AN ANALYSIS OF CAUSALITY IN EVERYDAY LANGUAGE

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This article gives an analysis of the notion of 'cause', as it is used in everyday language and in some sciences the vocabulary of which is not too removed from that language, such as law, history, some parts of psychology, sociology, and so on. The analysis however does not intend to be complete; on the contrary, it is interested mainly in the notions of necessary and sufficient conditions, and in their relationship with the concept of cause. I am greatly indebted to J. L. Mackie's notion of an *inus-condition*; and my article is only a development of his ideas, and an attempt to apply them when we describe the effect, or the cause, more precisely, viz. when the effect is provided with spatio-temporal coordinates.

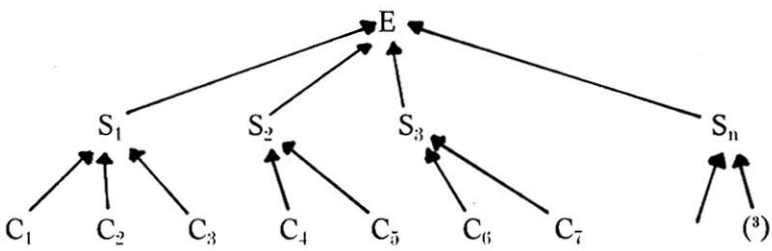
§ 1. *Necessary and/or sufficient conditions*

Very often, one says that an event C is the cause of another event E, if C is necessary and/or sufficient to E. But it is clear that many events, which are called 'causes' in everyday language, are not these sufficient and/or necessary conditions the definition requires. It is indeed rather exceptional that the 'cause' is always followed by the 'effect', or that the 'effect' is always preceeded by the 'cause'. It follows that the causal relation of everyday language will be weaker than a strictly sufficient and/or necessary condition. There are many ways now to construct such weaker causal relations (1). We will show some of them,

(1) One finds a good survey of these ways in Lars BERGSTRÖM, *The Alternatives and Consequences of Actions, An Essay on certain fundamental notions in teleological ethics, Acta Universitatis Stockholmiensis, Stockholm Studies in Philosophy*, 4, Stockholm, Göteborg, Uppsala, 1966.

and examine in which *sense* the 'cause' is still sufficient and necessary to the effect.

Therefore, we introduce a *causal genealogical tree,* showing us the total cause, in the sense of J. S. Mill (2). In this tree, E



is the effect (e.g. the destruction of a house), and S_1 to S_n are different conditions, which are sufficient to this effect (there are, alas, many ways to destruct a house !). Each of these sufficient conditions will normally be itself complex.

One sees immediately how this 'total cause' is a very complex class of conditions. Because of this complexity, most of our causal propositions are elliptical; and our causal laws are *gappy laws* (4), or *existential statements* (5). If we call an event C 'the cause of E', we (must) know that C is far from being sufficient to explain E; it produces E, only together with other events.

(2) J. S. MILL: "The cause, ... philosophically speaking, is the sum total of all conditions positive and negative taken together; the whole of the contingencies of every description, which being realized, the consequent invariably follows." (*A system of Logic,* III V 3).

(3) A. PAP, *Analytische Erkenntnistheorie,* Wien, 1955, p. 114.

(4) J. L. MACKIE, "Cause and Condition", in *American Philosophical Quarterly,* 1965, p. 255.

(5) Comp. Morton WHITE, *Foundations of historical Knowledge,* New York and London, 1965: "A statement of the form 'A is a contributory cause of C' is true if and only if there is an explanatory deductive argument containing 'A' as a premise, and 'C' as its conclusion", p. 60. The same idea is convincingly upheld by A. W. COLLINS, "Explanation and Causality", in *Mind,* 1966, 75, 482-500.

J. R. LUCAS ("The lesbian Rule", in *Philosophy,* 1955, XXX, 195-213) too studies this type of argument. He emphasizes its great importance in historical and ethical reasoning, and analyses its structure very nicely.

