CRITERIA OF STRENGTHENING EVIDENCE

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ABSTRACT

Confirmation theorists have frequently expressed an interest in evidence which strengthens a hypothesis or in evidence which makes a hypothesis firmer. A number of criteria have been offered, including the instantial criterion, the prediction criteria, and Hempel's satisfaction criterion. All of these criteria are dyadic, but the concept of strengthening evidence is triadic, for it makes explicit reference to an evidence report and a hypothesis, and implicit reference to prior evidence in the light of which a new evidence report must be evaluated. I argue that the approach to strengthening evidence reflected in these criteria is inadequate, that is, that dyadic criteria can be of only limited value in connection with a triadic concept. I discuss the possibility that these criteria have been offered for the concept of initially strengthening evidence. The latter explanation is rejected, and other explanations for having failed to consider prior evidence are discussed.
Criteria of Strengthening Evidence

I

It is not uncommon for successful predictions derived from a hypothesis or for newly observed instances of a hypothesis to be considered as strengthening the hypothesis in question. Although neither the prediction criterion nor the instantial criterion express plausible necessary conditions, these criteria have been widely thought to express sufficient conditions of evidence which strengthens a hypothesis. The first careful study of these criteria seems to have been Hempel's, published in "Studies in the Logic of Confirmation" some three decades ago. He rejected both criteria and offered in their stead what he called "the satisfaction criterion" of confirmation. Hempel's work on confirmation, especially the paradoxes of confirmation which he discovered, is well known and frequently discussed, and I shall assume familiarity with it.

In this paper I will first show that criteria such as the prediction criterion, the instantial criterion, and Hempel's satisfaction criterion are inappropriate for the concept of strengthening evidence. The inappropriateness is not one of mere wideness or narrowness but is a result of a basis dissonance between the concept and the mentioned criteria, for the criteria treat the confirmation relation as dyadic whereas the concept of strengthening evidence is triadic. This is significant, I think, inasmuch as the concept of strengthening evidence is central to the inductivist conception of knowledge acquisition, and inasmuch as the criteria mentioned, especially the prediction criterion and the instantial criterion, are widely endorsed as sufficient conditions of strengthening evidence. The inappropriateness of these criteria is shown by means of a very simple but telling illustration. This raises the question of whether I have correctly identified the explicandum for which inductivists have offered criteria. I shall discuss this question with special reference to Hempel's study of weak confirmation.

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1 This was first published in Mind, 54 (1945), but I shall refer to the paper published with changes in Hempel's Aspects of Scientific Explanation (New York: Free Press, 1966), pp. 3-46.

2 I use "weak confirmation" as follows. In the Preface to the Second Edition of Logical Foundations of Probability Carnap distinguished two senses of 'to confirm': the sense of 'to make firmer' and the sense of 'to make firm'. There are other senses as well according to R.H. Vincent in "Selective Confirmation," Dialogue, 14 (1975), pp. 3-49.

Senses of 'to confirm' which cluster around 'to make firmer' I refer to as weak senses. I recognize that this is inexact, but I do wish to convey the point that a sense of 'to confirm' other than 'to make firm' is under discussion.
and in so doing I shall dispel a common misconception regarding his work. I shall close with some comments about the possible source of the difficulty discussed.

II

The concept of evidence which strengthens a hypothesis, or makes a hypothesis firmer, is a familiar one within inductivist epistemology. It has been derided as an expression of "the thermometer theory" of knowledge acquisition. According to the theory, a hypothesis might enjoy a certain degree of credibility (degree of firmness) upon first being proposed, and as evidence is acquired it is either strengthened or weakened. Strengthening evidence is simply new evidence which makes a hypothesis firmer than the hypothesis was prior to the acquisition of the new evidence. Weakening evidence is characterized in an opposite fashion, and of course some putative evidence might neither strengthen nor weaken a hypothesis. I shall confine my attention to strengthening evidence henceforth. I have not used expressions familiar from confirmation theory such as "confirming evidence," "corroborating evidence," to express the concept of strengthening evidence, since I want a fairly neutral term to identify pre-analytically a concept belonging to a topic fraught with terminological problems. The concept I am identifying as the concept of strengthening evidence is identical with the concept of confirming evidence discussed by Carnap in *Logical Foundations of Probability* (section 86). I shall not assume, however, that a function satisfying the probability calculus must be used to define it.

