Causality and the Transitivity of Counterfactuals[1]

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§ 1. The analysis of causal statements in terms of counterfactual conditionals has given rise to an increasingly important field of inquiry in recent epistemology. Counterfactual conditionals are what ancient grammarians called « unreal hypothetical statements » : we state a counterfactual when we know that event A occurred, event B occurred and we assert that, if A had not occurred, B would not have occurred. Roughly speaking, any counterfactual theory of causality implies that, in some sense of the word « cause », to say that A has been a cause of B amounts to saying that A occurred, B occurred and that, had A not occurred, B would also have not occurred.

Even though the logical analysis of counterfactual conditionals is a new branch of modal logic, the counterfactual analysis of causal relation is indeed very old : jurists of the XIX Century called it the *conditio sine qua non* theory of causality, or the theory which reduces causes to necessary conditions.

The *conditio sine qua non* theory of causality has a venerable tradition in law studies but not in epistemology. It is proper in fact to recall that the mainstream tradition in contemporary epistemology reduces causes not to *necessary* conditions but to *sufficient* conditions. Contemporary humeans, the so called logical empiricists, have been faithful to the spirit of Hume's view of causality : a cause for them is simply an event which is followed in a non-accidental way by another event, which is called its effect. However, while Hume assumed that the existence of a causal connection is nothing more than a psychological illusion produced by habit, logical empiricists assumed that causal connections are granted by one or more laws of nature thanks to which the so-called effect

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is inferred by the so-called cause. Thus causes are seen as conditions which, conjoined with laws and other backgrounds conditions, are sufficient to infer the effect : as it is sometimes said, they are *ceteris paribus* sufficient for the effect.

By an odd accidental, however, Hume has been considered to be father both of the regularity view of causality and of the counterfactual view of causality. A perplexing passage in the *Enquiry Concerning Human Understanding* in fact runs as follows : « We may define a cause to be an object followed by another and where all the objects similar to the first are followed by objects similar to the second. Or, in other words, where, if the first object had not been, the second had never existed » (P. H. Nidditch ed., 1975, Oxford Clarendon, p. 86). In the second part of the sentence Hume uses a counterfactual conditional, while in the first he puts forward the notion of a cause as a sufficient condition. Moving just from the second part of Hume's celebrated sentence David Lewis formulated what is presently quoted as a paradigm version of a counterfactual theory of causation (see [7]). This theory differs from the humean one in at least in important respect : it does not include the requirement that causes are chronologically prior to the effects, and thus it allows backward causation and simultaneaous causation.

Furthermore, the motion of a counterfactual conditional is defined by Lewis not in terms of the inferability of the consequent from the antecedent but in terms of a particular relation obtaining among possible worlds. Lewis in fact introduces the conditional operator by the following definition :

> $A > B$ is true at a world w_0 if and only if all the worlds which are more similar to w_0 in which A is true are worlds in which B is true.

If we look more closely at Lewis' counterfactual theory of causality, however, we meet a puzzling point in his analysis. He distinguishes in fact between ***causal dependence*** and ***causation***. B, he says, is causally dependent from A if and only if A occurred, B occurred, and if A had not occured, B would also not have occurred. Let us define a ***causal chain*** as a finite sequence of particular events such that each one of them is causally dependent on the preceding one in the sequence. Then we will say that A causes B if and only if a causal chain exists between A and B.

Why is Lewis engaged in this strange duplication ? The reason is, to quote his words, that « causation must always be transitive; causal dependence may not be; so there can be causation whithout causal dependence » ([7], p. 563). In order to have a better understanding of this point, let us simply observe that the most similar A-worlds can be B-worlds, the most similar B-worlds can be C-worlds, but the most similar A-worlds may not be C-worlds.

§ 2. In what follows I will take for granted without discussion that *conditio sine qua non* theories of causality have more merits than sufficient condition

theories, even if they should be redormulated in a particular way which I shall try to elucidate in the second part of the paper. In the first part of the paper I shall argue that Lewis' contention that counterfactuals are not-transitive while causation is such is doubly defective. I shall try to argue in fact in favour of two different things :

1) There are strong arguments which support the transitivity of counterfactuals, especially in the particular case in which there are *causal* counterfactuals.
2) There are conflicting intuitions about the transitivity of causation which are obscured by Lewis' stipulation and we should take care to explain why such different intuitions arise.