Sometimes we know these other events; but often we ignore them. If we continue to say that C is the cause of E, we really mean that C, together with some unspecified conditions X, always produces the effect E. We claim that there exists a series of conditions, which is sufficient to E, and one element of which we know explicitly, viz. C. We can say the same thing in a more sophisticated way, by means of the formula that C, *ceteris paribus*, produces the effect E.

So, if everyday language calls the event C the cause of E, although C is far from being followed always by E, it is not very adequate to consider this statement as an instance of a statistical explanation. The claim is indeed that this cause C can be specified sufficiently, so that all C's are also E's. The claim is that there is a deductive argument with C as one of its premises, and with E as its conclusion.

This claim can be conclusively verified, by exhibiting such an argument. Its probability can be increased, by showing that C.E.-cases are more frequent than (not C).E-cases, that C.A.E.-cases are more frequent than (not C).A.E-cases, that C.A. ... N.E-cases are more frequent than (not C).A ... N.E-cases.

It will be difficult, on the other hand, to falsify such existential statements: from a given theory, one should deduce that the deductive argument cannot possibly exist, that it would contradict some other accepted theories. The improbability of the existential statement could be proved by showing that C.A. N.E-cases are not more frequent than (not C).A ... N.E-cases, or even that (not C).A ... N.E-cases are more frequent than C.A. ... N.E-cases.

Let us insist on some further aspects of our causal genealogical tree. Each of the sufficient conditions, S_1, S_2, ..., S_n can also contain negative elements: the absence of an efficient sprinkler can be said to have caused a fire. The tree can contain then situations which are normally negatively described.

Each of these series $S_1 \ldots S_n$ moreover is a *minimal* series, containing no superfluous elements. Although $S_1 \ldots S_n$ represent complex classes, they may contain only such elements which actually contribute to the effect. If a sufficient condition is not minimal, if it is, in other words, redundant, one of its elements

has erroneously been included in the causal tree. An element, that can be dispensed with within a given sufficient condition, cannot be a cause.

Finally, we must emphasize that our causal genealogical tree constitutes a maximally complex total cause, because the situation may be less complex. There are many possibilities, varying from the greatest complexity to the utmost simplicity.

Whereas the real cause of an event E is, according to J. S. Mill, shown by its genealogical tree, everyday language is far from being so complete and exhaustive. It usually considers as the cause only one (or some) condition(s), which is (are) part of the genealogical tree. We could ask ourselves which are the criteria governing this selection ([6]); but this is not our problem. We want only to know in which sense this — selected — condition can be said to be necessary and/or sufficient to the effect E. The answer depends on the complexity of the causal genealogical tree.

i. If this tree consists of only one, eventually complex sufficient condition, i.e. if $E = C_1.C_2.C_3. \ldots C_n$, then C_n is absolutely necessary to E.

ii. In the standard version of the tree however, C_n is neither sufficient, nor necessary to E. Very suggestively, J. L. Mackie ([7]) calls such a cause an "INUS-condition". Indeed, the so-called cause is an insufficient (*i*) but necessary (*n*) part of a condition which is itself unnecessary (*u*), but sufficient (*s*) for the result. This inus-condition then is only necessary to E, in so far as the other sufficient conditions are absent. Therefore Konrad Marc-Wogau ([8]) calls it *necessary post factum*. It is only after having

([6]) According to M. WHITE and to HART & HONORÉ (*Causation in the Law*, *Oxford*, 1958) we would always select the abnormal condition as the cause. This contention seems too general; on the other hand, it is however so vague — what is an abnormal condition ? — that perhaps it cannot be refuted.

([7]) *Op. cit.*, p. 245.