Consider the expression 'evidence $e$ strengthens hypothesis $h$' or 'evidence $e$ makes hypothesis $h$ firmer'. It is clear that the concept of strengthening evidence is triadic -- explicit reference is made to a new evidence report $e$ and a hypothesis $h$, but implicit reference is made to prior evidence $b$. To assert that $e$ strengthens $h$ is to implicitly assert that $e$ makes $h$ more credible than $h$ is on the evidence available prior to the acquisition of $e$, viz., the prior evidence $b$. And this concept is quite correctly identified, by Carnap and others, as an important epistemological concept, for it is implicit in the inductivist view of how hypotheses become accepted. Some theorists, of course, reject an epistemology which views evidence as assessible with respect to only one hypothesis, and contend, for example, that evidence must always choose between two or more rival hypotheses. I do not intend to discuss this much larger topic of an adequate epistemology here.

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3I cannot find the reference, but I think it was Popper or a Popperian who said it.
All the criteria mentioned above, i.e., the prediction criterion, the instantial criterion and Hempel's satistation criterion, treat the confirmation relation as dyadic — a relation holding between evidence and a hypothesis. Prior evidence is not considered in formulating the criterion, but is effectively ignored. Consequently, these criteria cannot be adequate for the concept of strengthening evidence, as the following simple example shows. I shall refer to the instantial criterion by way of illustration here. The instantial criterion asserts that a hypothesis $h$ is confirmed by all of its instances. This criterion is not clear, as Hempel showed, because the concept of an instance is not clear. Let us assume that the report $C$ of a black crow $c$ is an instance of the hypothesis $H$ that all crows are black — surely the most uncontested example of an instance. Although $C$ is an instance of $H$, $C$ does not strengthen $H$ given any prior evidence whatever. There are at least three conditions in which $i$ might not strengthen $H$ (or make $H$ firmer): i) if $H$ has already been established as certain, ii) if $H$ has already been falsified, iii) if $H$ has already received as much strengthening as it can from reports similar to $C$. So in spite of the fact that $C$ is an instance of $H$ it does not necessarily strengthen $H$, i.e., make $H$ firmer than it was on prior evidence. Exactly analogous remarks could be made concerning Hempel's criterion, the prediction criterion, and other dyadic criteria which ignore prior evidence. The apparent interest in providing a criterion of strengthening evidence -- a triadic concept -- has not been matched with suitable criteria.

I wish now to consider a number of objections to the argument in the preceding section.

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4 Hempel discussed the concept of an instance in "Studies" when discussing the instantial criterion of confirmation. There has not been much interest in the concept of an instance since that, since the instantial criterion is inadequate. While defining the concept might be of little interest, there is a conundrum involving the concept of an instance which is of some interest inasmuch as it resembles one in confirmation theory known as the confirmation paradoxes. The conundrum is expressed in the query: if $i$ is an instance of $h$, and $h$ is logically equivalent to $h'$, is $i$ an instance of $h'$? An affirmative answer might constitute a paradox of instancehood, which is not to be confused with a paradox of confirmation.

