IF, SINCE AND BECAUSE: A STUDY IN CONDITIONAL CONNECTION

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Thirty years ago Gilbert Ryle published a paper entitled *"If", "So", and "Because"* (Ryle [1950]) in which with great sensitivity he investigates the logical powers and limitations of these words. "If" provides us with an inference-ticket, "because" puts the inference-ticket to work in one way, "so" (which stands apart from the other two in signalling an argument) in another. Our concern here will be not so much with "so" but with "since", which I shall argue indicates a connection between antecedent and consequent in "since p, q" that is lacking in many uses of "if". With the help of "since" and "because" I shall single out a distinctive reading of "if" which *does* reflect such a connection, for which the task of the paper will be to provide precise truth-conditions.

My point of departure will be the truth-conditions for "if" found in Stalnaker [1968]. Consider the conditional:

(1) If the Polish government fails to crush Solidarity, labour unrest will spread to the Soviet Union.

How would you decide whether to accept (1) as true? Stalnaker's suggested procedure is as follows. Add the antecedent hypothetically to your stock of beliefs, make whatever adjustments reason demands, and ask whether you then believe the consequent. As Stalnaker points out, there are two cases. If you believe that a causal or some other kind of connection exists between antecedent and consequent, you will accept the consequent. If on the other hand you do not believe that such a connection exists, but believe the consequent on other grounds (say on grounds that labour unrest is inevitable in repressive regimes) then again you will accept the consequent. In either case, by Stalnaker's semantics, you accept the entire conditional (1) as true.

These semantics have the virtue of making causal or other connections between antecedent and consequent relevant when they are relevant, but at the same time allowing conditionals to be true on other grounds when they are absent.

Stalnaker's semantics, which allow for "connection" but fail to treat it as essential, provide an analysis of the conditional which admits of wide application and which has met with wide acceptance. It is certainly an advantage to be able to regard "if" as univocal, and to produce a single set of truth-conditions which work for all or almost all cases. But doubts remain about whether "if" really is univocal (see Aune [1967] for various kinds of "if"), and about whether in imposing a single set of truth-conditions we may not be forcing conditionals into a mould that fits some but not all. For example, suppose the present configuration of the solar system makes it inevitable that the earth will collide with a comet in 1997. Then Stalnaker's semantics verify the conditional:

(2) If the US does not renounce the use of nuclear weapons, the earth will be struck by a comet in 1997.

Yet it is doubtful that many would accept (2) as true, much less as a persuasive reason for nuclear disarmament. Lack of connection between antecedent and consequent would normally be given as the explanation, even though the consequent were accepted as true. For this reason it seems preferable to attempt to provide separate truth-conditions for a stricter variety of conditional which requires the presence of such a connection, the conditional in question coming out false if the connection is lacking. ([1])

A connection of this kind between antecedent and consequent can be explicated using a branching indeterministic modification of the

([1]) Conditionals based upon a supposed connection between antecedent and consequent have a venerable history. Sextus Empiricus, reporting the debate on the nature of conditionals in the fourth century BC, "when even the crows on the rooftops croaked about which conditionals were true", mentions one of four rival schools of thought as "introducing the notion of connection." See W. and M. Kneale [1962] p. 129. More recently, the idea of connection is discussed in Pollock [1975] and [1976], and in Nute [1980]. Pollock, however, does not provide connexive or "necessitation" conditionals with semantics built up from scratch, but defines them in terms of a basic Stalnaker-type conditional which is neutral with respect to connection.

possible world semantics for subjunctive and counterfactual conditionals developed by Stalnaker and Lewis. (2) Briefly, branched possible world model structures are tree-like continua, branching towards the future, each branch of which is a complete four-dimensional "history" of events. A branch point occurs at every moment in time when two or more sets of events are each physically possible relative to an earlier set of events. The actual history of the world is one branch of the tree, complete up to the present, but nothing dictates which of the many future branches will become actual. The structure is indeterministic because if determinism were true, only one set of events would be physically possible relative to each momentary state of affairs, and the tree would consist of only one branch. As we shall see, the semantics for connexive conditionals require many branches, the connection between antecedent and consequent being dependent on how the branches are arranged.