([8]) "When historians in a singular causal statement speak of a cause of a certain individual event b, then what they are referring to is another individual event a, which is a moment in a minimal sufficient, and at the same time necessary condition post factum for b." ("On historical Explanation", in *Theoria*, 28, 1962, p. 227).

established that the other sufficient conditions, S_1, S_2, ... are actually absent, that one may say that C_n is necessary for E.

iii. The necessity of the cause is increased in the case of a *contingently necessary condition* (9). A condition C_1 is *"contingently necessary to E"*, iff it is necessary to E, when another condition C_2 is present. There is no other way for C_2 to produce E, then together with C_1; formally: $(C_2 \rightarrow (E = C_1))$.

iii.bis One sees that an inus-condition does not want to be contingently necessary. On the other hand, it is possible that several conditions are contingently necessary. Suppose a sufficient condition S, consisting of the events C_1 and C_2. Let C_1 be a contingently necessary condition, so that we have

$$(C_2 \rightarrow (E = C_1)). \quad (1)$$

It is then possible, but not necessary that C_2 too is contingently necessary, in relation to C_1, so that we would have also

$$(C_1 \rightarrow (E = C_2)). \quad (2)$$

It is not even excluded that all the conditions are, at the same time, also contingently necessary in relation to each other. But this would not imply their absolute necessity, since (1) and (2) are indeed consistent with e.g.

$$D \rightarrow E \quad (3).$$

iv. Finally, a given condition may be common to all the — complex — classes of sufficient conditions S_1, S_2, ... S_n; the condition C_2 e.g. would be part of $S_1, S_2, \ldots S_n$.

So there are many possible causes of a fire; but in each series of sufficient conditions we will find the presence of oxygen.

And in this case too, this condition is absolutely necessary for the effect, because we can maintain that the effect cannot happen without the inus-condition.

(9) Ernest NAGEL, *The Structure of Science, Problems in the Logic of Scientific Explanation*, London, 1961, pp. 559-560.

Summing up this review, let us recall that we have distinguished four different senses of the term 'necessary condition'. The mere inus-condition (ii) is only post factum necessary. The contingently necessary condition (iii) is in a certain sense irreplaceable. The inus-condition which is a member of all the sufficient conditions (iv) is absolutely irreplaceable: it is indispensable, not only in relation to some circumstances, but in no circumstance whatsoever there can be dispensed with. When there is only one sufficient condition (i), each member of this unique sufficient condition is, *a fortiori*, absolutely necessary to the effect. (In case iv, there is at least one condition which is not absolutely necessary).

v. Let us mention very briefly, for the sake of completeness, in which sense the inus-condition is sufficient to the effect. It is only relatively sufficient: C_1 produces E, together with C_2, C_3 ... C_n. Because these other conditions C_2, ... C_n are considered as known, or because they remain unspecified, we say, as mentioned above, that C_1 leads, *ceteris paribus*, to E.

We conclude this review, by adding two remarks.

First, let us specify in which sense the inus-condition is only post factum necessary. It is necessary, we said, because some other sufficient conditions are absent. But this absence can ev. be explained; i.e. it can be shown to be physically necessary. So it is possible that it is necessary that C_1 as an inus-condition, is post-factum necessary.

Next, we emphasize a consequence of this analysis for the problem of the transitivity of the causal relation. Indeed, in most of the senses of the causal relation we have distinguished, this relation became a trinary relation. One can no longer ask: if A causes B, and if B causes C, is it true then that A causes C ? One should ask instead: if A causally implies C if and only if B, and if B causally implies C if and only if D, is it true then that A.B causally implie C if and only if B.D ? *e.g.* ([10]).

The problem is complicated furthermore, because A,B,C, ...,

([10]) A. W. BURKS, "The Logic of causal Propositions", in *Mind*, 60, 1951, 363-382, constructs a causal calculus with a transitive binary causal implication.

succeed to each other in time. This entails that a causal calculus should introduce some axioms and propositions of a tense logic ([11]).

§ 2. *The problem of the specification*

A. Multiple causation (plurality of causes).

The exposition of the preceeding section is based on a disputable assumption, viz. the assumption of multiple causation (or of the plurality of causes). The thesis of multiple causation asserts that there is at least one event for which it is true that not every condition which is sufficient for that event, is also necessary for the same event; it is possible that there are different sufficient conditions for the same effect.