§ 2.1. Lewis' semantics for conditionals is not the only possible way of associating a meaning to conditionals. The word « consequent » which is used to denote the second clause of a conditional suggests that the truth of a conditional depends on an elliptical consequence relation between the first and the second clause. This view of conditionals has been endorsed in the late '40 by Roderick Chisholm, Nelson Goodman and Hans Reichenbach. If we dislike speaking of the truth or falsity of a conditional, the consequence theory may be defended by looking at conditionals as condensed or « telescoped » arguments, which can be right or wrong but not true or false. The latter view has been supported by J. L. Mackie in many of his works (see especially [9]). From this theory it seems to follow that conditionals are transitive. If A > B is a telescoped argument from A to B, B > C is a telescoped argument from B to C, then A > C is a telescoped argument from A to C. The case of causal conditionals, however, could at a first sight be used against Mackie's theory. We can clear this point by recalling a well-known nursery rhyme which runs as follows :

For want of a nail the shoe was lost
For want of a shoe the horse was lost
For want of a horse the rider was lost
For want of a rider the battle was lost
For want of a battle the kingdom was lost
An all for the want of a horseshoe nail

Since Mackie favours a counterfactual theory of causality, the rhyme reduces to a list of counterfactuals, the last of which is « if a nail had not been lost a kingdom would not have been lost ». Mackie comments : « this conclusion is surprising if one assumes that causes must be proportional to their effects, but the moral of the nursery rhyme is that small causes can

trigger very large effects. Why not ? » ([10] p. 55). Mackie finds that the nursery rhyme gives no disproof of the transitivity of either causation or counterfactuals. So, being a supporter of the counterfactual theory of causation, he needs not subscribe to Lewis' perplexing distinction between causal dependence and causation.

Mackie's position, however, has to face the counterexamples to transitivity which are well known to students of Lewis' semantics. A well known counterexample is due to R. Stalnaker :

If Hoover had been Russian he would have been a communist.
If Hoover had been a communist he would have been a traitor
If Hoover had been Russian he would have been a traitor.

Stalnaker holds that in syllogism the premises are true while the conclusion is wrong. Reasoning in terms of Lewis' semantics, the most similar possible worlds in which Hoover was born in Russia are not worlds in which Hoover was a traitor. But a *prima facie* consideration about the syllogism is that the word « communist » is contextually ambiguous since it may mean « American communist » or « Russian communist ». In the first premise it is clearly intended (but not expressed) that a Russian Hoover would have been a Russian communist, while the second premise is true only if we intend to hypothesize that Hoover was an American communist. Mackie remarks here that we are in front of a case of an ambiguous middle term, a mistake which was well known to Medieval logicians. If Mackie was right, Stalnaker's example is reminiscent of some logical joke like the following

A cold coffee is better than nothing
Nothing is better than a warm coffee
A cold coffee is better than a warm coffee

which desappears if we stress the distinction between the surface structure and the deep structure of the sentences. The question of transitivity would then be solved by asking that sentences are disambiguated before being formalized.

Are we sure that disambiguation solves all the alleged counterexamples to transitivity ? It is not clear that this conclusion can be drawn in any case. Look for instance at the following example proposed by Crispin Wright ([17]) :

If there had been snow in the valley yesterday, I would have gone skiing
If an avalanche had then been taking place, there would have been snow in the valley yesterday
If an avalanche had been taking place yesterday, I would have gone skiing

Here it is not clear that an ambiguity occurs in the middle term, and yet a possible world theorist would say that the conclusion is false : in the most similar possible worlds where an avalanche had taken place it is false that I would have gone skiing.

Wright maintains that if the two premises are stated « in the same breath » we cannot really think that we are in front of a failure of transitivity, but simply think that the conclusion is correct. In this case, I am really transmitting my intention to go skiing in suicidal circumstances.

Wright proposes that when a counterfactual is entertained in a context where other counterfactuals are also entertained we adopt a semantic convention of the following sort :

> (C) When a number of counterfactual conditionals are in play in a single context, some single range of relevant worlds governs the assessment of them all.

