Problems and Changes in the Empiricist Criterion of Meaning

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1   Introduction

The fundamental tenet of modern empiricism is the view that all non-analytic knowledge is based on experience. Let us call this thesis the principle of empiricism.[1] Contemporary logical empiricism has added[2] to it the maxim that a sentence makes a cognitively meaningful assertion, and thus can be said to be either true or false, only if it is either (1) analytic or self-contradictory or (2) capable, at least in principle, of experiential test. According to this so-called empiricist criterion of cognitive meaning, or of cognitive significance, many of the formulations of traditional metaphysics and large parts of epistemology are devoid of cognitive significance—however rich some of them may be in non-cognitive import by virtue of their emotive appeal or the moral inspiration they offer. Similarly certain doctrines which have been, at one time or another, formulated within empirical science or its border disciplines are so contrived as to be incapable of test by any conceivable evidence; they are therefore qualified as pseudo- [42] hypotheses, which assert nothing, and which therefore have no explanatory or predictive force whatever. This verdict applies, for example, to the

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[1]This term is used by Benjamin, A. C., Is empiricism self-refuting? (Journal of Philos., vol. 38, 1941), in an examination of the foundations of empiricism. For a recent discussion of the basic ideas of empiricism see Russell, B., Human Knowledge, Simon and Schuster, New York, 1948, Part Six.

[2]In his stimulating article, Positivism, W. T. Stace argues, in effect, that the testability criterion of meaning is not logically entailed by the principle of empiricism. (See STACE, W. T., Positivism (Mind, vol. 53, 1944), especially section 11.) This is correct: According to the latter, a sentence expresses knowledge only if it is either analytic or corroborated by empirical evidence; the former goes further and identifies the domain of cognitively significant discourse with that of potential knowledge; i.e., it grants cognitive import only to sentences for which—unless they are either analytic or contradictory—a test by empirical evidence is conceivable.

neo-vitalist speculations about entelechies or vital forces, and to the "telefinalist hypothesis" propounded by Lecomte du Noüy.[3]

The preceding formulations of the principle of empiricism and of the empiricist meaning criterion provide no more, however, than a general and rather vague characterization of a basic point of view, and they need therefore to be elucidated and amplified. And while in the earlier phases of its development, logical empiricism was to a large extent preoccupied with a critique of philosophic and scientific formulations by means of those fundamental principles, there has been in recent years an increasing concern with the positive tasks of analyzing in detail the logic and methodology of empirical science and of clarifying and restating the basic ideas of empiricism in the light of the insights thus obtained. In the present article, I propose to discuss some of the problems this search has raised and some of the results it seems to have established.

2 Changes in the testability criterion of empirical meaning

As our formulation shows, the empiricist meaning criterion lays down the requirement of experiential testability for those among the cognitively meaningful sentences which are neither analytic nor contradictory; let us call them sentences with empirical meaning, or empirical significance. The concept of testability, which is to render precise the vague notion of being based—or rather baseable—on experience, has undergone several modifications which reflect an increasingly refined analysis of the structure of empirical knowledge. In the present section, let us examine the major stages of this development.

For convenience of exposition, we first introduce three auxiliary concepts, namely those of observation characteristic, of observation predicate, and of observation sentence. A property or a relation of physical objects will be called an observable characteristic if, under suitable circumstances, its presence or absence in a given instance can be ascertained [43] through direct observation. Thus, the terms "green", "soft", "liquid", "longer than", designate observable characteristics, while "bivalent", "radioactive", "better electric conductor", and "introvert" do not. Terms which designate observable characteristics will be called observation predicates. Finally, by an observation sentence we shall understand any sentence which—correctly or incorrectly—asserts of one or more specifically named objects that they have, or that they lack, some specified observable characteristic. The following sentences, for example, meet this condition: "The Eiffel Tower is taller than the buildings in its vicinity", "The pointer of this instrument does not cover the point marked '3' on the scale", and even, "The largest dinosaur on exhibit in New York's Museum of Natural History had a blue tongue"; for this last sentence assigns to a specified object a characteristic-having a blue

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[3]Cf. LECOMTE Du NOÜY, Human Destiny, New York, London, Toronto, 1947, Ch. XVI.

tongue-which is of such a kind that under suitable circumstances (e. g., in the case of my Chow dog) its presence or absence can be ascertained by direct observation. Our concept of observation sentence is intended to provide a precise interpretation of the vague idea of a sentence asserting something that is "in principle" ascertainable by direct observation, even though it may happen to be actually incapable of being observed by myself, perhaps also by my contemporaries, and possibly even by any human being who ever lived or will live. Any evidence that might be adduced in the test of an empirical hypothesis may now be thought of as being expressed in observation sentences of this kind.[4]

We now turn to the changes in the conception of testability, and thus of empirical meaning. In the early days of the Vienna Circle, a sentence was said to have empirical [44] meaning if it was capable, at least in principle, of complete verification by observational evidence; i. e., if observational evidence could be described which, if actually obtained, would conclusively establish the truth of the sentence.[5] With the help of the concept of observation sentence, we

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[4]Observation sentences of this kind belong to what Carnap has called the thing-language (cf., e. g., CARNAP, R., Logical foundations of the unity of science, In: Internat. Encyclopedia of Unified Science, 1, 1; Univ. of Chicago Press, 1938, pp. 52-53). That they are adequate to formulate the data which serve as the basis for empirical tests is clear in particular for the intersubjective testing procedures used in science as well as in large areas of empirical inquiry on the common-sense level. In epistemological discussions, it is frequently assumed that the ultimate evidence for beliefs about empirical matters consists in perceptions and sensations whose description calls for a phenomenalistic type of language. The specific problems connected with the phenomenalistic approach cannot be discussed here; but it should be mentioned that at any rate all the critical consideration presented in this article in regard to the testability criterion are applicable, mutatis mutandis, to the case of a phenomenalistic basis as well.