5 R. M. Eaton, for one, expressed the view that abundant evidence of one kind can finally exhaust its evidential value. See his General Logic, p. 485.
It might be objected that criteria of confirmation which treat the confirmation relation as dyadic ("dyadic criteria" for short) have not been offered for the concept of strengthening evidence as outlined above. It might be objected, in particular, that Hempel was trying to provide a criterion for some concept other than concept of strengthening evidence. In response to the general objection I would say first of all that informal comments about the prediction criterion or the instantial criterion frequently are to the effect that the criteria pick out evidence which strengthens a hypothesis. It is worth noting that Hempel says in his informal discussion of his explicandum that he is interested in evidence which strengthens a hypothesis. This comment does not settle the matter, for there are other informal comments which are difficult to reconcile with this comment, for example, he says also that he is interested in evidence which accords with a hypothesis. Whether evidence accords with a hypothesis if and only if it strengthens that hypothesis is a moot point. One cannot lean too heavily on informal comments, but it is significant that mention is made of strengthening evidence. Moreover, the concept of strengthening evidence as outlined is a vital element of inductivist epistemology. Carnap indicated in his study already mentioned that the concept of confirming evidence (in his terminology) was among the more important concepts of confirmation requiring explication. His own efforts were primarily directly of course to explicating 'to confirm' in the sense of 'to make firm'. It seems unlikely that Hempel and other inductivists have been concerned with another relatively insignificant concept.

Let me consider in more detail the particular objection that Hempel's explicandum could not be the concept of strengthening evidence. It might be objected that Hempel's explicandum has been correctly identified by Carnap as being the dyadic concept of initially confirming evidence, a special case of the concept of confirming evidence (strengthening evidence, in my terminology). Carnap noted when commenting on Hempel's study of confirmation that Hempel had made no reference in either his discussion or in his examples to prior evidence. Carnap concludes from this that Hempel must have had in mind the dyadic concept of initial

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6He mentions this in "A Purely Syntactical Definition of Confirmation," The Journal of Symbolic Logic, 8 (1943), p. 122. This is the technical counterpart to "Studies", in which he mentions at one place that disconfirming evidence is evidence which weakens a hypothesis (p.4).

7"Studies", p. 4.

confirming evidence, rather than the triadic concept of confirming evidence. This dyadic concept refers to the situation in which the prior evidence is null. It refers, that is, to the highly idealized situation in which a hypothesis is first proposed and no relevant evidence is available. Carnap's view seems to be shared by a number of Hempel's critics who have argued that Hempel's endorsement of the methodological fiction, which enjoins that additional information must be excluded, shows that he was concerned with the concept of initially confirming evidence. H. G. Alexander, for example, remarked "... Hempel's concept of confirmation seems outrageous because he is considering the ideal situation in which our minds though well-stocked with concepts are tabulae rasae as far as facts are concerned." Alexander continued in a later paper with the comment that "... the paradoxes of confirmation are discussed by Hempel in those cases in which we consider the bearing of evidence E on hypothesis H in the absence of all prior knowledge," and thought that the situation which Hempel envisaged is "... so artificially simplified as to be of no relevance to the logic of scientific procedure." J. W. N. Watkins, in a similar vein, has contended that Hempel's endorsement of the methodological fiction constitutes a deliberate exclusion of background knowledge. The supposition that there is no background knowledge is not only unrealistic and strange, Watkins says, but also one for which no reason to submit to it has been given. Alan Musgrave has recently remarked that "Watkins has solved the paradox of confirmation by recognizing Hempel's 'methodological fiction' for what it is, namely, a fiction ..." The scientist is never in a position of having no information other than E, he adds. I. J. Good shares the view that Hempel is concerned to evaluate E with respect to H in the absence of empirical knowledge.

9See Logical Foundations, pp. 468 and 463.


11Alexander, "The Paradoxes of Confirmation - A Reply to Dr. Agassi," BJPS, 10(1959), pp. 231-2. Italics are in the original.


I do not find the argument of Carnap and the critics just quoted convincing. I shall first dispel the argument from Hempel's endorsement of the methodological fiction.

