and the derivation be included in the explanans to insure that it includes "an account of the mechanism at work." ([8], pp. 215-217)

Few would argue with Railton's contention that explanations which rely only on simple instatiation of covering laws "explain but poorly" when compared to those which rely on general theoretical principles and hence reveal "the mechanism at work." However, the central point is not how well simple covering-laws explain things. Rather, it is whether they explain at all. Railton requires that they do not. On this point he is mistaken.

In general, we must accept the use of what Donogan terms "unexplained explainers." ([2], pp. 138-142) If we do not, then the process of explanation is without end; and we have no explanations of anything. The issue here is the "level" at which unexplained explainers are used.

As Scriven points out, explanation aims at producing "understanding. . . roughly, organized knowledge." ([11], pp. 224-225) Subsumption of a particular occurrence under a covering law does this. Showing that particular events conform to lawlike regularities systematizes them as part of an organized body of knowledge, at least to some degree. Hence, covering laws (no matter how their lawlike status is determined) can properly function as "unexplained explainers."

Further, Railton's account rules out many widely accepted scientific explanations and makes monsense of the history of science. At their introduction, many important laws lacked any theoretical basis. For example, Kepler's laws, Newton's laws, and Maxwell's equation were introduced in spite of the failure to provide the theoretical derivation required by Railton. According to his account they lacked explanatory force. Further, Railton's requirement arguably still cannot be met in some cases; for example, the various conservation laws. This is surely unacceptable.

Overall, Railton's requirement for a theoretical derivation is unnecessary and unreasonable. While explanations which reveal the theoretical basis or mechanism behind a covering law provide deeper understanding, it does not follow that covering-law explanations provide no understanding.

3. *A Model of Statistical Explanation*: If both Railton's and the traditional accounts of statistical explanation are unacceptable, then how do we account for statistical explanations? I suggest a satisfactory account can be developed by taking seriously comments by Angel, ([1], p. 28), Jeffrey, Railton, and others that for statistical explanation "the explanation is the same no matter what the outcome."

([6], p. 109)

In Suggesting that the explanation is the same no matter what the outcome, I do not suggest as Railton and Jeffrey do, that the same explanation explains the possible explananda taken singly. As Angel points out, this gives rise to the anomolous situation that one and the same explanans is an explanation for mutally exclusive events. ([1], pp. 281-282) This almost, but not quite, violates a fundamental requirement suggested by Ellis; *viz.*, the same explanans cannot be explanation for both an explanandum and its negation. ([3], p. 177) While Ellis' requirement is strictly not violated here, the case comes close enough to be unsatisfactory.

To avoid this, I suggest that statistical theories do not explain any single events, likely or unlikely. Following Angel, we take account of the fact that statistical theories deal not with single events, but with "statistical assemblages." ([1], p. 281) These assemblages or distributions of events are what statistical laws can and do explain.

Thus I suggest the following model for statistical explanation. The ordered couple (L&C), is a statistical explanation of E iff

(3a) L is an essentially statistical lawlike statement, or conjunction of lawlike statements at least one of which is essentially statistical.

(3b) C is a singular statement of initial conditions or a conjunction of such statements.

(3c) L is true.

(3d) C is true.

(3e) L satisfies the requirement of total evidence.[1]

(3f) P(E, L&C)=1 where $E=E1vE2v...vE_n$, and where the E_i's are those and only those statement's such that $P(E_i, L\&C)>0$.

Viewed along these lines statistical explanations dealing with distributions of events show that those events are the only theoretically possible alternatives given the explanans. All other alternatives are ruled out. In so far as the 'A' and 'B' in 'Why did A occur rather than B?' are viewed as referring to distributions of events, then statistical explanations provide adequate answers to that question. The answer is 'A was theoretically necessary and B was theoretically impossible'.

In so far as we want an explanation of single events, all we can say is the event occurred because it was among the theoretically possible alternatives. We could also point out that the explanandum is more or less probable or that it did occur, but those addenda are *truly* parenthetical. They contribute nothing to our understanding or explanation of why it occurred. If the situation is truly statistical, then that is inexplicable.

This account allows the explanatory force of statistical laws and theories such quantum mechanics. For example, quantum theory explains why a certain series of

quantum transitions are characteristic of hydrogen, and hence, why excited electrons always make one or the other of those transitions. But it cannot explain why a particular electron makes the transition it does rather than some other permissable transition.

On balance, the suggested account enables us to say everything we can, and need, to say about the explanatory adequacy of statistical theories. Most proponents of statistical explanation would point out here that statistical theories require changes in preconceived notions of explanation. In this regard Morgenbesser's general point is noteworthy:

> We should not begin with the assumption that it is or ought to be the aim of science to explain everything, but with the one that it is the aim of science to discover true theories as a result of which we will know what is capable of explanation and what is not. ([7], p. 55).

Along these lines I suggest the clear moral of statistical laws concerns not the nature of explanations involved, but the range of phenomena which can be explained. Where statistical laws obtain, single events, likely or unlikely, are simply beyond our explanatory reach.

[1]Requirements (3c) and (3d), especially (3c), are controversial. However, as they are incidental to the central concern here I shall not discuss their appropriateness or adequacy.

NOTES

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