The Contrary-to-Fact Conditional

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I.—THE CONTRARY-TO-FACT CONDITIONAL.[1]

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I.

A significant part of our knowledge is usually expressed in subjunctive and "contrary-to-fact" conditional statements. We seem to have knowledge of what *might* have happened, of what *would* happen if certain conditions were realized, of what tendencies, faculties, or potentialities an object *could* manifest in suitable environments. And this, most of us would be inclined to say, is valid and significant, even though the possible events to which it seems to pertain may never become actual. The type of statement in which this knowledge is usually formulated, however, appears to have been by-passed by contemporary logic; for the theories of generality, implication, and "statement composition", as they have been developed in recent years, seem to concern only indicative statements and to make no adequate provision for what we usually express in the subjunctive. Our problem here is to determine whether there is any other means of expressing this important counter-factual information. As we shall see, the philosophical problems which this question involves are fundamental to metaphysics, epistemology, and the general philosophy of science.

Many contrary-to-fact conditionals are not expressed in the subjunctive mood and many conditionals which are expressed in this mood are not actually contrary-to-fact, but in the present

[1] I am much indebted to W. V. Quine, with whom I have discussed this question at length. He should not be held responsible, however, for any of my remarks.

discussion we may use the labels "subjunctive conditional" and "contrary-to-fact conditional" interchangeably. Neither term is adequate, but each has been used in recent literature. The essential characteristics of this important type of statement will be more clearly delineated as we proceed.

There is a variety of types of situation where the use of the contrary-to-fact conditional appears to be the most natural means of expressing what we claim to know. First of all, of course, there are those occasions where we assert a conditional statement, knowing or believing its antecedent to be false. I may contend, for example, that had we followed a different policy toward Germany in the 1920's, the second World War would not have occurred. If this contention is correct, it must be considered, along with all other true and relevant opinions, in any reasonable discussion of contemporary policy. In general, it may be said that adequate understanding of science and history requires the ability to consider the consequences of hypotheses known to be contrary-to-fact. In the study of anatomy, for instance, it would be difficult to assess the importance of an organ or function unless we were able to conceive what would happen if that organ or function did not exist. In physics it is necessary to be able to conceive of states of affairs which, in all likelihood, will never become actual. Thus Galileo, as is well known, founded his dynamics upon the conception of a body moving without the influence of any external force. Examples of this sort may be readily multiplied.[1]

Equally important, from the point of view of knowledge, are those subjunctive conditionals which we assert, not knowing whether the antecedents are true or false. C. I. Lewis has emphasized that it is only by means of such conditionals that we can adequately express the reasons behind our precautionary activity; it is essential for a being who is active that "there should be 'If—then—' propositions whose truth or falsity is independent of the truth or falsity of the condition stated in their antecedent clauses".[2] I try to avoid falling through the ice because I believe that if I were to fall I should get wet. Since I believe the conditional to be true, I endeavour to prevent the realization of the conditions mentioned in the antecedent.

[1] *Cf.* Ch. V, "Facts and Ideals", *An Essay on Man,* by Ernst Cassirer; M. R. Cohen, *Reason and Nature*, p. 69; C. G. Hempel, "Studies in the Logic of Confirmation", MIND, Vol. LIV, No.'s 213 and 214 (1945), esp. p. 16.

[2] C. I. Lewis, *Mind and the World Order*, p. 142; *cf.* pp. 140-142, 182-183. *Cf.* the same author's "Meaning and Action", *Journal of Philosophy,* Vol. XXXVI, No. 21. *Cf.* F. H. Bradley, *Logic,* Part I, Ch. II.

Bradley's " All trespassers will be prosecuted " is a further example: what this intends to convey is that if anyone were to trespass he would be prosecuted—and the message is usually posted conspicuously in order to insure that it remain contrary-to-fact.

Still another use of this type of conditional is what has been called its " deliberative use ".[1] When we prepare for a crucial experiment, we review the situation and consider what would happen if our hypothesis were true and what would happen if it were false. The subjunctive conditional is essential to the expression of these deliberations. In defending a hypothesis, I may employ a subjunctive conditional even though I believe the antecedent to be true ; I may say, " If this were so, that would be so ; but, as you see, this *is* so. . . ." It is said that detectives talk in this manner. Whenever we modify our conditional assertions " for the sake of argument ", withholding commitment concerning the truth or falsity of their antecedents, we find ourselves falling into the subjunctive.[2] Similarly, in order to falsify a theory or reduce it to absurdity, we must be able to consider its consequences in a conditional, the component truth-values of which we deliberately ignore and which, therefore, we should normally express in the subjunctive.[3]

This type of conditional is implicit in the use of what Broad and Carnap have called " dispositional adjectives " or " disposition terms "—terms such as " malleable ", " fragile ", " soluble " and so on—which are used when we want to refer to the dispositions or potentialities of a thing.[4] Broad has pointed out that " whenever we conjoin a dispositional adjective to a substantive we are expressing in a categorical form a hypothetical proposition of the following kind. ' If this *were* in a certain state, and *were* in certain relations to certain other things of certain specified kinds, then certain events of a specific kind *would* happen either in it or in one of these other things ' ".[5] To say that a thing is fragile, for instance, is to say that if certain conditions were realized it would break. To say that an acorn is potentially an oak is to say at least that, under certain conditions which may or may not become actual, it would grow into an oak. This potentiality increases with the likelihood of the conditions being realized.