In syntactical terms, the idea of Wright may be rendered more formally in this way. We may define A > B as « **W** $\wedge$ A logically implies B », where **W** stands for a constant which describes a fixed set of possible worlds, namely a set of worlds in which a fixed set of propositions is true. This is one of the possible ways in which we may render the idea that the consequent follows *ceteris paribus* from the antecedent. Then it may be proved that in any logic of what we may generically name logical implication (deductibility, strict implication, entailment) the syllogism

W $\wedge$ A logically implies B
W $\wedge$ B logically implies C
W $\wedge$ A logically implies C

is a valid one.

Wright's argument is convincing but perhaps not conclusive. Asking that counterfactuals in a syllogism are uttered « in the same breath » seems to imply that they are part of an argument, and also that the conclusion is a telescoped argument beginning with A and ending with C. Thus we are led back to Mackie's theory, and Wright's convention about the single range of possible worlds governing the assessment of counterfactuals works as a semantical counterpart of Mackie's theory of conditionals. But let us recall that this is not the only way to look at a consequence theory of conditionals. If we wish to assign a truth value to conditionals and take into consideration the Chisholm-Goodman-Reichenbach theory of conditionals, we may also think that the correct analysis of A > B is given by « **W**(A) $\wedge$ A logically implies B », where **W**(A) stands for the stock of background knowledge which is

revised in function of A. (If A is a counterfactual supposition, this revision consist in the minimal revision of the stock of knowledge which is compatible with A). If we endorse their perspective, however, the following syllogism turns out to be an unsound one :

$$\frac{\mathbf{W}(A) \wedge A \text{ logically implies } B \qquad \mathbf{W}(B) \wedge B \text{ logically implies } C}{\mathbf{W}(A) \wedge A \text{ logically implies } C}$$

§ 3. In the present context I will take for granted the consequence theory of conditionals, but I prefer to remain neutral between Mackie's version of it and the Chisholm-Goodman-Reichenbach one. It may also be admitted that if we do not think of counterfactuals as telescoped arguments then transitivity may not be defended in every case. What can be plausibly maintained in my opinion is however the weaker point that *causal* counterfactuals are transitive even in the Chisholm-Goodman-Reichenbach theory.

What is a causal counterfactual ? This definition is not difficult since a causal counterfactual, according both to common sense and to humean theory, is one in which the events which are supposed to be false are such that the first is chronologically prior to the second. What may be suggested here is what might be called a humean-counterfactual approach to causality. This makes a difference with Lewis'approach. Lewis avoids requiring temporal priority since he intends to grant that it makes sense to speak of simultaneous causality and of retrocausality. But if we assume, as I think we should do, that no argument in favour of these notions can be seriously entertained,[3] I see no serious argument against the requirement of temporal priority.

The temporal priority requirement throws a different light on the question of transitivity of counterfactuals. For instance, the counterfactual « If Hoover had been communist he would have been a traitor » is not a causal counterfactual in the defined sense, since the events « Hoover was *not* a communist » and « Hoover was *not* a traitor » are not such that the first is chronologically prior to the second. If one gives a restricted sense to the term « event », for instance in the sense of Kim'events (3-ples [A, x, t] where A is a property, x is and individual, t is a time), one might also maintain that they are not events at all. (see [5])

In the case of a syllogism involving causal counterfactuals $\neg\neg A > \neg B, \neg B >$

3 The relevant argument is exposed in [11]. One of the presupposition of the argument here is that we can always find a temporal interval under which, for any given causal notion, the causal inference turns out to be transitive. This implies of course that we always find an interval in which counterfactual inference is transitive : in a sense, this amounts to a chronological variant of what Wright calls « the same breath », which is here identified non as property of utterance but as property of the chronological distance between the events which are supposed to be false.

$\neg C$ then we have $t(A) < t(B) < t(C)$ (where $t(A)$ stands for the time at which event A has a beginning). Now it is reasonable to introduce a principle governing the relation between the temporal order of events and the revision of background knowledge of chronologically ordered events. The weakest statement of this principle seems to be the following :

(R1) If $t(A) < t(B)$ then $\mathbf{W}(\neg A) \wedge \neg B$ logically implies $\mathbf{W}(\neg B)$.