The preceeding section rests on this assumption, because, if each causal genealogical tree were simple, if there were always only one, ev. complex sufficient condition, then each member of this sufficient condition would be absolutely necessary. And it would be useless then to make a distinction between an absolutely necessary condition, and a post factum necessary condition.

Admittedly, very often a complex causal genealogical tree can be simplified and reduced to a more simple one, by describing the effects more precisely. C_1, C_2, and C_3 may be sufficient to E; but if we describe the effect precisely, we will retain perhaps only one condition e.g. C_1, which will become then necessary and sufficient ([12]).But it is an unproved assertion, a sort of metaphysical belief, that each complex tree can be simplified; and

([11]) A. N. PRIOR, *Time and Modality*, Oxford, 1957; G. H. von WRIGHT, "And Next", in *Acta Philosophica Fennica*, fasc. XVIII, 1965, Helsinki, 293-304; John E. CLIFFORD, "Tense Logic and the Logic of Change", in *Logique et Analyse*, 1966, 9, 219-230.

([12]) "If e_1 and e_2, different instances of the same kind of effect, E, seem to be caused by different conditions c_1 and c_2, a closer analysis will reveal, according to the argument, a corresponding dissimilarity between e_1 and e_2 (A. PAP, *Introduction to the Philosophy of Science*, London, 1963, 257).

According to B. RUSSELL, plurality of causes always is only apparent:

it is certainly false that for each event, there is a unique necessary and sufficient condition.

One understands moreover that the specification of the effect, from which it should result that there is only one possible sufficient condition for this effect, is a very complicated matter. Indeed, it amounts to the assertion that the actual causal process is at the same time the unique possible one. Such a far-reaching contention supposes elaborate research and knowledge, which are certainly not characteristic for the average state of mind. So we are entitled to think that most causal statements in everyday language, which is our concern, start from the hypothesis of multiple causation.

B. Specification, generalization, and the concepts of a necessary and a sufficient condition.

So we see once again how the concept of 'cause' is a very relative concept. We started indeed from a definition in function of the couple necessary-sufficient condition. But we experience how the specification of a certain effect entails that a condition may cease to be necessary or sufficient to this effect, or, conversely, that it becomes sufficient or necessary by doing so. Let us make this explicit.

B.i. The following relation holds. The specification of a consequence from E to E′ makes it less probable that a condition C is sufficient to E′. This implies that, if C was sufficient to E, one cannot infer from this relation that C will be sufficient to E′; on the other hand: if C was sufficient to E′, then it is certainly sufficient to E ([13]).

So a dagger-stab e.g. can be considered, for argument's sake, as sufficient for killing somebody; but it is not sufficient in order to kill someone in specified circumstances: with convulsions, goggling eyes, spasmodic symptoms, and so on.

"Plurality of causes... results only from conceiving the effect vaguely and narrowly, and the cause precisely and widely." ("On the Notion of Cause", in *Mysticism and Logic*, London, 1963,[13]) A. PAP, *op. cit.*, p. 256 on the contrary considers multiple causation as real.

([13]) One can find some data in this sense in BERGSTRÖM, *o.c.*, p. 74.

The specification of an effect can thus make an absolutely sufficient condition only relatively sufficient. It may even be so that it changes an absolutely sufficient condition into an absolutely necessary condition. Indeed, let A, B, and C be absolutely sufficient to E. We specify E to E′, so that neither A, nor B, nor C is sufficient. Let us call the cause, which is sufficient to E′, and to which A e.g. belongs, A . X. It is possible now that the complex A . X has become necessary to E′, so that A becomes absolutely necessary. (see B. ii).

B.ii. On the other hand, the specification of the effect E to E′ makes it more probable that a condition C becomes necessary to E′. In some cases, we can thus describe the effect so precisely that an inus-condition, which appears to be only post factum necessary, becomes contingently or even absolutely necessary.

To be sure, the opportunity of such a specification is rather problematic. Much depends on the intention with which the causal question is asked: sometimes it will be adequate to give many details; in other situtations, such a procedure will be pedantic and boring.