[1] Roderick Firth, *Sense-Data and the Principle of Reduction*, Ph.D. Thesis, Harvard University Library, 1943, ch. VII.

[2] *Ibid.*

[3] *Cf.* Bertrand Russell, *Introduction to Mathematical Philosophy*, p. 161.

[4] C. D. Broad, *Examination of McTaggart's Philosophy*, Vol. I, pp. 148 ff.; R. Carnap, " Testability and Meaning ", *Philosophy of Science*, Vol. 3, No. 4 (1936), pp. 419-471, and Vol. 4, No. 1 (1937), pp. 1-40.

[5] *Op. cit.* p. 149. Italics mine.

To say that an individual is predisposed toward psychoneurosis is to say that under certain conditions he would become neurotic and possibly also that under those conditions a normal individual would not become neurotic. This notion of " disposition " is central to the ancient philosophical questions concerning possibility and potentiality.

There are many other important philosophical theories whose central tenets depend upon the admissibility of what is formulated in the contrary-to-fact conditional. Four instances may be cited from contemporary philosophy. (1) The phenomenalist maintains that, apart from those sense-data which are objects of actual experience, the ultimate constituents of the universe are what H. H. Price has called " hypothetical sense-impressions ", sense-data which *would* become actual if certain other sense-data *were* to become actual. Indeed, Price notes that " the phrase ' hypothetical sense-impression ', in fact, is just an abbreviation for a hypothetical *statement* of the form: if so and so were the case, such and such a sort of sense-impression would exist ".[1] (2) The essence of pragmatism, as well as of " realism ", according to C. S. Peirce, is to make " the ultimate import of what you please to consist in conceived conditional resolutions, or their substance ".[2] These conditional resolutions are formulated in subjunctive conditionals which state what the " real generals " of the universe " *would* or might (not actually *will*) come to in the concrete ".[3] (3) Much of contemporary analytic philosophy seems also to involve these conditionals, although somewhat less explicitly. The subject-matter of this philosophy comprises statements or sentences, so that a philosophical assertion may be a statement such as " The scientist compares his hypothesis with the protocol statements ". Inasmuch as many, if not most, of the statements thus mentioned, are never actually uttered, discussion of them seems to presuppose an implicit use of the subjunctive (concerning what the scientist *would* state if he *were* to formulate his observations, etc.). Thus Carnap tells us that, implied in his notion of " protocol statement ", is " a simplification of actual scientific procedure *as if* all experiences, perceptions, . . . etc., . . . *were* first recorded in writing as ' protocol ' to provide the raw material for a subsequent organization ".[4] (4) Finally it is significant to note the extent to which those logicians who have not explicitly sanctioned the use of such

[1] H. H. Price, *Hume's Theory of the External World*, p. 179. *Cf.* A. J. Ayer, *Language, Truth and Logic*, pp. 75 ff., esp. p. 78; *The Foundations of Empirical Knowledge*, Ch. V.

[2] C. S. Peirce, *Collected Papers*, 5. 453.

[3] *Ibid.* 6. 485. Peirce's italics. *Cf.* 5. 526, 5. 517, 3. 526 ff.

[4] R. Carnap, *The Unity of Science*, p. 43. My italics.

conditionals are apparently unable to avoid falling into that mode of speech in the formulation of crucial points in the logic of science.[1]

It is clear, then, that the subjunctive or contrary-to-fact conditional seems to be required for the formulation of important assertions which are constantly made in philosophy, science, and ordinary discourse. Although there is extreme difficulty involved in analysing the meaning of these assertions, we are not thereby justified in dismissing counter-factual questions as " pseudo-problems " or in concluding that the contrary-to-fact conditional does not say anything.[2] We may agree with Broad that the distinction between what will be and what would be must in some sense " correspond to something real " and that philosophy cannot afford to ignore it.[3] In the present paper, I shall try to make some progress toward clarifying and solving this problem.

II.

Our problem is to render a subjunctive conditional of the form, " $(x)(y)$ if x were ϕ and y were ψ, y would be χ ", into an indicative

[1] Instances may be drawn from the writings of the logicians referred to thus far who fit in this category. Carnap, " Testability and Meaning " : " If we knew what it *would* be for a given sentence to be found true then we *would* know what its meaning is. . . . We call it [a sentence] *confirmable* if we know under what conditions the sentence *would* be confirmed. . . . A sentence may be confirmable without being testable ; *e.g.* if we know that our observation of such and such a course of events *would* confirm the sentence, and such and such a different course *would* confirm its negation without knowing how to set up either this or that observation ". (pp. 420-421). Carnap takes " observable " and " realizable " as basic descriptive terms in his theory of empiricism (p. 454). Like " confirmable " and " testable " these are disposition terms and thus may be said to furnish abbreviations for subjunctive conditionals.