[5]Originally, the permissible evidence was meant to be restricted to what is observable by the speaker and perhaps his fellow-beings during their life times. Thus construed, the criterion rules out, as cognitively meaningless, all statements about the distant future or the remote past, as has been pointed out, among others, by Ayer, A. J., Language, Truth and Logic, Oxford Univ. Press, 1936; 2nd ed., Gollancz, London, 1946., Chapter 1; by Pap, A., Elements of Analytic Philosophy, The Macmillan Co., New York, 1949, Chapter 13, esp. pp. 333 ff.; and by Russell, B., Human Knowledge, Simon and Schuster, New York, 1948, pp. 445-447. This difficulty is avoided, however, if we permit the evidence to consist of any finite set of "logically possible observation data", each of them formulated in an observation sentence. Thus, e. g., the sentence S_1, ("The tongue of the largest dinosaur in New York's Museum of Natural History was blue or black" is completely verifiable in our sense; for it is a logical consequence of the sentence S_2, "The tongue of the largest dinosaur in New York's Museum of Natural History was blue"; and this is an observation sentence, as has been shown above.

And if the concept of verifiability in principle and the more general concept of confirmability in principle, which will be considered later, are construed as referring to logically possible evidence as expressed by observation sentences, then it follows similarly that the class of statements which are verifiable, or at least confirmable, in principle includes such assertions as that the planet Neptune and the Antarctic Continent existed before they were discovered, and that atomic warfare, if not checked, may lead to the extermination of this planet. The objections which Russell (cf. RUSSELL, B., Human Knowledge, Simon and Schuster, New York, 1948, pp. 445 and 447) raises against the verifiability criterion by reference to those examples do not apply therefore if the criterion is understood in the manner here suggested. Incidentally, statements of the kind mentioned by Russell, which are not actually verifiable by any human being, were explicitly recognized as cognitively

can restate this requirement as follows: A sentence S has empirical meaning if and only if it is possible to indicate a finite set of observation sentences, $O_1, O_2, \ldots, O_n$, such that if these, are true, then S is necessarily true, too. As stated, however, this condition is satisfied also if S is an analytic sentence or if the given observation sentences are logically incompatible with each other. By the following formulation, we rule these cases out and at the same time express the intended criterion more precisely: [45]

(2.1) *Requirement of complete verifiability in principle:* A sentence has empirical meaning if and only if it is not analytic and follows logically from some finite and logically consistent class of observation sentences.[6]

significant already by Schlick (in SCHLICK, M., Meaning and Verification (Philos. Review, vol. 45,1936). (Also reprinted in Feigl and Sellars, Readings in Philosophical Analysis, New York, 1949), Part V), who argued that the impossibility of verifying them was "merely empirical". The characterization of verifiability with the help of the concept of observation sentence as suggested here might serve as a more explicit and rigorous statement of that conception.

[6]As has frequently been emphasized in empiricist literature, the term "verifiability" is to indicate, of course, the conceivability, or better, the logical possibility of evidence of an observational kind which, if actually encountered, would constitute conclusive evidence for the given sentence; it is not intended to mean the technical possibility of performing the tests needed to obtain such evidence, and even less does it mean the possibility of actually finding directly observable phenomena which constitute conclusive evidence for that sentence—which would be tantamount to the actual existence of such evidence and would thus imply the truth of the given sentence. Analogous remarks apply to the terms "falsifiability" and "confirmability". This point has been disregarded in some recent critical discussions of the verifiability criterion. Thus, c. g., Russell (cf. RUSSELL, B., Human Knowledge, Simon and Schuster, New York, 1948, p. 448) construes verifiability as the actual existence of a set of conclusively verifying occurrences. This conception, which has never been advocated by any logical empiricist, must naturally turn out to be inadequate since according to it the empirical meaningfulness of a sentence could not be established without gathering empirical evidence, and moreover enough of it to permit a conclusive proof of the sentences in question! It is not surprising, therefore, that his extraordinary interpretation of verifiability leads Russell to the conclusion: "In fact, that a proposition is verifiable is itself not verifiable" (l[oc]. c[it].) Actually, under the empiricist interpretation of complete verifiability, any statement asserting the verifiability of some sentence S whose text is quoted, is either analytic or contradictory; for the decision whether there exists a class of observation sentences which entail S, i. e., whether such observation sentences can be formulated, no matter whether they are true or false—that decision is a matter of pure logic and requires no factual information whatever.

A similar misunderstanding is in evidence in the following passage in which W. H. Werkmeister claims to characterize a view held by logical positivists : "A proposition is said to he 'true' when it is 'verifiable in principle'; i. e., when we know the conditions which, when realized, will make 'verification' possible (cf. Ayer)." (cf. WERKMEISTER, W. H., The Basis and Structure of Knowledge, Harper, New York and London, 1948, p. 145). The quoted thesis, which, again, was never held by any logical positivist, including Ayer, is in fact logically absurd. For we can readily describe conditions which, if realized, would verify the sentence "The outside of the Chrysler Building is painted a bright yellow"; but similarly, we can describe verifying conditions for its denial; hence, according to the quoted principle, both the sentence and its denial would have to be considered true. Incidentally, the passage under discussion does not accord with Werkmeister's perfectly correct observation, l. c., p. 40, that verifiability is intended to characterize the meaning of a sentence—which shows that verifiability is meant to be

This criterion, however, has several serious defects. The [46] first of those here to be mentioned has been pointed out by various writers:

(a) The verifiability requirement rules out all sentences of universal form and thus all statements purporting to express general laws; for these cannot be conclusively verified by any finite set of observational data. And since sentences of this type constitute an integral part of scientific theories, the verifiability requirement must be regarded as overly restrictive in this respect. Similarly, the criterion disqualifies all sentences such as "For any substance there exists some solvent", which contain both universal and existential quantifiers (i. e., occurrences of the terms "all" and "some" or their equivalents); for no sentences of this kind can be logically deduced from any finite set of observation sentences.