A very natural specification of the effect consists in indicating the time and place where it occurred. So, one who is accused of euthanasy, can hardly be called the necessary condition of the death of the patient; for, without his intervention, the latter would have died also. Death indeed occurs to all living beings automatically; it must not be caused. But without the euthanasy, the patient would not have died so quickly; his death, the effect, has been hastened. In a following section, we will emphasize this temporal specification.

B.iii. The condition too can be described more or less precisely. For the sake of completeness, we indicate the results of a specification, resp. generalization in the description of the conditions.

Here, we have just the reversed situation as in B.i. and B.ii. The more precisely the condition is described, the higher the probability that it is sufficient for a given effect, and the smaller the probability that it is necessary for this effect. Therefore, we shall describe the condition, or the complex of conditions, in principle as precisely as possible, without however achieving

such a precision which is no longer relevant on the level of common sense.

On the other hand, the more generally a condition is described, the lower the probability that it is sufficient for the effect, and the higher the probability that it is necessary for this effect. Consequently, one could make an inus-condition absolutely necessary, by describing it in a sufficiently general way.

When somebody is hit by a falling stone, and dies immediately after, one could hardly consider this falling stone as a necessary condition for the death of the unlucky passer-by. But one could maintain that the stone becomes necessary in certain circumstances. First, we should describe the effect more precisely, viz. as a mortal fracture of the skull. And then we might contend that mortal fractures of the skull require the action of forces, which have at least a specified value. The force developed by the falling stone, would then become an instance of the required value, and be, as such, necessary for the death of the victim.

B.iv. This instance invites us however to make a restriction which holds also for the other cases of specifications, resp. generalizations of the conditions and of the effect.

We said that the probability that a given condition is sufficient for the effect decreases, if this condition is described more generally, but that the probability that this condition is necessary to the effect increases in the same situation.

This contention can however be made true in a trivial way. Indeed, let A be sufficient to E. If we generalize A to 'A or B', it is no longer certain that this generalized condition 'A or B' would be sufficient for E. On the other hand the probability that 'A or C' is necessary for E is clearly higher than the probability that A is necessary for E.

But when we formulated some propositions concerning the result of the specification and of the generalization of the conditions and of the effect, we intended a more sensational contention. It is indeed a very complicated and sophisticated matter to construct rules and criteria which always indicate the more general and the more specific event in a satisfactory manner. I would suggest the following procedure.

Let us start from simple events, represented by capital letters

A, B, C, ... I neglect here the very difficult question how we could define such simple facts. Then we transform each non-atomic formula in its disjunctive normal form. The idea is that we should admit 'A . B' e.g. as more general than 'A . B . C'; and as more specific than 'A', but that we should reject 'A v B' e.g. as more general than A. We would thus limit the initial comparison to conjunctions. A conjunctive formula X would then be more specific than a conjunctive formula Y if i, it contains at least one atomic formula more than Y, and if ii. all the events of Y would also be events of X.

Next we should have criteria which allow comparisons between formulas which would not have all their elements in common, but the non-common elements of which are related in some way: they imply the same event. And finally, we need rules in order to determine the generality of a complex event as a function of the generality of the conjunctions, and rules governing the way in which those disjunctions of conjunctions can be compared which each other. What about (A . B . C) v (D . E) and (A . B) v (E . H), e.g. ? The application of these rules and criteria would guarantee then that the more specific event implies the more general, and that the implication is not reciprocal. But the latter relation is not sufficient in order to define in a satisfactory way the specific and the general event ([14]).

§ 3. *Spatio-temporal coordinates*

A. The position of Konrad Marc-Wogau ([15]).

In the previous section, we showed how specification is a recipe that can sometimes change a condition, which is only

([14]) See the definition of BÉRGSTRÖM, *op. cit.*, p. 27: "a' is a version of a, if and only if, (i) a' is different from a, (ii) a' is agent identical with a, (iii) a' is time-identical with a, and (iv) it is logically necessary that if a' is performed, then a is also performed".