Hempel, *op. cit.* p. 109 ; " The concept of the development of a hypothesis H, for a finite class of individuals, C, can be defined [as] what H *would* assert if there existed exclusively those objects which are elements of C ". *Cf.* also pp. 2, 25.

Russell, *Inquiry into Meaning and Truth,* pp. 278-279. An " unexperienced percept " is what " *would* verify ' ϕa ' if we could assert ' ϕa '. But we cannot assert it. . . ." *Cf.* also pp. 250, 281, 320, 350.

The italics in the above quotations are mine.

[2] *Cf.* E. Mach, *Die Mechanik in ihrer Entwickelung,* 1st ed., p. 216. Mach held that it is always invalid to argue on the basis of an assertion about what-would-have-happened-if. It is of historical interest to note Russell's early repudiation of Mach's view in *The Principles of Mathematics,* pp. 492-493. A recent dismissal of counter-factual questions as " pseudo-problems " occurs in a review by Robert Eisler, of *The Philosophy of Bertrand Russell, Hibbert Journal,* Vol. XLIII, No. 3, p. 283.

[3] *Op. cit.* Vol. I, p. 264.

statement which will say the same thing. Some subjunctive conditionals are simpler, *e.g.* they may be of the form, "(x) if x were ϕ, x would be ψ", or "if a were ϕ, a would be ψ" (where "a" represents a proper name); and some are more complex. But we shall find that the problem is the same in principle, whatever the complexity of the conditional. Like Russell in his theory of descriptions, we want to find a new way of saying something—in this case, in order to assure ourselves that we *can* restate what we ordinarily express in subjunctive conditionals. The problem is epistemological and metaphysical, as well as logical and linguistic; we want to know what it is, if anything, that we have to assume about the universe if we are to claim validity for our counter-factual knowledge.

There appears to be no problem connected with those subjunctive conditionals which are logically true (*e.g.* "If wishes were horses, wishes would be horses") or those which are analytic (*e.g.*, "If that animal were a quadruped, it would have four legs"). Hence, in what follows, all reference to subjunctive or contrary-to-fact conditionals should be understood to intend only those which are not analytic or logically true. Similarly, any reference to statements or to specific types of statement should be understood to intend only *indicative* non-counter-factual statements, unless qualification is made. At the present stage of the discussion we shall leave undecided the question whether statements name (or, in any sense, refer to) propositions.

The simplest methods of translating these conditionals are clearly inadequate. Consider this example: "If the vase were dropped to the floor, it would break". Is an adequate translation yielded by replacing the 'were' and 'would' by 'is' and 'will' and interpreting the statement as a truth-functional material conditional? If it is a material conditional, there can be no doubt of its truth, for (let us assume) the vase will never have been dropped to the floor. Such conditionals are true when their antecedents are false. This becomes more evident when we transform the conditional into an alternation, which is another means of expressing the same thing: "Either the vase will not be dropped on the floor or it will break". On similar grounds, this material conditional is also true: "If the vase is dropped on the floor, it will grow into an oak". But this conditional, we may agree, is not relevant in any discussion concerning the care of the vase. A material conditional seldom affords a ground for action unless one can assert the corresponding subjunctive. In the present instance, the corresponding subjunctive, "If the vase were dropped on the floor, it would grow into an oak ", is (according to all evidence) false. A subjunctive conditional cannot be transformed into a simple alternation and it may be false when its antecedent is false and may be false when its consequent is true. Therefore, since the subjunctive conditional may be true when the corresponding material conditional is not, and *vice versa*, we may conclude that the subjunctive cannot be thus simply rendered. As Lewis has put it, we want to be able to infer the consequent *hypothetically* from the antecedent ; but, knowing merely that the antecedent of a material conditional is false (or that its consequent is true) and hence that the conditional is true, we cannot say that the consequent *would* be true if the antecedent *were* true.[1] A subjunctive conditional is one such that we can know that the antecedent in some sense implies the consequent without knowing the truth-values of either.

A similar objection may be made to the simple translation of a universal subjunctive statement. Consider : " (x) if x were a vase and were dropped to the floor, x would break ". Interpreted as an indicative universal conditional (or " formal implication "), it would be true merely if no vases were ever dropped to the floor, for what such a statement really says is : " (x) either x is not a vase which is dropped to the floor or x breaks ". On similar grounds we may assert, " (x) if x is a vase and is dropped to the floor, x bounces to the ceiling ". In cases such as these, the universal statements may be said to be only trivially or vacuously true and, although admissible in logic, of little interest either in science or in ordinary discourse. The inadequacy of these types of statement is most apparent in science when we wish to make a universal statement which we believe to be without existential import—for instance, a statement about the behaviour of bodies which are freely falling, or are at absolute zero, or in a perfect vacuum.

Carnap has proposed a rather involved method of dealing with " disposition predicates " which might appear to be relevant to our problem.[2] He does not note that they involve an implicit use of the subjunctive (*i.e.* that they may be regarded as abbreviations of subjunctive conditionals), but he admits that apparently they cannot be defined by the usual techniques. Despairing of defining them, he offers another method of " introducing " them, *viz.* the use of " reduction sentences ", which he

[1] C. I. Lewis and C. H. Langford, *Symbolic Logic,* p. 261.