Since the principle does not hold in case $t(A) \geq t(B)$, it actually implies that there an asymmetry in the revision of our knowledge depending on the relative position of B in respect of A on the time axis. The idea is simply that in the direction of the future the revision operated in function of a prior hypothesis entails the revision in function of any posterior hypothesis, while nothing of this kind is requested for the past. The past is, then, more insensitive to revision than the future : we are in front, actually, of a weak version of the so-called principle of Past Dominance, which is endorsed by many authors working with tensed variants of Stalnaker-Lewis logic[4].

If we accept this plausible principle the following inferential schema turns out to be sound

(0) $t(A) < t(B)$
(1) $\mathbf{W}(\neg A) \wedge \neg B$ logically implies $\mathbf{W}(\neg B) \wedge \neg B$
(2) $\mathbf{W}(\neg A) \wedge \neg\neg A$ logically implies $\neg B$
(3) $\mathbf{W}(\neg B) \wedge \neg B$ logically implies $\neg C$
(4) $\mathbf{W}(\neg A) \wedge \neg A$ logically implies $\neg C$

The justification for line (4) may be given as follows : line (1) follows from R1 and standard logic, line (2) equals (2') : $\mathbf{W}(\neg A) \wedge \neg A$ logically implies $\mathbf{W}(\neg A) \wedge \neg B$, and (4) follows from (2') (1) and (3) by transitivity of logical implication. Then by adopting R1 we have that from $A > B$ and $B > C$, $A > C$ necessarily follows, so that transitivity is to be accepted for causal counterfactuals.

§ 5. Let us take stock. I have argued that if we subscribe, as I do, to the consequence theory of conditionals, even if we are uncertain about their having or not a truth value, there are strong arguments justifying the transitivity of what we named causal counterfactuals.

4 See for instance [3]. This does not mean of course that « back-tracking counterfactuals » are all false, as it was maintained by Lewis int his first reflections on this topic, but simply that the applicability of the *ceteris paribus* clause in the direction from past to future may be easier in given contexts, so that validating non-back-tracking counterfactuals becomes more frequently a legitimate move than working in the reverse temporal direction.

Our analysis seems at this point convergent with Lewis' analysis, even if Lewis introduces by *fiat* transitivity as a property of causation by *fiat* while denying that it holds for causal (counterfactuals) dependence. The problem is now to understand why causal transitivity has been so widely criticized and negated, up to the point reached by those philosophers who hold that causal relations are essentialy *in*transitive. The answer I will try to articulate is that modern epistemology failed to perceive that we do not use a unique notion of a cause but a plurality of them, some of which are correctly assumed to be transitive, while others are correctly assumed to be non-transitive.

An implicit suggestion in this direction comes from Suppes' probabilistic theory of causality, even if this author did not develop properly the subject of the plurality of causal notions. Suppes' theory may be informally stated by saying that A is a *prima facie* cause of B if and only if A precedes B and A increases the probability of B ($Pr(B/A) > Pr(B)$), while it is a *genuine* cause if and only if no third event C exists whose probability « factors out » the probabilistic relevance of A for B ($Pr\ B/A \wedge C) = Pr(B/C)$. In the latter case we say that A is a *spurious* cause of B.

It is not difficult to find that the notion of a genuine cause is not transitive for every probability value, but we can also realize that there are meaningful probability values for which transitivity holds. The simplest case is given by the so called sufficient cause, defined as $Pr(A/B) = 1$. If $Pr(B/A) = 1$ and $Pr(C/B) = 1$, then $Pr(C/A) = 1$.

What emerges from this remark is that if we stipulate that every probability assignment identifies a different causal notion it follows that there are different causal notions which have a different logical behaviour in respect of transitivity. This interesting feature of Suppes' theory of causality may suggest that this theory is really more basic than other theory of causality since it gives an account of a spectrum of different causal notions.