Two further defects of the verifiability requirement do not seem to have been widely noticed:

(b) Suppose that S is a sentence which satisfies the proposed criterion, whereas N is a sentence such as "The absolute is perfect", to which the criterion attributes no empirical meaning. Then the alternation $S \vee N$ (i. e., the expression obtained by connecting the two sentences by the word "or"), likewise satisfies the criterion; for if S is a consequence of some finite class of observation sentences, then trivially $S \vee N$ is a consequence of the same class. But clearly, the empiricist criterion of meaning is not intended to countenance sentences of this sort. In this respect, therefore, the requirement of complete verifiability is too inclusive.

(c) Let "P" be an observation predicate. Then the purely existential sentence "$(\exists x)P(x)$" ("There exists at least one thing that has the property P") is completely verifiable, for it follows from any observation sentence (asserting of some particular object that it has the property P. But its denial, being equivalent to the universal sentence "$(x)\sim P(x)$" ("Nothing has the property P") is clearly not completely verifiable, as follows from comment (a) above. Hence, under the criterion (2.1), the denials of certain empirically–and thus cognitively-significant sentences–are empirically meaningless; and as they are neither analytic nor contradictory, they are cognitively meaningless. But however we may [47] delimit the domain of significant discourse, we shall have to insist that if a sentence falls within that domain, then so must its denial. To put the matter more explicitly: The sentences to be qualified as cognitively meaningful are precisely those which can be significantly said to be either true or false. But then, adherence to (2.1) would engender a serious dilemma, as is shown by the consequence just mentioned: We would either have to give up the fundamental logical principle that if a sentence is true or false, then its denial is false or true, respectively (and thus cognitively significant); or else, we must deny, in a manner reminiscent of the intuitionistic conception of logic and mathematics, that "$(x)\sim P(x)$" is logically equivalent to the negation of "$(\exists x)P(x)$". Clearly, the criterion (2.1), which has disqualified itself on several other counts, does not

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a criterion of cognitive significance rather than of truth.

warrant such drastic measures for its preservation; hence, it has to be abandoned.[7]

Strictly analogous considerations apply to an alternative criterion, which makes complete falsifiability in principle the defining characteristic of empirical significance. Let us formulate this criterion as follows: A sentence has empirical meaning if and only if it is capable, in principle, of complete refutation by a finite number of observational data; or, more precisely:

(2.2) *Requirement of complete falsifiability in principle:* A sentence has empirical meaning if and only if its denial is [48] not analytic and follows logically from some finite logically consistent class of observation sentences.[8]

This criterion qualifies a sentence as empirically meaningful if its denial satisfies the requirement of complete verifiability; as is to be expected, it is therefore inadequate on similar grounds as the latter:

(a) It rules out purely existential hypotheses, such as "There exists at least one unicorn", and all sentences whose formulation calls for mixed—i. e., universal and existential—quantification; for none of these can possibly be conclusively falsified by a finite number of observation sentences.

(b) If a sentence S is completely falsifiable whereas N is a sentence which is not, then their conjunction, $S \cdot N$ (i. e., the expression obtained by connecting the two sentences by the word "and") is completely falsifiable; for if the denial of S is entailed by some class of observation sentences, then the denial of $S \cdot N$ is, a fortiori, entailed by the same class. Thus, the criterion allows empirical significance to many sentences which an adequate empiricist criterion should rule out, such as, say "All swans are white and the absolute is perfect."

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[7]The arguments here adduced against the verifiability criterion also prove the inadequacy of a view closely related to it, namely that two sentences have the same cognitive significance if any set of observation sentences which would verify one of them would also verify the other, and conversely. Thus, e. g., under this criterion, any two general laws would have to be assigned the same cognitive significance, for no general law is verified by any set of observation sentences. The view just referred to must be clearly distinguished from a position which Russell examines in his critical discussion of the positivistic meaning criterion. It is "the theory that two propositions whose verified consequences are identical have the same significance" (RUSSELL, B., Human Knowledge, Simon and Schuster, New York, 1948, p. 448). This view is untenable indeed, for what consequences of a statement have actually been verified at a given time is obviously a matter of historical accident which cannot possibly serve to establish identity of cognitive significance. But I am not aware that any logical positivist ever subscribed to that "theory".

[8]The idea of using theoretical falsifiability by observational evidence as the "criterion of demarcation" separating empirical science from mathematics and logic on the one hand and from metaphysics on the other is due to K. Popper (cf. POPPER, K., Logik der Forschung, Springer, Wien, 1935. [Subsequently translated as The Logic of Scientific Discovery (revised) Harper Torchbook: 1965 in paperback.], section 1-7 and 19-24; also see POPPER, K., The Open Society and its Enemies, 2 vols., Routledge, London, 1945, vol. 11, pp., 282-285). Whether Popper would subscribe to the proposed restatement of the falsifiability criterion, I do not know.

(c) If *"P"* is an observation predicate, then the assertion that all things have the property *P* is qualified as significant, but its denial, being equivalent to a purely existential hypothesis, is disqualified (cf. (a)). Hence, criterion (2.2) gives rise to the same dilemma as (2.1).