[2] " Testability and Meaning ", pp. 440 ff. *Cf.* " Logical Foundations of the Unity of Science ", *Encyclopedia of Unified Science,* Vol. I, No. 1, pp. 50 ff.

admits, can at best yield "a partial determination only".[1] Whatever its merits, however, this method is of little aid to us in our present problem.

A reduction sentence for the property Q_3 (*e.g.* soluble in water) is a statement that the conjunction in any object of two other properties—the "experimental situation" Q_1 (being placed in water at time *t*) and the "experimental result" Q_2 (dissolving in water at time *t*)—is a sufficient condition for the predication of the disposition term "Q_3", provided that the conjunction of Q_1 and Q_2 occurs at least once. In the simplest cases, the situation is such that the non-occurrence of Q_2 indicates that the thing in question does not have the property Q_3. A reduction sentence for any disposition term, then, is a sentence stating a *sufficient* condition for the application of that term, but it gives us a rule for applying the term only in those cases in which the sufficient condition (Q_1 and Q_2 in our illustration) is realized. We may state more and more sufficient conditions, but "a region of indeterminateness" will always remain—*i.e.* those cases where none of the sufficient conditions ever obtain. Thus Carnap admits that "if a body *b* consists of such a substance that for no body of this substance has the test condition—in the above example: 'being placed in water'—ever been fulfilled, then neither the predicate nor its negation can be attributed to *b*".[2] We are compelled to say that, in this "region of indeterminateness" where neither the predicate nor its negation may be applied, the disposition term has "no meaning".[3] In other words, instead of saying that our rare body *b* either is or is not soluble, we must say that it is *meaningless* to call it soluble (or insoluble). Even if this were consonant with actual practice, which seems at least doubtful, this conclusion would hardly be satisfactory. This is particularly evident in view of the fact that the statements "Body *b* is placed in water at time *t*" and "Body *b* dissolves at time *t*" (which would be the components of a reduction sentence pertaining to body *b*) are themselves perfectly meaningful.[4] Carnap's method, therefore, does not solve our problem, nor does it seem to be a completely satisfactory means of dealing with disposition terms.[5]

[1] "Testability and Meaning", p. 449. [2] *Ibid.* p. 445. [3] *Ibid.* p. 449.

[4] *Cf.* Firth, *op. cit.* Ch. VII. Firth's discussion, to which I am indebted, contains a penetrating analysis of Carnap's theory and its relation to the general problem of the contrary-to-fact conditional.

[5] Carnap does not discuss what would be the consequences for the philosophy of empiricism if this method were to be applied to the terms, "observable" and "realizable", which are the two basic terms of his

In *The Examination of McTaggart's Philosophy*, Broad proposed the view that a subjunctive conditional about what a particular entity might have been, or could be, should " be taken as an abbreviation " for a " statement about *any* thing of a given *kind* ". A statement about the disposition of an individual then becomes a statement which says, among other things, " that, if at *any* time any substance of this kind were put into a situation which was any determinate form of S, its determinate behaviour would be . . ." etc., etc.[1] This view does not contribute toward the solution of our problem, however, since it merely reduces subjunctives about individuals to subjunctives about classes. Similarly, we may dismiss C. L. Stevenson's brief treatment of dispositions in *Ethics and Language* (pp. 46 ff.), since his account admittedly presupposes the notions of " cause " and " law " At the present stage of our discussion, these notions would, of course, be question-begging.

The most fruitful means of handling disposition terms, apparently, is to make explicit the subjunctive conditionals which they involve (*e.g.* " If body *b* were placed in water at time *t*, it would dissolve at time *t* ") and then to consider these as instances of our more general problem. Given a method of treating the subjunctive, it may then be possible to throw light, not only upon disposition predicates, but also upon such notions as " law ", " cause ", " physical necessity ", etc. These latter applications, however, will not be made in the present paper.

III

Let us now consider in detail the difficulties which are involved in the attempt to eliminate the contrary-to-fact conditional. We may proceed on the basis of certain suggestions made by F. P. Ramsey in his posthumous paper, " General Propositions and Causality ".[2] Let us assume that my belief in the conditional, " If you were to see the play, you would not enjoy it ", constitutes my principal reason for suggesting that you do not go. The situation may be described in this manner : I feel that you would be ill-advised in going, because I have (or believe I have) information which is such that from it and the hypothesis that you do see the play, I can derive the conclusion that you won't enjoy

" empirical methodology ". (" Testability and Meaning ", p. 454.) Applied to the former term, it might conceivably lend new support to the doctrine that to be is to be perceived.

[1] Vol. I, p. 276.