I suggest, that these critics have misconstrued the intent of methodological fiction. Hempel does not employ this fiction in order to indicate that he is interested in evidence acquired in the absence of all other information. The methodological fiction is simply an injunction to the effect that one should avoid presenting extraneous information along with an evidence report. He is concerned that additional information might make the evidence report appear paradoxical or perhaps mask the confirmatory value of that report completely. Hempel first argued in "Studies in the Logic of Confirmation" that extraneous (or additional) information could make a confirmatory report appear paradoxical. This claim has been the object of considerable contention. In a later publication\(^\text{15}\) he has argued that additional information could do more than simply make a confirmatory report appear paradoxical -- it could conceal the confirmatory value of an evidence report completely. The later discussion is clearer on the use of the methodological fiction. The evidence report 'c is a black crow and d is a non-black crow' does not confirm (according to his criterion) the hypothesis that all crows are black, although it has an obvious confirmatory component (according to his theory), namely, the report of c. The latter information is "buried" in an evidence report which has falsifying information, namely, the report of d. The methodological fiction only asserts that in order to evaluate the confirmatory value of an evidence report with respect to a hypothesis one must not include additional information along with that evidence report. In order to assess the confirmatory value of the report of the black crow c one would need to consider that report on its own, without other information which might make the report appear paradoxically confirmatory or mask the confirmatory value altogether. Hence Hempel's endorsement of the methodological fiction does not give grounds for construing Hempel's explicandum to be the concept of initially confirming evidence.

Moreover, Hempel has discussed at least one example which cannot be squared with the view that his explicandum is the concept of initially confirming evidence. In a more recent paper on confirmation he discusses the confirmation of the hypothesis 'All marbles in this bag are red' by the twenty marbles in the bag.\(^\text{16}\) Each of the marbles confirms the hypothesis, he says, and when each has been checked for


color, the hypothesis, has been exhaustively tested. Although this example is developed in connection with another point, it is obvious that Hempel's concept of confirmation is not the concept of initially confirming evidence. For after the first marble is checked and the second is about to be, it is clear that there is prior evidence. This does not prevent him from considering the second marble (or the report of it) as confirming evidence for the hypothesis. So although Carnap's comment that Hempel did not explicitly discuss prior evidence is correct, a closer examination of Hempel's studies shows that he was not concerned only with initially confirming evidence. It is true that this paper in which this example is discussed is one with which Carnap obviously did not have contact when writing Logical Foundations of Probability, but the general tenor of Hempel's earlier work on weak confirmation makes the claim that he was concerned only with initially confirming evidence implausible.17

It might be objected further that Hempel's explicandum must be some dyadic concept or other, since in all the conditions of adequacy, which express characteristics of the explicandum, the confirmation relation is dyadic. I shall illustrate this objection in connection with the entailment condition, which asserts that e confirms h if e entails h. The entailment condition is not even plausible as it stands for the triadic concept of confirming (strengthening) evidence, for if prior evidence b should entail h then, although e might entail h, it is absurd to hold that e strengthens h given b, i.e., that e makes h firmer than it was on just b.18 Can it be maintained in the face of this objection that Hempel's explicandum might have been the triadic concept of strengthening evidence? I will offer two possible explanations for the apparent fact that a confirmation theorist, while attempting to provide a criterion for the triadic concept of strengthening evidence, might have considered dyadic criteria for it.

First of all, perhaps these criteria have been seen as criteria for what I shall call the concept of potentially strengthening evidence, understood in the following way. Suppose that a hypothesis is proposed and strengthening evidence is sought. Whether or not a given report will

17Hempel discussed examples of confirmation in "Empirical Statements and Falsifiability," Philosophy, 33 (1958), involving an infinite number of instances (p. 345). Such a remark is difficult to square with the claim that his explicandum was the concept of initially confirming evidence.

actually strengthen a hypothesis will depend, in part, upon the prior evidence available at the time it is evaluated. The criteria under discussion might have been intended to pick out the evidence reports that are capable in principle of strengthening a hypothesis, provided the prior evidence is not of an inappropriate sort. In short, these criteria might have been intended to pick out evidence which is at least potentially strengthening evidence -- the sort of evidence which should be canvassed when searching for actual strengthening evidence. This concept would be dyadic, for reference to prior evidence would not be essential, and a criteria would need to refer only to $e$ and $h$. But the epistemological value and significance of such a concept seems marginal, for knowing that a given evidence report is potential strengthening evidence for a concept does not guarantee that that report will in fact make the hypothesis firmer than it is already on the prior evidence available when that report is brought to bear on the hypothesis. Although this explanation is possible, it does seem remote. Hempel certainly does not appear to construe 'confirm' in this way.