In sum, then, interpretations of the testability criterion in terms of complete verifiability or of complete falsifiability are inadequate because they are overly restrictive in one direction and overly inclusive in another, and because both of them require incisive changes in the fundamental principles of logic.

Several attempts have been made to avoid these difficulties by construing the testability criterion as demanding merely a partial and possibly indirect confirmability of empirical hypotheses by observational evidence. [49]

(2.3) A formulation suggested by Ayer[9] is characteristic of these attempts to set up a clear and sufficiently comprehensive criterion of confirmability. It states, in effect, that a sentence *S* has empirical import if from *S* in conjunction with suitable subsidiary hypotheses it is possible to derive observation sentences which are not derivable from the subsidiary hypotheses alone.

This condition is suggested by a closer consideration of the logical structure of scientific testing; but it is much too liberal as it stands. Indeed, as Ayer himself has pointed out in the second edition of his book, Language, Truth, and Logic,[10] his criterion allows empirical import to any sentence whatever. Thus, e. g., if *S* is the sentence "The absolute is perfect", it suffices to choose as a subsidiary hypothesis the sentence "If the absolute is perfect then this apple is red" in order to make possible the deduction of the observation sentence "This apple is red," which clearly does not follow from the subsidiary hypothesis alone.[11] [50]

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[9]AYER, A. J., Language, Truth and Logic, Oxford Univ. Press, 1936; 2nd ed., Gollancz, London, 1946., Ch. I.—The case against the requirements of verifiability and of falsifiability, and favor of a requirement of partial confirmability and disconfirmability is very clearly presented also by Pap in PAP, A., Elements of Analytic Philosophy, The Macmillan Co., New York, 1949, Chapter 13.

[10]AYER, A. J., Language, Truth and Logic, Oxford Univ. Press, 1936; 2nd ed., Gollancz, London, 1946, 2d ed., pp. 11-12.

[11]According to Stace (cf. STACE, W. T., Positivism (Mind, vol. 53, 1944), p. 218), the criterion of partial and indirect testability, which he calls the positivist principle, presupposes (and thus logically entails) another principle, which he terms the Principle of Observable Kinds: "A sentence, in order to be significant, must assert or deny facts which are of a kind or class such that it is logically possible directly to observe some facts which are instances of that class or kind. And if a sentence purports to assert or deny facts which are of a class or kind such that it would be logically impossible directly to observe any instance of that class or kind, then the sentence is non-significant." I think the argument Stace offers to prove that this principle is entailed by the requirement of testability is inconclusive (mainly because of the incorrect tacit assumption that "on the transformation view of deduction", the premises of a valid deductive argument must be necessary conditions for the conclusion (l. c., p. 225)). Without pressing this point any further, I should like to add here a remark on the principle of observable kinds itself. Professor Stace does not say how we are to determine what "facts" a given sentence asserts or denies,

(2.4)   To meet this objection, Ayer has recently proposed a modified version of his testability criterion. The modification restricts, in effect, the subsidiary hypotheses mentioned in (2.3) to sentences which are either analytic or can independently be shown to be testable in the sense of the modified criterion.[12]

But it can readily be shown that this new criterion, like the requirement complete falsifiability, allows empirical significance to any conjunction $S \cdot N$, where S satisfies Ayer's criterion (2.3), while N is a sentence such as "The absolute is perfect," which is to be disqualified by that criterion. Indeed: whatever consequences can be deduced from S with the help of permissible subsidiary hypotheses can also be deduced from $S \cdot N$ by means of the same subsidiary hypotheses, and as Ayer's new criterion is formulated essentially in terms of the deducibility of a certain type of consequence from the given sentence, it countenances $S \cdot N$ together with S. Another difficulty has been pointed out by Professor A. Church, who has shown[13] that if there are any three observation sentences none of which alone entails any of the others, then it follows for any sentence S whatsoever that either it or its denial has empirical import according to Ayer's revised criterion.

3   Translatability into an empiricist language as a new criterion of cognitive meaning

I think it is useless to continue the search for an adequate criterion of testability in terms of deductive relationships to observation sentences. The past development of this search—of which we have considered the major stages—seems to warrant the expectation that as long as we try to set up a criterion of testability for individual sentences in a natural language, in terms of logical relationship to observation sentences, the result will be either too restrictive or too inclusive, [51] or both. In particular it appears likely that such criteria would allow empirical import, in the manner of (2.1) (b) or of (2.2) (b), either to any alternation or to any

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or indeed whether it asserts or denies any "facts" at all. Hence, the exact import of the principle remains unclear. No matter, however, how one might choose the criteria for the factual reference of sentences, this much seems certain: If a sentence expresses any fact at all, say f, then it satisfies the requirement laid down in the first sentence of the principle; for we can always form a class containing f together with the fact expressed by some observation sentence of our choice, which makes f a member of a class of facts at least one of which is capable, in principle, of direct observation. The first part of the principle of observable kinds is therefore all-inclusive, somewhat like Ayer's original formulation of the empiricist meaning criterion.

[12]This restriction is expressed in recursive form and involves no vicious circle. For the full statement of Ayer's criterion, see AYER, A. J., Language, Truth and Logic, Oxford Univ. Press, 1936; 2nd ed., Gollancz, London, 1946. [Subsequently in Dover paperback.] , 2d edition, p. 13.

[13]Church, A., Review of AYER, A. J., Language, Truth and Logic, Oxford Univ. Press, 1936; 2nd ed., Gollancz, London, 1946. [Subsequently in Dover paperback.], 2nd. ed. (The Journal of Symb. Logic, vol. 14, 1941), pp. 52-53).

conjunction of two sentences of which at least one is qualified as empirically meaningful; and this peculiarity has undesirable consequences because the liberal grammatical rules of English as of any other natural language countenance as sentences certain expressions ("The absolute is perfect" was our illustration) which even by the most liberal empiricist standards make no assertion whatever; and these would then have to be permitted as components of empirically significant statements.