[2] Included in *Foundations of Mathematics*, pp. 237-257.

it. And if you should question my advice, our difference would most probably be with respect to this alleged information. Ramsey stated the essence of the matter: "In general we can say with Mill that 'If p then q' means that q is inferrible from p, that is, of course, from p together with certain facts and laws not stated but in some way indicated by the context. This means $p \supset q$ follows from these facts and laws. . . . If two people are arguing about 'If p will q?' and are both in doubt as to p, they are adding p hypothetically to their stock of knowledge and arguing on that basis about q".[1] What is the nature of the connection on the basis of which we derive q? We shall go astray if we confine ourselves to a search for the "connection" which must hold *between* p and q. This is confirmed by the fact that we affirm many subjunctive conditionals in order to show that there is *no* relevant connection between antecedent and consequent; *e.g.* "Even if you were to sleep all morning, you would still be tired". What then, is the nature of the "connection" which is involved and between what entities does it obtain?

W. V. Quine has suggested that possibly some "strong relation of statements" such as logical implication or entailment could be used when we want to formulate what is expressed in a subjunctive conditional.[2] An entailment, which may be interpreted as saying something *about* statements, does not involve the paradoxes of "vacuous truth" which we have considered in the cases of the material and universal conditionals and material and formal implication. Now it is obvious that the antecedents of most subjunctive conditionals do not logically entail the consequents, for in most cases (as in our example) there is no *contradiction* involved in denying one and affirming the other. We have, in fact, restricted ourselves in this discussion to a consideration of those subjunctive conditionals which are not analytic or logically true. But let us consider this along with the previous suggestion and look in another place for this "strong relation of statements". C. I. Lewis has pointed out that, when an inference is made in ordinary discourse, even though a material conditional may be involved, we are using an entailment of the form "p and $p \supset q$ logically imply q".[3] Let us consider, then, whether a subjunctive or contrary-to-fact conditional can be reformulated as an entailment stating that the consequent is

[1] *Ibid.* pp. 248, 247. *Cf.* A. Tarski, *Introduction to Logic*, p. 24; W. V. Quine, *Elementary Logic*, p. 24.

[2] *Mathematical Logic*, p. 29.

[3] *Cf.* C. I. Lewis and C. H. Langford, *Symbolic Logic*, pp. 242-246.

entailed by the antecedent taken in conjunction with a previous stock of knowledge.

Consider this conditional, C: "If Holbrook were elected, the price of wheat would rise." Is this another way of saying that the indicative statement "Holbrook is elected" (which we may call 'H') in conjunction with certain previous information entails "The price of wheat will rise" (W)? First of all, it is necessary to revise the reference to "previous information", since the meaning of the conditional should not be confused with the particular grounds upon which it happens to be asserted. You and I may have quite different "stocks of knowledge" and affirm C on extremely divergent grounds, but when each of us does affirm C, we are, it must be assumed, saying exactly the same thing. The "something additional" which each of us adjoins to H in order to deduce W need not be a statement expressing any particular item in either of our stores of knowledge, nor indeed need it express any knowledge at all. When we assert a subjunctive conditional, we are saying something more general. In the present instances, we are saying that there is *some* true statement which, taken with H, entails W. If, knowing nothing about politics and economics, I none-the-less presume to conjecture that prices would rise if Holbrook were elected, I am conjecturing that there is some true statement, I know not what, which, in conjunction with H, entails W. If I knew *what* the true statement is, I could be said to have an *explanation* for the situation which C describes, but, obviously, I do not need to know such an explanation in order to know the *meaning* of C. It is quite possible that the statement may refer in part to some future events concerning which I shall never know anything.

May we conclude, then, that our conditional C is another way of saying: "There is a statement p such that p and H entail W and p is true"? This is a plausible suggestion, but a number of modifications must be made if it is to be satisfactory. It is necessary to place restrictions upon p so that there will be no possibility of finding a value for p which would trivialize the translation. Thus, if p included a statement which was vacuously true, the translation would not say enough. For instance, if we may suppose that Holbrook will never be elected to public office, then the universal conditional "(x) if x is a public office and Holbrook is elected to x, the price of wheat will rise" is vacuously true and its inclusion as a part of p would make our translation inadequate. That this is so becomes evident if we reflect that the universal conditional, "(x) if x is a public office and Holbrook is elected to x, this year's wheat will turn to gold ", is also vacuously true. Our formula, as it now stands, would require that, on the basis of this triviality, we assert the subjunctive conditional, " If Holbrook were elected, this year's wheat would turn to gold ", which, we may assume, is absurd.

It is necessary to modify the formula in order to insure that it contain no " vacuous truths ", *i.e.* in order to insure that it contain no universal conditional whose antecedent determines an empty class and no material conditional (or material implication) which is asserted merely on the ground that its antecedent is false (or its consequent true). Every universal conditional included in p must have " existential import ", that is, every universal conditional must have conjoined with it a statement asserting that there are members of the class determined by the antecedent. Even this is not enough, however.