Even if we are convinced of the importance of Suppes' theory, however, we cannot deny that the notion of spurious causation and of genuine causation introduced in it are seriously defective. Let us think for instance of the cases of so-called overdetermination, namely of the cases of two causes jointly sufficient and none necessary for the effect. Let us suppose that Watson and Holmes aim to kill Moriarty by firing two different shots which reach his body simultaneously.[5] Thus $Pr\ A/B = 1$, $Pr\ A/C = 1$, $Pr\ A/B \wedge C = 1$, and the conclusion is that B is a spurious cause for the effect C if $t(C) < t(B)$. Thus it seems that there is something wrong in the notion of spuriousness in Suppes' sense. And we may understand why : the most simple way to discriminate spurious causes and genuine causes is to perform a *Gedankexperiment*, namely to imagine what would have happened if the supposed cause had been absent. The celebrated example of the barometer is a quite

5 I borrow this example from [13], p. 109.

standard example. The falling of a barometer is a spurious cause of the following storm since, in possible worlds where the barometer does not exists and so it is false the barometer fell, it is still true that the storm took place.[6] The same simple idea is defended by Max Weber in his *Critical Essays about the Logic of Human Sciences* ([16], Ch. 2., part II) : in order to establish if the Sarajevo shots were or were not the cause of the First World War we have to ask what would have happened if they nad not been fired.

In moving from a criticism to the probabilistic theory of causality, we are so taken back again to a counterfactual theory of causality. We have now to show that it is possible to save the basic idea of this theory in such a way as to treat the question of transitivity in a framework which admits the existence of a plurality of causal notions.

The key idea which I would like to defend is that what I before called causal counterfactuals represent a notion of causality which is simply a « threshold » causal notion, namely something minimal under which we cannot go whenever we want to say something which is causally meaningful. Using « O » as a symbol for the occurrence operation, we can so define a causal counterfactual as a zero-degree causal notion :

$$A\ C^{o}B =_{Df} OA \wedge OB \wedge \text{not-}OA > \text{not-}OB \wedge t(A) < t(B)$$

Let us notice however that this notion is a zero-degree one in two different senses. First, the zero-degree notion of a cause is the degenerate case in which no further information about A and B is specified. Notions such as the ones of contributory cause, determining cause, triggering cause, retarding cause ecc. are different causal notions which are obtained by adding further qualified information to the zero-degree causal notions. If we want to give a name to this minimal notion, we may call it the notion of *causal relevance.* But is a degenerate notion of causality also in a different sense. In order to illustrate the second sense let me open a logical parenthesis.

A conditional may contain as well-formed subparts other conditionals, in this way :

$A > B$	1° degree
$A > (B > C)$, $(A > B) > C$ etc.	2° degree
$A > (B > (C > D))$ etc.	3° degree

Contrary to what some philosophers maintain,[7] we may give an independent meaning to iterated conditionals. $A > (B > C)$ might for instance be

6 The reason to suppose that the barometer does not exists is clarified in the last section of the paper.

7 See for instance [1] and [4].

read in the following way : from the truth of A it is inferrable that a possible situation exists such that in it it would be true to assert that C is inferrable from B. This is not the same as saying $(A \wedge B) > C$. In fact, the members of a conjunction may be permuted, while the antecedents of an interated conditionals may not. Look for instance at this couple of statements :

If I were thirsty, drinking a glass of water I would feel better
If I had drunk a glass of water, being thirsty I would feel better

The latter no only sounds different from the former, but seems to be false in cases in which the first seems to be true.

A simple notion of cause which can be defined by using first degree conditionals is the notion which we will call of concurring cause. We may say in fact :

A is concurring along with B for
$C =_{Df} OA \wedge OB \wedge OC \wedge \neg OA > (\neg\neg OB > \neg OC) \wedge t(A) < t(C) \wedge t(B) < t(C)$[8]

In which cases may we find examples of what we call here concurring causes ? The most simple reply is : just in the case of overdetermination which was unsolved in a probabilistic framework. We may say « if Watson had not fired his shot then, in absence of Homes'shot, Moriarty would have not died ». Thus in the present framework overdetermination is not a problem for counterfactual theories, while it is for probabilistic theory. And the problem cannot be easily solved by probabilistic means since iteration of probabilistic statement turns out to be a puzzling problem for probabilistic theory. This result may be seem as somewhat surprising since overdetermination has been always considered to be a problem for *conditio sine qua non* theories of causality, and not for probabilistic ones (see [12]).

We have now to look at what follows from the present viewpoint for the question of transitivity.

The first result may be simply stated as follows. Let C' and C'' be two first-degree causal notions and let us suppose that A C'B and B C'' C. Since we already know that any first degree causal notion has form A C° B $\wedge \delta$, where δ is some qualified additional information, each one of these statements implies A C° B and B C° C respectively. And since we know that C° is transitive, we conclude that A C° C.