The predicament would not arise, of course, in an artificial language whose vocabulary and grammar were so chosen as to preclude altogether the possibility of forming sentences of any kind which the empiricist meaning criterion is intended to rule out. Let us call any such language an empiricist language. This reflection suggests an entirely different approach to our problem: Give a general characterization of the kind of language that would qualify as empiricist, and then lay down the following

(3.1) *Translatability criterion of cognitive meaning:* A sentence has cognitive meaning if and only if it is translatable into an empiricist language.

This conception of cognitive import, while perhaps not explicitly stated, seems to underlie much of the more recent work done by empiricist writers; as far as I can see it has its origin in Carnap's essay, Testability and Meaning (especially part IV).

As any language, so also any empiricist language can be characterized by indicating its vocabulary and the rules determining its logic; the latter include the syntactical rules according to which sentences may be formed by means of the given vocabulary. In effect, therefore, the translatability criterion proposes to characterize the cognitively meaningful sentences by the vocabulary out of which they may be constructed, and by the syntactical principles governing their construction. What sentences are singled out as cognitively significant will depend, accordingly, on the choice of the vocabulary and of the construction rules. Let us consider a specific possibility: [52]

(3.2) We might qualify a language L as empiricist if it satisfies the following conditions:

(a) The vocabulary of L contains:

(1) The customary locutions of logic which are used in the formulation of sentences; including in particular the expressions "not", "and", "or", "if ... then ...", "all", "some", "the class of all things such that ...", "... is an element of class ...";

(2) Certain observation predicates. These will be said to constitute the basic empirical vocabulary of L;

(3) Any expression definable by means of those referred to under (1) and (2).

(b) The rules of sentence formation for L are those laid down in some contemporary logical system such as Principia Mathematica.

Since all defined terms can be eliminated in favor of primitives, these rules stipulate in effect that a language L is empiricist if all its sentences are expressible, with the help of the usual logical locutions, in terms of observable characteristics of physical objects. Let us call any language of this sort a thing-language in the narrower sense. Alternatively, the basic empirical vocabulary of an empiricist language might be construed as consisting of phenomenalistic terms, each of them referring to some aspect of the phenomena of perception or sensation. The construction of adequate phenomenalistic languages, however, presents considerable difficulties[14], and in recent empiricism, attention has been focussed primarily on the potentialities of languages whose basic empirical vocabulary consists of observation predicates; for the latter lend themselves more directly to the description of that type of intersubjective evidence which is invoked in the test of scientific hypotheses.

If we construe empiricist languages in the sense of (3.2), then the translatability criterion (3.1) avoids all of the short-comings pointed out in our discussion of earlier forms of the testability criterion [53]

(a) Our characterization of empiricist languages makes explicit provision for universal and existential quantification, i. e., for the use of the terms "all" and "some"; hence, no type of quantified statement is generally excluded from the realm of cognitively significant discourse;

(b) Sentences such as "The absolute is perfect" cannot be formulated in an empiricist language (cf. (d) below); hence there is no danger that a conjunction or alternation containing a sentence of that kind as a component might be qualified as cognitively significant;

(c) In a language L with syntactical rules conforming to Principia Mathematica, the denial of a sentence is always again a sentence of L. Hence, the translatability criterion does not lead to the consequence, which is entailed by both (2.1) and (2.2), that the denials of certain significant sentences are non-significant;

(d) Despite its comprehensiveness, the new criterion does not attribute cognitive meaning to all sentences; thus, e. g., the sentences "The absolute is perfect" and "Nothingness nothings" cannot be translated into an empiricist language because their key terms are not definable by means of purely logical expressions and observation terms.

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[14]Important contributions to the problem have been made by Carnap, R., Der logische Aufbau der Welt, Berlin, 1928. [Subsequently translated by Rolf A. George as The Logical Structure of the World (Univ. of California Press: 1967); paperback in 1969.] and by Goodman, N., The Structure of Appearance, To be published soon, probably by Harvard University Press. [Harvard: 1951; second edition, Bobbs-Merrill: 1966 in paperback.].

4   The problem of disposition terms and of theoretical constructs

Yet, the new criterion is still too restrictive—as are, incidentally, also its predecessors—in an important respect which now calls for consideration. If empiricist languages are defined in accordance with (3.2), then, as was noted above, the translatability criterion (3.1) allows cognitive import to a sentence only if its constitutive empirical terms are explicitly definable by means of observation predicates. But as we shall argue presently, many terms even of the physical sciences are not so definable; hence the criterion would oblige us to reject, as devoid of cognitive import, all scientific hypotheses containing such terms—an altogether intolerable consequence.

The concept of temperature is a case in point. At first glance, it seems as though the phrase "Object x has a temperature of c degrees centigrade", or briefly "$T(x) = c$" could [54] be defined by the following sentence, (D): $T(x) = c$ if and only if the following condition is satisfied: If a thermometer is in contact with x, then it registers c degrees on its scale.

