

Causation as regularity. The short circuit A caused the fire P. Meaning what? Maybe this: Earlier event both necessary and sufficient for effect. But that can't be quite right. The short circuit isn't necessary – why not? It isn't sufficient either – why not?

OK, but something related seems true. The short circuit *conjoined with certain other obtaining conditions* is sufficient. And the short circuit is an indispensable part of the conjunction. Take it out and you no longer have sufficiency. It is necessary after all, not in the original sense but in the sense of a necessary part of a sufficient condition. It's for short an INUS condition: Insufficient but Necessary part of a condition Unnecessary but Sufficient for the result.

Say A is the inus condition. It together with B and C is sufficient. Also sufficient, let's say, would be D, E, and F, G, H, and I, etc. So $ABC \vee DEF \vee GHI \vee \dots$ is necessary and sufficient. Now we simplify by abbreviating BC to X and $DEF \vee GHI \vee \dots$ to Y; the result is $AX \vee Y$.

A is an INUS condition of a result P iff

for some X and Y, (i) $AX \vee Y$ is necessary and sufficient for P, but (ii) A is not sufficient itself (insufficient necessary part) itself and (iii) neither is X (insufficient necessary part); also AX is not necessary (...of an unnecessary sufficient condition).

Here is the proposal: "A caused P" often means that

- (i) A is an INUS condition of P
- (ii) A was present on the occasion in question
- (iii) the X factors if any were present
- (iv) the Y disjuncts were absent (simplifying here)

This misses something. See it best with general causation. What causes flu? This might mean: what distinguishes people in general who get it from those who don't. (They catch a bug.) Or it might mean: what distinguishes those exposed who get it from those who don't? (Weak immune system.) So causal attributions are relative to a "causal field"; people in general, or people exposed.

Can see it in singular case too: what caused this student's skin cancer? Could mean: why did she develop it now as opposed to earlier? (Radiation.) Or: why did she develop it while others equally exposed to radiation did not? (Forgot to wear protective clothing.) Causal field in first case is stages of the student's life, in second it's people exposed to radiation.

Go back to fire example. Most natural interpretation is: why did it catch fire now as opposed to earlier or later? But could also mean: why this house in particular since short circuits are happening all the time? Field is sometimes called contrast class. In place of (i) we need

- (ia) A is INUS in field F – meaning there is a condition $AX \vee Y$ such that $(AX \vee Y)$ is necessary and sufficient *looking just at cases of type F* (so, $(AX \vee Y) \wedge F \Leftrightarrow P \wedge F$)

Field often implicit or taken for granted; interesting exercise to work out what it is.

General causal statements. "Lack of credit causes unemployment." "Eating sweets causes tooth decay." Analysis similar except that A, P etc. become types of event rather than tokens. This means we have to drop conditions like (ii) and (iii); A and X will be present sometimes and not other times.

In a "developed economic theory," you'd have to state the field, and possibly also X and Y. At the other extreme you'd say some salient F, X, and Y, not sure which. Usually we're somewhere in between. "We do not know, indeed it is not true, that the eating of sweets by any such person is a sufficient condition for dental decay:" some people have peculiarly resistant teeth, some brush a lot..."All we know is the sweet-eating combined with a set of positive and negative factors we can specify only roughly and incompletely constitute a sufficient and unnecessary condition for dental decay."

Next, what is meant by necessity and sufficiency in claims like "S is a necessary condition of T." If S and T are general, could mean all cases of T are cases of S. But not if they are singular. "All cases of this house's catching fire just now are cases of a short-circuit occurring here a moment before." Why can't that work? No, a particular token event S is necessary for a particular token event T iff T would not have occurred if S hadn't occurred. Notation for this is $\sim S \square \rightarrow \sim T$. What about sufficiency? Mackie suggests a so-called semi-factual: "since a short-circuit occurred here, this house caught fire." Hard to explain semi-factuals the way we explain counterfactuals. True $\square \rightarrow$ True is always True on the standard nearest-possible-world analysis.

A word about causal priority since this is Lewis's reason for preferring counterfactual account. It might seem that S is sufficient/necessary for T iff T is necessary/sufficient for S. But then *S necessary and sufficient for T* is equivalent to *T necessary and sufficient for S*. Given time-symmetry of laws, it seems likely we can find a future $AX \vee Y$ that is necessary and sufficient for current P. E.g., putting a dollar in the coke machine (that's P) is necessary and sufficient for the following disjunction: coke coming out and no money returned (that's AX) \vee no coke coming out and money returned (that's Y).

How to handle priority? Could stipulate that the event that happens first is the cause. Two problems with this. One, couldn't there be backward or simultaneous causation? Maybe not, but it shouldn't be stipulated away; need an explanation of why not and this is prevented if temporal priority is written into the definition. Two, there is a separate problem of explaining temporal priority, and some would want to do it causally.

Mackie gestures in the direction of an idea of Popper's. Let A be necessary and sufficient for B; which is prior? Imagine that A is simple (rock hitting pond) and B a complex coincidence (corks bobbing all over pond). Then other things equal we think that A causes B rather than other way around.

You could formalize the idea like this. Suppose B is a complex event might up of $B_1 \dots B_n$. And suppose there are strong probabilistic correlation between $B_1 \dots B_n$: $P(B_i/B_j) \gg P(B_i)$. (It's likelier that this cork will bob if that one does.) A is prior to B iff these correlations are "screened off" by A. $P(B_i/B_j \& A)$ is NOT $\gg P(B_i/A)$. That the cork correlations are screened off by the rock hitting the water suggests that any information B_1 is giving you about B_2 is due to the fact that B_1 and B_2 are both probabilistically linked to their common cause A.

Further examples. A is dollar going in, B_1 is light coming on, B_2 is coke emerging. A's causation of B_1 and B_2 shows up in the fact that any correlation between the B_i s "goes away" when you stipulate that A occurred. Again, Betty's turning in homework on a certain day correlates with Bob's turning them in. $P(B_2/B_1) \gg P(B_2)$. But the reason is all to with the instructor's request A. $P(B_2/B_1 \& A)$ is not $\gg P(B_2/A)$. So, Mackie says, direction of causation is direction of screening off.