8 Notice that counterfactuals having an embedded conditional in the antecedent, as it happens for instance in $(\neg OA > \neg\neg OB) > \neg\neg OC$ or in $\neg(OA > OB) > \neg OC$, are normally not interpretable as causal counterfactuals. This does not exclude that some far-fetched causal notion different from the one of a concurring cause could find a definition in terms of nested conditionals, but ir unlikely that this may add something to the framework which is here outlined.

What precedes is simply the minimum we are able to say on this subject, since it amounts to saying that transitivity holds if the conclusion expresses the weakest causal relation we are able to define. (In a sense this result gives a particular version of the principle *sequitur conclusio peiorem partem*) But we can prove that transitivity sometimes holds, depending from the definition of δ, even if causal relations of the same type are involved in the syllogism. Think for instance of the notion of *remote* cause. It is intuitive that if A is a remote cause of B and B is a remote cause of C then A is also a remote cause of C. And the syllogism can be rendered formally if we define this notion as $A \; C^{\circ} \; B \wedge \delta$, where δ stands for a statements implying $[t(B) - t(A)] > m$, where m is an interval after which a cause is considered to be a remote one.

The notion of proximate cause is however not transitive : if A is a proximate cause of B and B is a proximate cause of C, then A in general is not a proximate cause of C.

The notions of *anticipating* and *retarding* cause on the other hand are transitive : if A is an anticipating cause of B and B is an anticipating cause of C, then A is an anticipating cause of C; if A is a retarding cause of B and B is a retarding cause of C, then A is a retarding cause of C.

The presence of this spectrum of causal notions of course leaves us with the problem of identifying the general form of a causal statement, or the form of a generic causal statement. This problem falls out of the scope of our analysis here, but it is not of difficult solution. By employing existential quantification we may define in fact « being a cause » as « being a concurring cause of some degree (where the degree is defined in terms of the number of nesting of the corner operator) conjoined with some additional statement δ ».

The question of transitivity becomes more complex if one of the premisses contains not a zero-degree but a higher-degree causal notion. It makes sense to ask what follows for instance from the premisses « A is concurring with B for C » and « C is causally relevant for D ». Might we conclude that A is a concurring cause along with B for D ? The answer seems to be a negative one, but a correct reply might be given by applying a suitable decision procedure for the conditionals which are formalized in the background logic.[9]

An interesting paper by Peter Unger published in 1977 (see [15]) suggests the thought-provoking thesis that causation is intransitive. Unger remarks that it is a grammar mistake to say something like « Bill's sneezing caused

9 In the case of syllogisms involving higher degree causal notions it is even difficult to give a correct formulation of what transitivity should be like. It is plausible to take for granted that, If A is a concurring cause with B for C, and C is causally relevant for D, then transitivity holds if A is a concurring cause with B for C. But this stipulation might also be questioned, since we might make the stronger request that transitivity holds if, under the given premisses, A is causally relevant for C *and* B is also such, ot the weaker request that transitivity holds if, under the given premisses, A is causally relevant for C *or* B is such.

Betty to catch a cold, and so did something else » or « the stone broke the glass, and also something else did ». Thus in the case of a causal syllogism what we must say is : « the stone broke the glass, the breakage of the glass dirtied the floor, so the stone was not the cause of dirty on the floor ». But the trouble is that Unger has in mind a particular notion of causality, the notion of *productive* cause. From Piaget's analysis we may agree that this is the most psychologically primitive notion of causality we dispose of : it is sometimes called the genetic notion of causation, which is covered by the so-called transitive verbs in ordinary language : to push, to move, to kill, to remove, to dirty (ironically, then, it seems, that just transitive verb give rise to an intransitive notion of causality).

What Unger notes is then the uncontroversial fact that at least a causal notion C''' exists such that

$$\frac{A\ C'''\ B \qquad B\ C'''\ C}{\text{not}(a\ C'''\ C)}$$

is true. But we are able to say that

$$\frac{A\ C'''\ B \qquad B\ C''''\ C}{A\ C^{o}\ C}$$

is a correct syllogism. Notice in fact that if we paraphrased the example in the language of events it makes sense, and it is true, to say : if the stone had not broken the glass, the floor would have not been dirtied.