Disregarding niceties, it may be granted that the definiens given here is formulated entirely in reference to observables. However, it has one highly questionable aspect: In Principia Mathematica and similar systems, the premise "if p then q" is construed as being synonymous with "not p or q"; and under this so-called material interpretation of the conditional, a statement of the form "if p then q" is obviously true if (though not only if) the sentence standing in the place of "p" is false. If, therefore, the meaning of "if ... then ..." in the definiens of (D) is understood in the material sense, then that definiens is true if (though not only if) x is an object not in contact with a thermometer—no matter what numerical value we may give to c. And since the definiendum would be true under the same circumstances, the definition (D) would qualify as true the assignment of any temperature value whatsoever to any object not in contact with a thermometer! Analogous considerations apply to such terms as electrically charged", "magnetic", "intelligent", "electric resistance", etc., in short to all disposition terms, i. e., terms which express the disposition of one or more objects to react in a determinate way under specified circumstances: A definition of such terms by means of observation predicates can not be effected in the manner of (D), however natural and obvious a mode of definition this may it first seem to be.[15]

There are two main directions in which a resolution of the difficulty might be sought. On the one hand, it could be argued the definition of disposition terms in the manner of (D) is perfectly adequate provided that the phrase "if...then..." in the definiens is construed in the sense it is obviously intended to have, namely as implying, in the else of (D), that even if x is not actually in contact with a thermometer, still if it were in such contact, then the

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[15]This difficulty in the definition of disposition terms was first pointed out and analyzed by Carnap (in CARNAP, R., Testability and meaning (Philos. of Science, vol. 3, 1936, and vol. 4, 1937); see esp. section 7).

thermometer would register c degrees. In sentences such as this, the phrase "if... then..." is said to be used counterfactually; and it is in this strong" sense, which implies a counterfactual conditional, [55] that the definiens of (D) would have to be construed. This suggestion would provide an answer to the problem of defining disposition terms if it were not for the fact that no entirely satisfactory account of the exact meaning of counterfactual conditionals seems to be available at present. Thus, the first way out of the difficulty has the status of a program rather than that of a solution. The lack of an adequate theory of counterfactual conditionals is all the more deplorable as such a theory is needed also for the analysis of the concept of general law in empirical science and of certain related ideas. A clarification of this cluster of problems constitutes at present one of the urgent desiderata in the logic and methodology of science.[16]

An alternative way of dealing with the definitional problems raised by disposition terms was suggested, and developed in detail, by Carnap. It consists in permitting the introduction of new terms, within an empiricist language, by means of so-called reduction sentences, which have the character of partial or conditional definitions.[17] Thus, e. g., the concept of temperature in our last illustration might be introduced by means of the following reduction sentence, (R): If a thermometer is in contact with an object x, then $T(x) = c$ if and only if the thermometer registers c degrees.

This rule, in which the conditional may be construed in the material sense, specifies the meaning of "temperature", i. e., of statements of the form "$T(x) = c$", only partially, namely in regard to those objects which are in contact with a thermometer; for all other objects, it simply leaves the meaning of "$T(x) = c$" undetermined. The specification of the meaning [56] of "temperature" may then be gradually extended to cases not covered in (R) by laying down further reduction sentences, which reflect the measurement of temperature by devices other

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[16]The concept of strict implication as introduced by C. I. Lewis would be of no avail for the interpretation of the strong "if... then..." as here understood, for it refers to a purely logical relationship of entailment, whereas the concept under consideration will, in general, represent a nomological relationship, i. e., one based on empirical laws. For recent discussions of the problems of counterfactuals and laws, see Langford, C. H., Review in The Journal of Symb. Logic, vol. 6 (1941), pp. 67-68.; Lewis, C. I., An Analysis of Knowledge and Valuation, Open Court Publ., La Salle, Ill., 1946, pp. 210-230; Chisholm, R. M., The contrary-to-fact conditional (Mind, vol. 55, 1946); Goodman, N., The problem of counterfactual conditionals (Journal of Philos., vol. 44, 1947); Reichenbach, H., Elements of Symbolic Logic, The Macmillan Co., New York, 1947, Chapter VIII; Hempel, C.G. and Oppenheim, P., Studies in the logic of explanation (Philos. of Science, vol. 15, 1948). [Subsequently reprinted in Feigl, H., & Brodbeck, M., (eds.), Readings in the Philosophy of Science (Appleton-Century-Crofts, Inc.: 1953.] [63] , Part 111; Popper, K., A note on natural laws and so-called "contrary-to-fact conditionals" (Mind, vol. 58, 1949).

[17]Cf. Carnap, R., Testability and meaning (Philos. of Science, vol. 3, 1936, and vol. 4, 1937); a brief elementary exposition of the central idea may be found in Carnap, R., Logical foundations of the unity of science, In: Internat. Encyclopedia of Unified Science, 1, 1; Univ. of Chicago Press, 1938, Part III. The partial definition (R) formulated above for the expression "$T(x) = c$" illustrates only the simplest type of reduction sentence, the so-called bilateral reduction sentence.

than thermometers.

Reduction sentences thus provide a means for the precise formulation of what is commonly referred to as operational definitions.[18] At the same time, they show that the latter are not definitions in the strict sense of the word, but rather partial specifications of meaning.

The preceding considerations suggest that in our characterization (3.2) of empiricist languages we broaden the provision (a 3) by permitting in the vocabulary of L all those terms whose meaning can be specified in terms of the basic empirical vocabulary by means of definitions or reduction sentences. Languages satisfying this more inclusive criterion will be referred to as thing-languages in the wider sense.