([15]) Konrad MARC-WOGAU, a.c., p. 226; his position is criticised by Knut Erik TRANØY, "Historical Explanation: Causes and Conditions", in *Theoria,* 1962, 28, 234-249.

post factum necessary, in an absolutely necessary one. According to Marc-Wogau however, there are never absolutely necessary conditions, because even the most absolutely necessary condition is replaceable.

Mr. Johnson is suffering from tuberculosis. A necessary condition for his disease is the presence in his body of certain bacilli. But, according to this argument, we cannot say that the concrete, individual group of bacilli which is active in Johnson's body, is necessary to the disease. For, if this group was not there, another group could have caused the same disease. The bacilli are thus only post factum necessary: because no other group was actually present, the specific group in Mr. J.'s body was necessary for his disease.

We showed under B. iii of the previous section how a condition A can become necessary for the effect E, by generalizing A. A becomes then a version, A′, of all A's which are necessary and sufficient. Does the necessity of A′ disappear, because another A, viz. A″ too leads to E ?

It is clear that this argument is based on a certain confusion concerning the meaning of the terms 'necessary- sufficient conditions'. An individual event c can only be called the cause of another individual event e, in sofar as events of the type to which c belongs, namely the C's, are sufficient, resp. necessary to events of the type to which e belongs, namely the E's.

This confusion is made possible however by the vague and existential nature of most causal statements. One does not know exactly the real content of the 'cause' and of the 'effect'. Many causal statements moreover are still formulated in the *causa efficiens* — terminology, and this too involves that one may be inclined to consider the 'bearer' of the properties as 'cause' and as 'effect'. One thinks then of the individual event c as the cause of the individual event e. But afterwards one finds that another C, viz. c_i, would have led to E quite as well. But that a given c is replaceable by another c, does not mean that it is false that the class of the C's is necessary to E.

All this is self-evident; but it invites us to give a more precise definition of the inus-condition. It becomes senseful to speak

of individual events as inus-conditions ([16]), only when one considers these individual events as instances of two different types of events. We say then that a concrete event c is an inus-condition of another concrete event e, if c belongs to the class of the C's, which are relatively sufficient to the class of the E's, and which are necessary to this same class, because the class of the D's, which are also sufficient to E, is not represented.

B. Spatio-temporal coordinates.

There is another reason why we have included this discussion in this article. For it seems possible to refute Marc-Wogau positively. The necessity of c_i not only does not get into a corner by the presence of c_{ii}, but c_i, to the exclusion of c_{ii}, can be shown to be necessary to the effect.

Let us explain therefore a very trivial matter. If someone attacks the necessity of the C's to E, he can do this in a significant way only if his counterexamples, the G's e.g., which lead also to E, are actually G's, and lead to E as being G's. For if he was allowed to use contrary-to-fact arguments, he would only obtain logically true statements. It is indeed only significant to use such arguments, when one examines whether or not there is a real causal connection between an alleged cause C and an alleged effect E. But here, *ex hypothesi,* this causal connection is already established. So I could not say that if g (actually an old cow) was c (a piece of copper), then e would happen after heating (e is expansion); for this is plain nonsense.

Therefore, if C is a causally relevant characteristic, and if one attacks its necessity by observing that if G were C, then E would happen equally well, this objection not only does not attack C's necessity, but rather proves it.

Let us return to Mr. J.'s disease. A necessary condition for it, is the presence, in *his* body, and, more specifically in *his* blood, of certain bacilli. For if these bacilli were in my blood, Mr. J. would be as right as rain.

([16]) Indeed, an inus-condition can also be a general or typical event, as when I say e.g. "Poverty is the cause of wars".

Generalizing this example, we can say that there is a lawful connection between certain phenomena C and E. If each phenomenon e ($\in$E) is provided with spatiotemporal coordinates, and if the same happens to each c ($\in$C), we find a one-to-one correspondence between each member of the C's and each member of the E's. A necessary condition of the disease of mr. J. is the presence, in *his* blood, of some bacilli; a necessary condition for a given decease is the absorption immediately before of cyanide. We conclude then that the spatiotemporal coordinates form part of the relevant characteristics which the causal connection relates to each other.