The most interesting question about transitivity of causality arises, in fact, when we look at some alleged counterexamples to transitivity in which the conclusion of the syllogism is simply a causal counterfactual. The most interesting counterexample I found in the literature has been recently proposed by Jig-Chuen-Lee (see [6]).

The example is as follows. Smith somehow mistook a glass of scotch on the rocks as a glass of water and was about to drink it. Just moments before Smith drank from the glass, Jones poured orange juice into the glass. Although Smith was not allergic to orange juice, he was allergic to alcohol. He sneezed as a result of drinking punch. Now we may argue that Jones' pouring orange juice into the glass was a cause of Smith's drinking punch, Smith's drinking punch was a cause of Smith's sneezing, but not that Jones' pouring orange juice is a cause of Smith's sneezing. The conclusion of the syllogism seems to be incorrect also interpreting causal relations counterfactually. It seems to be wrong to conclude that if

Jones had not poured orange juice Smith would have not sneezed : he would have sneezed anyway, since he was allergic to alcohol and not to orange juice, contrary to the thesis which has been defended up to this point.

This *prima facie* counterexample has the merit of throwing light on how difficult is to ascertain the truth value of a counterfactual, especially if the negation of some event-occurrence is hypothesized in it. As we have already remarked, sentences have to be disambiguated before establishing their truth-value. Thus if I say

> « If Jones had not drunk punch he would have not sneezed » the orthol-inguistic version is
> « If it were false that occurred the event which is Jones' drinking punch, it would be false that occurred the event which is Jones' sneezing ».

The key point here is that to suppose the falsity of an occurrence statement seems to involve an ambiguity. If I deny, for instance, that Jones met Smith, which is the part (or the parts) of the statement which I am denying ? The choice is for instance between

a) it is false that *Jones* met Smith
b) it is false that Jones *met* Smith
c) it is false that Jones met *Smith*

Following Fred Dretske (see [2]) let us call *propositional allomorphs* the different variants of the same sentences. Dretske claims that causal *relata* are not events but descriptional allomorphic events as, for instance, « *Smith's* drinking punch », « Smith's *drinking* punch », « Smith's drinking *punch* ».

We may reach the same result which is involved in Dretske' analysis in another way. We may stick in fact to the already mentioned Kim's view of the events, which we may now define in a more general way as as 3-ples of form $[A^k, b^n, t]$, where A^k is a n-place predicate, b^n a n-ple and t a period. Thus we may stipulate that events occurr when b has the property A at t, that it lacks this property at t-1, and that all the objects in b really exist in interval t. Asserting that $[A^k, b^n, t]$ does not occurr is then an ambiguous assertion, since it consists in denying at least one or the other of these subassertions.

Saying that a counterfactual $-\neg OA > -\neg OB$ is true, if A stands for an event in the mentioned sense, amounts then to asserting that the consequent $-\neg OB$ follows from *every one* of such sub-hypotheses along with the minimally revised background knowledge.

Let us then consider what follows from the hypotheses that punch was not existing (in that particular spatio-temporal location or universally). Since it is contextually presupposed that the glass was full with whiskey on the rocks, it follows that Smith would have drunk whiskey on the rocks or perhaps whiskey on the rocks along with something else, different from orange juice, which Jones might have poured into his glass. It is then false that, if he had not drunk punch, he would have not sneezed : in fact, he would have drunk anyway whiskey not mixed with orange juice. Thus the second premisse of the syllogism is false and the syllogism turns out to be vacuously correct.

Reasoning in terms of Lewis' semantics, the most similar possible worlds in which Smith drank something but no punch are worlds in which Smith drank whiskey, so he had surely sneezed, being allergic to alcohol. The consequentialist answer in this case is coincident with Lewis' one : the consequent does not follow *ceteris paribus* from the antecedent.

The procedure here described may seem to be more complicated than we normally believe whould be applied to conditional statements. It should be clear, however, that the procedure is nothing more than an application of the principle that every sentence has to be disambiguated before we assign it a truth value. A pleasant result of this supplementary work is anyway that transitivity of causal relations, at least in the restricted sense which I tried to characterize, turns out to be insensitive also to some counterexamples due to the ambiguity of event-description.

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