Suppose, for instance, we desired to translate our earlier example, " If you were to see the play you would not enjoy it ", according to the formula thus restricted. Trivialization is still possible. Let p be " (x) $[x =$ you $: \supset :$ x saw the play $. \supset . x$ did not enjoy the play], there exists an x such that $x =$ you ". This will be a true statement if the vacuous material conditional corresponding to the original subjunctive conditional is true (and, of course, whenever we can assert the subjunctive, we can also assert the corresponding indicative). The translated subjunctive will then become equivalent to the material conditional. To preclude this type of difficulty, we may add a further provision to our formula, without sacrificing anything essential. Let us say: p includes no universal conditional whose consequent includes any two functions which are logically equivalent to " x sees the play " and to " x does not enjoy the play " ; *i.e.* any consequent must exclude either functions logically equivalent to " x sees the play " or functions logically equivalent to " x does not enjoy the play ".[1] We may now state in more general terms the formula proposed:

A subjunctive or contary-to-fact conditional of the form, " $(x)(y)$ if x were ϕ and y were ψ, then y would be χ ", which is not analytic or

[1] If we understand the term " entailment " in the very strict sense of logical implication, this provision will take care of our difficulty, but if, as is often the case, the term is construed in a wider sense, further modification is necessary. *I.e.* if we so construe it that " x sees the play " and " x witnesses the play " may be said to entail each other (on the ground that, although they are not logically equivalent in the strict sense, they are *synonymous*), the latter phrase may be substituted for the former and the translation trivialized as before. Hence, if we use " entailment " in the wider sense, we should substitute " synonymous " for " logically equivalent " in the provision. For a discussion of these terms, see W. V. Quine, *O Sentido da Nova Lógica*, pp. 148-152.

logically true, may be rendered as : " There is a a true statement p such that : p and 'x is ϕ and y is ψ' entail 'y is χ' ; p includes no propositional function having free variables other than x and y which is not either a universal conditional or an existential statement ; p includes no universal conditional which does not have existential import ; and p includes no universal conditional whose consequent includes any two functions which are logically equivalent to functions having 'x is ϕ and y is ψ' and 'y is χ' as corresponding instances, or whose antecedent includes any function not containing the variable of quantification ".[1]

There are more qualifications to be made. To preclude trivialisation in those cases where the consequent of the subjunctive conditional happens to be true, we should add that the indicative version of the consequent does not entail p. And some types of subjunctive conditional must be reformulated before the formula can be applied. *E.g.*, " Even if you were to sleep all morning you would still be tired ". This type of statement is what one gets by negating the consequent of an ordinary subjunctive conditional and then denying the whole thing : " It is false that if you were to sleep all morning you would not be tired ". The " even if " conditionals must be reduced to this form ; hence they would read : " It is false that there is a true statement p . . . etc ".[2] (If we reformulate the even-if conditionals in the manner suggested, we may then say correctly that the problem of the subjunctive conditionals concerns the *connection* which obtains between antecedent and consequent.) With all these qualifications, however, we still cannot make the formula sufficiently restrictive.

Suppose that one afternoon two men, quite independently of each other (as we should ordinarily say), were to sit on the same park bench, that they were alone there, and that, as it happened, each of them was Irish. We could then say : " (x) if x is on . . . park bench at . . . time, x is Irish ". Our formula is such that, if we were to apply it to this case, we could infer : " If Ivan were to be on . . . park bench at . . . time, Ivan would be Irish ". But this conclusion would hardly be warranted. (It would be warranted, if we were to interpret the subjunctive

[1] The term *statement* is so used here that " Frank sees the play " and " The play is seen by Frank " are different statements. Since the formula refers to statements and not to propositions, some such term as Quine's *statement matrix* might be preferable to *propositional function.*

[2] These " even if " subjunctives are usually employed either (a) when we have affirmed the consequent and desire to stress its inevitability, or (b) as appendages to other subjunctive conditionals (*e.g.* " If you should work like that all night you would be tired and even if you were to sleep all morning you would still be tired ").

conditional as saying "If Ivan were *identical* with any one on the bench . . . ", but this, as we shall see, is not what we should ordinarily intend it to say.) Again, consider a small community where each of the lawyers happens to have three children. We may say: "(x) if *x* is a lawyer in . . . community in 1946, *x* has three children". But we should not want to say of Jones, whom we know not to be a lawyer there, that if he *were* to have practised there he too would have had three children. The difficulty is that our universal conditionals about the park bench and the lawyers describe what are, in some sense, "accidents" or "coincidences". How are we to distinguish such "accidental" conditionals, of which examples are easily multiplied,[1] from statements such as "all men are mortal", "All wolves are ferocious", etc., which describe "non-accidental" connexions? This is the crux of the whole problem. Our formula must exclude these "accidental" universal conditionals; but the only means we have of distinguishing these is to note that, unlike the "non-accidental" ones, they do not warrant the inference of certain contrary-to-fact conditionals. That is to say, in the case of the park bench we should hesitate to infer "If *a* were on the park bench, *a* would be Irish"; but in the case of the wolves we should not hesitate to infer "If *a* were a wolf, *a* would be ferocious". (These considerations will become more obvious when we consider, below, the question of the formulation of contrary-to-fact conditionals.)

It is plain that the statements which formulate "natural laws" are a sub-class of the non-accidental universal conditionals. One cannot say, as most philosophers and logicians now incline to do, that a natural law is merely what is expressed in a synthetic universal conditional. We must find the differentia so that we can exclude the "accidental" conditionals. The alternatives are: (1) supply the qualification which our formula lacks and thus reduce the subjunctive to the indicative; (2) accept the subjunctive as describing some kind of irreducible connection and thus reject, or alter radically, the extensional logic which most contemporary logicians have tried to apply to the philosophical problems of science. The problem is not an easy one; indeed, we may be justified in asserting that it constitutes *the* basic problem in the logic of science.