If we formulate the results of this analysis more precisely, we can say that the statement 'C is necessary for E', is elliptic. It really means: if E is to happen, events of the type C must happen, and the spatiotemporal coordinates of those events are a function f of the spatiotemporal coordinates of the effect. Events of type E cannot happen, without events (i) which are of type C, and (ii) the spatiotemporal coordinates of which are determined by those of E by means of function f (or vice versa).

Since we have modified thus the concept of a necessary condition, let us examine the concepts of an absolutely and of a post factum necessary condition in the light of this modification.

I. Let C be an absolutely necessary condition to E (the bacilli in Mr. J.'s body e.g.). E has the spatiotemporal coordinates ij, which determine the coordinates of C; let them be kh.

The necessary condition of E_{ij} becomes then a complex one; we need indeed (i) a C, (ii) with coordinates kh. We call C_{kh} a concrete C. So the concrete group of bacilli which caused Mr. J.'s disease, was absolutely necessary to that disease.

To be sure, if some other group of bacilli, with coordinates lm, would have had the coordinates kh, then it would also have made Mr. J. ill. But we have seen how this trivial truth does not attack at all the actual necessity of the concrete group of bacilli which caused mr. J.'s disease. So, if Marc-Wogau says that another group of bacilli could have caused the disease of J. equally well, he is not very precise. For either this group does not have the required coordinates, and then it would remain harmless; or it has the required coordinates, but then we have

a case of cumulative causality we deal with in the following section, and which is entirely consistent with our position. In the first situation on the other hand, Marc-Wogau's remark is as pointless, as if one said: if a cow was a piece of copper, then it would expand after heating.

2. Let C be an inus-condition for E. E has the spatiotemporal coordinates ij, which determine the coordinates of C; let them be kh. We have then the following situation. C is necessary for E, only because some other sufficient conditions, e.g. the D's, are absent. But, if those D's are absent, then C should have the coordinates kh, in order that E may happen; with C_{lm} e.g., nothing would happen. This means that the concrete C_{kh} is post factum necessary for E. Now it is possible that the function which determines the spatiotemporal coordinates of C, is the same as the function determining the spatiotemporal coordinates of D. In this case, we would have a curious state of affairs. In so far as C_{kh} is a C, it is only post factum necessary; in so far as it has the coordinates kh, it would be absolutely necessary.

The following remarks are intended both to clarify and to shade somewhat the position of this section.

1. When we discussed Marc-Wogau's position, we asserted that a condition C can only be said to be necessary, if we consider it as an instance of the class of events it belongs to. But now, we say that the concrete C_{kh} is absolutely or post factum necessary for E.

This contention is nevertheless consistent with the previous point of view, for C_{kh} too can be considered as an instance of a class of events; its concreteness does not imply its absolute uniqueness. Necessary for E are all those events which (i) have the characteristic C, and (ii) the spatiotemporal coordinates of which are a given function f of the spatiotemporal coordinates of E. This is obvious, for there is a lawful connection between C and E, and between the spatiotemporal coordinates of both. So the spatiotemporal coordinates of C, which make it concrete, exemplify some functional connection, viz. f.

Even if we consider an E with given spatiotemporal coordinates, e.g. the "concrete" E_{ij}, it is possible that there are 2 or n

C's, having moreover the required spatiotemporal coordinates; — which proves convincingly that the concrete C_{kh} is a repeatable event; and that it is called the cause of E_{ij} only in so far as it is an instance of a type of events.

2. It seems shocking to consider the spatiotemporal coordinates of a given object as causally relevant proprieties; some people may have ontological scruples and objections against such a viewpoint. But the spatiotemporal coordinates have very often the statute of causally relevant data. If I know the position and velocity of a particle, I can calculate its position at any point of time. But also in other laws, which are neither mathematical, nor functional, nor physical, the spatiotemporal determination plays a prominent part. So the psychological theory of fixation contends that one will return to the *first* form of an intensive need-reduction.