If the concept of empiricist language is broadened in this manner, then the criterion (3.1) covers—as it should—also all those statements whose constituent empirical terms include "empirical constructs", i. e., terms which do not designate observables, but which can be introduced by reduction sentences on the basis of observation predicates. Even in this generalized version, however, our criterion of cognitive meaning may not do justice to advanced scientific theories, which are formulated in terms of "theoretical constructs", such as the terms "absolute temperature", "gravitational potential", "electric field", "ψ-function", etc. There are reasons to think that neither definitions nor reduction sentences are, adequate to introduce these terms on the basis of observation predicates. Thus, e. g., if a system of reduction sentences for the concept of electric field were available, then—to oversimplify the point a little—it would be possible to describe, in term of observable characteristics, some necessary and some sufficient conditions for the presence, in any given region, of an electric field of any mathematical description, however complex. Actually, however, such criteria can at best be given only for some sufficiently simple kinds of fields. [57]

Now theories of the advanced type here referred to may be considered as hypothetico-deductive systems in which all statements are logical consequences of a set of fundamental assumptions. Fundamental as well as derived statements in such a system are formulated either in terms of certain theoretical constructs which are not defined within the system and thus play the role of primitives, or in terms of expressions defined by means of the latter. Thus, in their logical structure such systems equal the axiomatized uninterpreted systems studied in mathematics and logic. They acquire applicability to empirical subject matter, and thus the status of theories of empirical science, by virtue of an empirical interpretation. The latter is effected by a translation of some of the sentences of the theory—often derived rather than fundamental ones—into an empiricist language, which may contain both obser-

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[18]On the concept of operational definition, which was developed by Bridgman, see, for example, Bridgman, P. W., The Logic of Modern Physics, The Macmillan Co., New York, 927, BRIDGMAN, P. W., Operational analysis (Philos. of Science, vol. 5, 1938), and Feigl, H., Operationism and scientific method (Psychol. Review, vol. 52, 1945). (Also reprinted in Feigl and Sellars, Readings in Philosophical Analysis, New York, 1949.).

vation predicates and empirical constructs. And since the sentences which are thus given empirical meaning are logical consequences of the fundamental hypotheses of the theory, that translation effects, indirectly, a partial interpretation of the latter and of the constructs in terms of which they are formulated.[19]

In order to make translatability into an empiricist language an adequate criterion of cognitive import, we broaden therefore the concept of empiricist language so as to include thing-languages in the narrower and in the wider sense as well as all interpreted theoretical systems of the kind just referred to.[20] With this understanding, (3.1) may finally serve as a general criterion of cognitive meaning. [58]

5   On "the meaning" of an empirical statement

In effect, the criterion thus arrived at qualifies a sentence as cognitively meaningful if its non-logical constituents refer, directly or in certain specified indirect ways, to observables. But it does not make any pronouncement on what "the meaning" of a cognitively significant sentence is, and in particular it neither says nor implies that that meaning can be exhaustively characterized by what the totality of possible tests would reveal in terms of observable phenomena. Indeed, the content of a statement with empirical import cannot, in general, be exhaustively expressed by means of any class of observation sentences.

For consider first, among the statements permitted by our criterion, any purely existential hypothesis or any statement involving mixed quantification. As was pointed out earlier, under (2.2) (a), statements of these kinds entail no observation sentences whatever; hence their content cannot be expressed by means of a class of observation sentences.

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[19]The distinction between a formal deductive system and the empirical theory resulting from it by an interpretation has been elaborated in detail by Reichenbach in his penetrating studies of the relations between pure and physical geometry; cf., e. g., Reichenbach, H., Philosophic der Raum-Zeit-Lehre, Berlin, 1928. The method by means of which a formal system is given empirical content is characterized by Reichenbach as "coordinating definition" of the primitives in the theory by means of specific empirical concepts. As is suggested by our discussion of reduction and the interpretation of theoretical constructs, however, the process in question may have to be construed as a partial interpretation of the non-logical terms of the system rather than as a complete definition of the latter in terms of the concepts of a thing-language.

[20]These systems have not been characterized here as fully and as precisely as would be desirable. Indeed, the exact character of the empirical interpretation of theoretical constructs and of the theories in which they function is in need of further investigation. Some problems which arise in this connection—such as whether, or in what sense, theoretical constructs may be said to denote—are obviously also of considerable epistemological interest. Some suggestions as to the interpretation of theoretical constructs may be found in Carnap, R., Foundations of logic and mathematics. Internal. Encyclopedia of Unified Science, 1, 3; Univ. of Chicago Press, 1939, section 24. and in Kaplan, A., Definition and specification of meaning (Journal of Philos., vol. 43, 1946); for an excellent discussion of the epistemological aspects of the problem, see Feigl, H., "Existential hypotheses; realistic vs. interpretations," (Philos. of Science, vol. 17, 1950)..

And secondly, even most statements of purely universal form (such as "All flamingoes are pink") entail observation sentences (such as "That thing is pink") only when combined with suitable observation sentences (such as "That thing is a flamingo").

This last remark can be generalized: The use of empirical hypotheses for the prediction of observable phenomena requires, in practically all cases, the use of subsidiary empirical hypotheses.[21] Thus, e. g., the hypothesis that the agent of tuberculosis is rod-shaped does not by itself entail the consequence that upon looking at a tubercular sputum specimen through a microscope, rod-like shapes will be observed: a large number of subsidiary hypotheses, including the theory [59] of the microscope, have to be used as additional premises in deducing that prediction.

Hence, what is sweepingly referred to as "the (cognitive) meaning" of a given scientific hypothesis cannot be adequately characterized in terms of potential observational evidence alone, nor can it be specified for the hypothesis taken in isolation: In order to understand "the meaning" of a hypothesis within an empiricist language, we have to know not merely what observation sentences it entails alone or in conjunction with subsidiary hypotheses, but also what other, non-observational, empirical sentences are entailed by it, what sentences in the given language would confirm or disconfirm it, and for what other hypotheses the given one would be confirmatory or disconfirmatory. In other words, the cognitive meaning of a statement in an empiricist language is reflected in the totality of its logical relationships to all other statements in that language and not to the observation sentences alone. In this sense, the statements of empirical science have a surplus meaning over and above what can be expressed in terms of relevant observation sentences.[22]

6   The logical status of the empiricist criterion of meaning

What kind of a sentence, it has often been asked, is the empiricist meaning criterion itself? Plainly it is not an empirical hypothesis; but it is not analytic or self-contradictory either; hence, when judged by its own standard, is it not devoid of cognitive meaning? In that case, what claim of soundness or validity could possibly be made for it?