A second possible explanation is that the concept these criteria are intended for is the concept of strengthening evidence, but it is assumed that the prior evidence is not of the sort that can play a significant role in affecting the import of an evidence report with respect to a hypothesis. It perhaps is assumed, for example, that the prior evidence is neither falsifies $h$ nor establishes $h$ as certain, and so the criterion offered, while intended for the triadic concept, is applicable only under the two conditions specified. So a criterion for $e$ strengthens $h$ given $b$' is offered referring to only $e$ and $h$ since it is assumed that $b$ is not of the sort which will render $e$ otiose with respect to $h$. This strikes me as being the most plausible and perhaps most charitable explanation for the claim that Hempel attempts to provide a criterion for the triadic concept of strengthening evidence while searching among dyadic criteria.

There are a number of difficulties with this approach, if it in fact is that taken by Hempel and other theorists. In the first place, such an approach is strictly speaking inadequate since the criterion might classify an evidence report as strengthening evidence while it is not. In the second place, since the dyadic criterion is applicable only under appropriate conditions specified in an assumption, the details of this assumption must be supplied to make the criterion workable. I suggested in the preceding paragraph the kind of assumption about prior evidence that Hempel and others might be making is that the prior evidence neither falsifies nor renders certain the hypothesis. I

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19. Perhaps a criterion for the concept of initially strengthening evidence would serve also as a criterion for this concept. My interest here, however, is not in the adequacy or inadequacy of criteria.
I suggested in an earlier section, however, that there are theorists who have thought that an evidence report of a particular sort might finally exhaust its evidential value, even though the hypothesis upon which evidence is brought to bear has not been falsified or made certain by prior evidence. There might be yet other prior evidence conditions which nullify the effect of putative evidence. All of these conditions would have to be spelled out to make the criterion workable. In the third place, a dyadic criterion which ignored prior evidence would not serve as a helpful first step in developing a criterion for the quantitative form of the concept of strengthening evidence, for a criterion of the latter sort would have to take into account the effect of prior evidence. This objection perhaps is not as telling as it once might have been -- it seems that confirmation theorists are not very confident that a criterion for the quantitative form of the concept can be found.

IV

It is clear, then, that an adequate criterion of the concept of strengthening evidence requires a recognition of its triadic character. Criteria which fail to consider the effect of prior evidence can only be of marginal value, if of any value at all. We might admit that a given theory can be used to predict a certain event (which is found to occur) but before we can be assured that the predicted event strengthens the theory in question we will have to ascertain its effect on that theory in relation to prior evidence. Similarly, instances of a hypothesis might not always strengthen a hypothesis, for this will depend, in part, on the effect that prior evidence has already had on the hypothesis in question. And it might be clear that an evidence sentence satisfies a hypothesis, in accord with Hempel's criterion, but before we can assert that that evidence sentence strengthens the hypothesis we will have to judge its effect relative to the prior evidence that is available.

It seems to me that weak confirmation theorists have been laboring under an erroneous approach to their subject matter. They have discarded the early inductivist view, thoroughly discredited for some time now, that a hypothesis could be mechanically inferred (or generated) by instances or evidence reports, in favor of the view that a hypothesis could be evaluated for credibility by being confronted with instances or evidence reports isolated from the experimental context expressed in the statement of prior evidence. This latter position is in error too, an error that has been fostered by a preoccupation with an inductive logic in which the "logical relation" holds between two sentences. While a dyadic inductive logic might well have its place, e.g., in the study of 'to confirm' in the sense of 'to make firm', it must be recognized that the qualitative form of the concept of strengthening evidence requires a "logic" relating three discrete items, namely, a sentence
expressing a hypothesis, an evidence report, and a sentence expressing the prior evidence against which the effect of the evidence report upon the hypothesis is assessed. Until criteria take full account of the effect of prior evidence they will not be appropriate for the concept of strengthening evidence.

20 I recognize that a criterion for strengthening evidence might be outlined by securing a measure for the degree of firmness of x on y (f(x,y)), where e strengthens h given b if and only if f(h, e & b) ≥ f(h, b).

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