Normally however, the spatiotemporal dependance of cause and effect is self-evident. From (Ax) $(fx \rightarrow gx)$, one infers, in relation to the *same* object a, a conjunction of the characteristics f and g; and so the spatiotemporal contiguity is guaranteed by the formulation of the law itself.

But when we deal with the vague and gappy causal laws of everyday language, where the spatiotemporal dependance of cause and effect does not result from the formulation of the law itself, it becomes relevant again to mention this spatiotemporal dependance.

The conclusion is then that the spatiotemporal coordinates are causally relevant data. Whether they have the same ontological statute like characteristics such as 'yellow' e.g., is a problem that we can ignore.

3. We said that there is a functional relation connecting the spatiotemporal coordinates of the effect and those of the cause, so that there would be a one-to-one correspondence between each c $(\in C)$ and each e $(\in E)$. But this is a too idealistic presentation. Especially the gappy causal laws will determine only vaguely the spatiotemporal area of the cause; there will be a more or less extensive spatiotemporal area where we can find the cause. Therefore, more than one cause may be active in the delimitated area; such a situation is called *cumulative causality*.

4. Let us finally emphasize that the spatiotemporal dependance of the cause on the coordinates of the effect (or vice versa) is consistent with the hypothesis of multiple causation.

Spatiotemporal coordinates of the effect delimitate more or less precisely the area in which the cause must happen. In this way the cause has received a spatiotemporal determination; but that is all. Its further specification is left entirely undecided. Given E_{ij}, one can still have C_{kh}, D_{lm}, F_{op}, and so on. Exceptionally, one will have, as observed above, $(C \vee D \vee F \ldots)_{ij}$, when the function connecting the spatiotemporal coordinates of cause and effect is the same for all the possible causes.

§ 4. *Cumulative Causality*

We alluded already to cumulative causality. Let us develop this theme, in order to show its implications for the notion of a cause. There is cumulative causality when two possible sufficient conditions of the causal genealogical tree are present at the same time, or when two instances of the same sufficient condition are present.

Let us call the first (instance of the) sufficient condition "a", and the second one "b"; and let the other relevant conditions be X. If a and b are absolutely sufficient conditions, it is obviously superfluous to include X; but let us assume that they are only relatively sufficient.

We have then the complex sufficient condition 'a and b and X'. This sufficient condition clearly is not minimal; it is redundant. So a and b should be ruled out as inus-conditions.

But we observe that either a *or* b is superfluous. And therefore, we transform the redundant sufficient condition 'a and b and X' into two minimal sufficient conditions 'a and X' and 'b and X'. And in these new minimal sufficient conditions, there is no objection to consider a and b as causes ([17]).

([17]) Contra MARC-WOGAU, a.c.: In such a situation as this, we are unsure how to use the word 'cause'. Id. J. L. MACKIE, *op. cit.* Naturally, there are many cases where only one of the conditions is redundant. Then, we change 'a.b.X' into 'b.X.' e.g.; and a is ruled out as an inus-condition *and* as a cause.

Nevertheless, it is impossible to maintain that a and b are necessary, not even post factum; either a or b can disappear, without the effect disappearing. Therefore, once again, they cannot be called inus-conditions. But this means that it is not part of the definition of a cause that it should be necessary, even in the most loose sense of the term. I think indeed that the causal vocabulary of everyday language emphasizes the minimal character of the sufficient condition. A condition is not acceptable as a cause if it makes a sufficient condition redundant; and conversely, it is called a cause if it is part of a minimal sufficient condition.

To be sure, a member of a minimal sufficient condition will normally be necessary, at least post factum. But in the case of cumulative causality, this is not so. Because it is possible to construct two minimal sufficient conditions, of which the cumulative causes are a part, I think it is reasonable to consider them as causes, even if they are not post factum necessary. This point of view is moreover in conformity with usage: we say indeed that there are two causes in situations of cumulative causality.

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