[1] *Cf.* C. H. Langford, review, *Journal of Symbolic Logic*, Vol. 6, No. 2 (June 1941), pp. 67-8 Langford provides here a very clear statement of the present problem. Along with C. I. Lewis, he has been one of the few logicians to recognise explicitly the importance for the logic of science of the subjunctive conditional.

IV

There are three further considerations which will enable us to see more clearly what is involved in this problem.

(1) A contrary-to-fact conditional, when formulated in the customary manner, may give rise to misunderstanding if considered outside the context of its utterance. Given a conditional with an antecedent of the form " if x were y " one may ask whether the supposition is that x is changed to accommodate itself to y or y is changed to accommodate itself to x. I might say, for instance, " If Apollo were a man, he would be mortal ", to which the reply could be made, " No : if Apollo were a man, at least one man would be immortal ". The possibility of this type of misunderstanding is most apparent where the antecedent of the conditional designates some equivalence relation (*e.g.* " if x were identical with y ", " if x were in the same place as y ") or some relation of comparison (*e.g.* " x is greater than y "). But theoretically it might occur in connexion with the interpretation of any antecedent.

Let us refer to " If Apollo were a man, he would be mortal " as *a* and to " If Apollo were a man, at least one man would be immortal " as *b*. Knowing Apollo to be immortal and all men to be mortal, should we assert *a* or *b ?*[1] The answer depends upon whether we are supposing our beliefs about Apollo, or our beliefs about men, to be contrary-to-fact. (If we were supposing *neither* to be contrary-to-fact, the antecedent would be, not merely false, but contradictory ; if we were supposing *both* to be contrary-to-fact, we could assert neither *a* nor *b*.) Ordinarily the context of inquiry determines which supposition is being made. But in a language which was logically adequate, the antecedents of these conditionals would be so formulated that such misunderstanding and ambiguity would not arise.[2] Thus one who had asserted *a* instead of *b* would have said something like,

[1] It was evidently difficulties of this sort which led Broad to question whether subjunctive conditionals about individuals were meaningful if taken literally. (*Op. cit.* Vol. I, pp. 273-278.)

[2] In their customary formulation, the antecedents of subjunctive conditionals are, to a certain extent, analogous to " He is a thief ", " I am hot ", " Your dog is here ", etc., which statements, when considered in isolation, are incomplete and may be true or not, depending upon which of the many possible interpretations of " I ", " He ", " here ", etc. are selected. Like the subjunctive conditionals, these statements are such that when uttered in ordinary discourse, the context of their occurrence determines the interpretation, but in a logically adequate language they would receive a more satisfactory formulation.

"If Apollo were different from what we have believed him to be and had instead the attributes which all men possess, then he would be mortal". And one who had asserted *b* would have said something like, "If the class of men were wider than what we have believed it to be and included Apollo, then some men would be immortal". In the first case, Apollo's status is in question and one is supposing certain commonly accepted statements about him to be false, and in the second case, it is not Apollo, but it is the class of men, which is in question. The advantage of thus formulating the antecedents of these conditionals, so that the wording leaves no doubt concerning which is the object of hypothesis and which is assumed to remain "as is", is further evident when we consider the extent to which the usual canons of inference may be applied to subjunctive conditionals when the object of hypothesis is left ambiguous.[1]

Let us assume, for the moment, the view held by Wittgenstein, Ramsey, and others, according to which, "For all x, fx" is held to be equivalent to the logical product of the values of "fx" (*i.e.* to the conjunction of fx_1, fx_2, fx_3, etc.) and "There exists an x such that fx" is held to be equivalent to their logical sum (*i.e.* to the alteration, either fx_1, or fx_2, or fx_3, etc.). This view, whatever its limitations as an ultimate ontology, has the advantage that it makes clear the manner in which valid inferences can be made connecting particular instances with the general rules under which they fall.[2] Suppose, now, we are considering "If Apollo were a man, Apollo would be mortal". The statement p in our translation may be assumed to be "All men are mortal and there are men". Let us assume that Socrates, Plato, and Aristotle are all the men there are ; p then becomes "Socrates, Plato, and Aristotle are men and are mortal". But this statement, taken in conjunction with "Apollo is a man" does not entail "Apollo is mortal". Hence one might contend that use of the contrary-to-fact conditional necessitates the preservation of an "element of generality" in our universal statements, so that "all men" will refer to more than the particular men who will have existed.[3] And it might be concluded, therefore, that

[1] There seems to be a convention implicit in ordinary discourse according to which the antecedent is always so formulated that the subject-term designates the entity which we are supposing to be different or are considering hypothetically. When one says, "If Paoli were the same size as New York . . .", it is more natural to conclude "Paoli would be larger than it is" than "New York would be smaller". The latter conclusion would be drawn from the converse of our antecedent.

[2] *Cf.* Ramsey, *op. cit.* pp. 153-154.