One might think of construing the criterion as a definition which indicates what empiricists propose to understand by a cognitively significant sentence; thus understood, it would not have the character of an assertion and would be neither true nor false. But this conception would attribute to the criterion a measure of arbitrariness which cannot be reconciled

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[21]This point is clearly taken into consideration in Ayer's criteria of cognitive significance, which were discussed in section 2.

[22]For a fuller discussion of the Issues here involved cf. Feigl, H., "Existential hypotheses; realistic vs. interpretations," (Philos. of Science, vol. 17, 1950), and the comments on Feigl's position which will be published together with that article.

with the heated controversies it has engendered and even less with the fact, repeatedly illustrated in the present article, that the changes in its specific content have always been [60] determined by the objective of making the criterion a more adequate index of cognitive import. And this very objective illuminates the character of the empiricist criterion of meaning: It is intended to provide a clarification and explication of the idea of a sentence which makes an intelligible assertion.[23] This idea is admittedly vague, and it is the task of philosophic explication to replace it by a more precise concept. In view of this difference of precision we cannot demand, of course, that the "new" concept, the explicatum, be strictly synonymous with the old one, the explicandum.[24] How, then, are we to judge the adequacy of a proposed explication, as expressed in some specific criterion of cognitive meaning?

First of all, there exists a large class of sentences which are rather generally recognized as making intelligible assertions, and another large class of which this is more or less generally denies. We shall have to demand of an adequate explication that it take into account these spheres of common usage; hence an explication which, let us say, denies cognitive import to descriptions of past events or to generalizations expressed in terms of observables has to be rejected as inadequate. As we have seen, this first requirement of adequacy has played an important role in the development of the empiricist meaning criterion.

But an adequate explication of the concept of cognitively significant statement must satisfy yet another, even more important, requirement: Together with the explication of certain other concepts, such as those of confirmation and of probability, it has to provide the framework for a general theoretical account of the structure and the foundations of scientific knowledge. Explication, as here understood, is not a mere description of the accepted usages of the terms under [61] consideration: it has to go beyond the limitations, ambiguities, and inconsistencies of common usage and has to show how we had better construe the meanings of those terms if we wish to arrive at a consistent and comprehensive theory of knowledge. This type of consideration, which has been largely influenced by a study of the structure of scientific theories, has prompted the more recent extensions of the empiricist meaning

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[23]In the preface to the second edition of his book, Ayer takes a very similar position: be holds that the testability criterion is a definition which, however, is not entirely arbitrary, because a sentence which did not satisfy the criterion "would not be capable of being understood in the sense in which either scientific hypotheses or commonsense statements are habitually Understood" (AYER, A. J., Language, Truth and Logic, Oxford Univ. Press, 1936; 2nd ed., Gollancz, London, 1946., p. 16).

[24]Cf. Carnap's characterization of explication in his article, CARNAP, R., The two concepts of probability (Philos. and Phenom. Research, vol. 5, 1945), which examines in outline the explication of the concept of probability. [Boardman's note: See Carnap's discussion of "explication" from his Logical Foundations of Probability (1950).] The Frege-Russell definition of integers as classes of equivalent classes, and the semantical definition of truth—cf. Tarski, A., The semantic conception of truth and the foundations of semantics (Philos. and Phenom. Research, vol. 4, 1944) (Also reprinted in Feigl and Sellars, Readings in Philosophical Analysis, New York, 1949.)—are outstanding examples of explication. For a lucid discussion of various aspects of logical analysis see Pap, A., Elements of Analytic Philosophy, The Macmillan Co., New York, 1949, Chapter 17.

criterion. These extensions are designed to include in the realm of cognitive significance various types of sentences which might occur in advanced scientific theories, or which have to he admitted simply for the sake of systematic simplicity and uniformity,[25] but on whose cognitive significance or non-significance a study of what the term "intelligible assertion" means in everyday discourse could hardly shed any light at all.

As a consequence, the empiricist criterion of meaning, like the result of any other explication, represents a linguistic proposal which itself is neither true nor false, but for which adequacy is claimed in two respects: First in the sense that the explication provides a reasonably close analysis of the commonly accepted meaning of the explicandum—and this claim implies an empirical assertion; and secondly in the sense that the explication achieves a "rational reconstruction" of the explicandum, i. e., that it provides, together perhaps with other explications, a general conceptual framework which permits a consistent and precise restatement and theoretical systematization of the contexts in which the explicandum is used—and this claim implies at least an assertion of a logical character.

Though a proposal in form, the empiricist criterion of meaning is therefore far from being an arbitrary definition; it is subject to revision if a violation of the requirements of adequacy, or even a way of satisfying those requirements more fully, should be discovered. Indeed, it is to be hoped that [62] before long some of the open problems encountered in the analysis of cognitive significance will be clarified and that then our last version of the empiricist meaning criterion will be replaced by another, more adequate one.

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[25]Thus, e. g., our criterion qualifies as significant certain statements containing, say, thousands of existential or universal quantifiers-even though such sentences may never occur in every-day nor perhaps even in scientific discourse. For indeed, from a systematic point of view it would be arbitrary and unjustifiable to limit the class of significant statements to those containing no more than some fixed number of quantifiers. For further discussion of this point, cf. Carnap, R., Testability and meaning (Philos. of Science, vol. 3, 1936, and vol. 4, 1937), sections 17, 24, 25.

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