[3] What this reference to an "element of generality" means, of course,

the contrary-to-fact conditional, even granted the adequacy of our formula for translation, presents unique problems in the theory of inference, for we do not encounter such difficulties in connection with " If Socrates is a man, Socrates is mortal ".

As in the previous instance, however, the apparent difficulty is explained by the fact that the antecedents of subjunctive conditionals are usually formulated inadequately. The difficulty vanishes if we formulate them in the manner proposed above. If, instead of " If Apollo were a man ", we say something like " If Apollo were different from what we have believed him to be and had instead the attributes which all men possess ", the problematic inference is seen to be valid, even though statements about all men refer only to Socrates, Plato and Aristotle. Hence, by formulating the antecedents of subjunctive conditionals unambiguously, we cut the ground from under two objections which might otherwise be made to the use of this type of statement.

(2) It is very important to note that, wherever we have a " non-accidental " non-vacuous universal conditional, we can always supply an " accidental " one which will cover the same instances. Suppose, for instance, (i) " (x) if (x) drinks from that well, x is poisoned " is such a conditional. And suppose that, of those who have thus been poisoned, one was born in place p at time t, another in p' at t', etc. We can assert the " accidental " conditional: (ii) " (x) if x is born in p at t, or in p' at t', etc., x is poisoned ". It is quite plain that (ii) is accidental and (i) is not, for, given (i) we could infer " If a were to drink from that well a would be poisoned " ; but, given (ii), we cannot infer " If a had been born in p at t, a would have been poisoned ". Whether a universal conditional is to appear " accidental " or not thus depends upon how one has *described* the entities which fulfil the component clauses.[1] This suggests that the terms of " non-accidental " connexions are the *properties* of things. And if we

is not altogether clear, but, as we shall see, it is the sort of thing which we must countenance if we are to regard the subjunctive as irreducible.

[1] These considerations are unquestionably connected with the distinction, recently noted by Nelson Goodman, between " projectible " and " non-projectible " predicates and with the fact that degree of confirmation " varies widely with the way the given evidence is described ". (" A Query on Confirmation ", *Journal of Philosophy,* Vol. XLIII, No. 14, pp. 382-5.) The distinction between " accidental " and " non-accidental " universal statements is fundamental to the theory of confirmation. These considerations also suggest the possibility of an alternative formula for eliminating the subjunctive, referring to classes or properties but not to statements. The " class method ", however, seems to involve many more difficulties than does the " statement method " and it breaks down at an earlier point.

cannot get rid of the subjunctive by any other means, we can define it in terms of these "connections". To say "(x) if x were ϕ, x would be ψ", would then be to say "ϕ and ψ are *connected*". *Connection* becomes an irreducible ontological category and a source of embarrasment for empiricism. It was this doctrine that C. S. Peirce was defending with his concept of "thirdness".

It is really not clear, of course, what we are trying to convey when we assert that "connection" or "thirdness" is an ultimate ontological category, if we mean to do more than state the problem. And it still may be that the ontology of logical atomism is correct, that, being creatures having a need to rationalise, we have invented these notions of what-might-have-been and what-might-but-won't-be, and that they have no objective significance. But apparently we can't say all the things we want to say in our more serious moments unless we employ them.

(3) Any formula, of the sort which was described in section III above, must presuppose a satisfactory solution to the problem of the designata of statements. Application of our formula for translation must involve in every case a reference to a *statement* and, in many, if not in the majority, of cases, a reference to a statement which has never been uttered, written down, or even conceived. What is the status of a statement which will never have been made? Is it a merely *possible* statement, one which *might* or *could* be made? It might be assumed that, if we attempt to dispense with entities designated by statements, as is sometimes done in logic,[1] we must employ the contrary-to-fact conditional in discussing the statements which have not been made. In this event, we should find ourselves using the contrary-to-fact conditional in the very application of the formula which was designed to eliminate it. If we were to revise our formula so that it would mention facts or states of affairs where it now mentions statements, we should then have to countenance the existence of entities which are merely possible but not actual states of affairs. In this case, instead of defining the merely possible in terms of the subjunctive (as what *would* happen if . . .), we should be following the reverse course, which would have been easy enough at the outset, although not particularly clarifying. If we are to admit the types of case which give rise to these difficulties, there are apparently only two alternatives left to us. The first is to assume that there exist entities which function as designata of sentences; these may be objectivs, propositions, etc. This assumption, of course, is very often made

[1] *Cf.* W. V. Quine, "Ontological Remarks on the Propositional Calculus", MIND, Vol. XLIII (1934), pp. 472-476; *Mathematical Logic*, p. 32.

on other grounds. If we adopt this course, we may substitute for the reference to *statements* in our formula a reference to *propositions* (or whatever entity we had chosen). But if we are deterred by "the obscurity of these alleged entities", we may attempt to extend the term "statement" beyond its normal usage in order to insure that there be an actual entity to answer for every conceivable statement. But how should we describe the semantical properties of these "statements" (which they must have if they are to be statements at all) except by saying that they *would* designate or *would* denote such-and-such things if some interpreter *were* to take account of them? These difficult questions, however, are beyond the scope of the present paper.