As an example take Strawson's counterfactual:

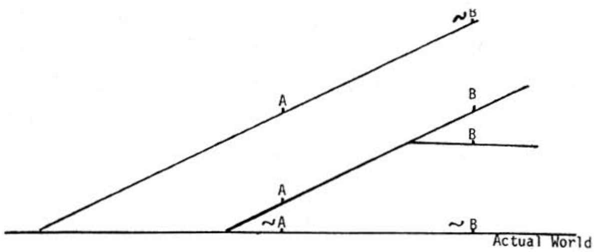
(3) If the Germans had invaded England in 1940, they would have won the war.

To determine whether (3) is true, we follow Stalnaker's and Lewis' instructions and examine those possible worlds in which the antecedent is true but which in other respects most closely resemble the actual world. In the branched course-of-events semantics we examine those worlds which branch off from the actual world in 1940, or as close as possible to 1940. The reason why we do not consider worlds which branch off earlier, say in the 1920's and 30's when Churchill was urging military preparedness, is that in some of these worlds Britain's armed strength would doubtless here been greater than it actually was in 1940; these considerations are irrelevant to the truth or falsehood of (3). At the same time, we cannot consider histories in which there is a discontinuity with the actual world, and in which Germany miraculously assembles an invasion armada overnight. The transition must in all cases be smooth and lawlike (at least within the bounds of physical possibility), which of course gives Britain a certain amount of time to prepare countermeasures. All this is relevant to the

(2) STALNAKER [1968], LEWIS [1973] and [1979]. The branched version is found in McCALL [1976] and [1982].

truth of (3). In the branched worlds semantics the rather flexible notion of possible world similarity, purposely left vague in Lewis [1973], is replaced by the more precise notion of the amount of common past that two branching worlds share.

A counterfactual $A \Box\!\!\rightarrow B$, then, is non-vacuously true if and only if in the following diagram every closest A-world is a B-world: (3)



The truth-conditions can also be stated in this way: some A & B-world is closer to the actual world than any A & $\sim B$-world (Pollock [1976], p. 19; cf. Lewis [1973] p. 16). What is important here is the location of the A & $\sim B$-worlds which falsify the conditional. The key to the notion of "connection" which we are trying to capture lies in the requirement that they must in all cases fall outside the set of A & B-worlds, $\sim A$ & $\sim B$-worlds, and possibly also $\sim A$ & B-worlds, centred on the actual world.

Can there be true counterfactuals the time of whose antecedents is later than that of their consequents? There seems no reason why not. In order to fly to London, one must leave Montreal the previous night. Hence the following conditionals hold:

(4) If Alex had not left Montreal Tuesday night, he would not have arrived in London Wednesday morning;
(5) If Alex had arrived in London Wednesday morning, he would have had to leave Montreal Tuesday night.

(3) "Every closest" because as Lewis points out there may be ties for closest, or an open set of closer and closer worlds but no closest. In addition, at least one A & B-world must exist. $A \Box\!\!\rightarrow B$ is vacuously true in Lewis' and Stalnaker's semantics if there are no A-worlds.

Let us call (4) a "forward counterfactual", and (5) a "backward counterfactual". Plainly there are many true backward counterfactuals, which are characterized by a syntactic peculiarity noted by Lewis (1979), p. 458. It would be possible to replace the words "he would have had to leave" in (5) by "he would have left", although the result would be less idiomatic. This modalization of the consequent of backward conditionals is part of standard usage, although its underlying rationalization is unclear. ([4])

What truth-conditions are appropriate for backward counterfactuals? Essentially the same as for forward ones. The counterfactual $A \Box\!\!\rightarrow B$ is non-vacuously true iff every closest A-world is a B-world. This holds whether the time of A is earlier than, later than or the same as the time of B. The conditional (5) above will be true if every closest branch on which Alex arrives in London Wednesday morning is a branch on which he leaves Montreal Tuesday night. The truth-conditions for backward counterfactuals are thus no different from those for forward ones.

Counterfactual conditionals are those in which both antecedent and consequent are false. If antecedent and consequent are both true, the result is what Goodman [1955], p. 4 calls a "factual" conditional. Such conditionals are expressed with greater felicity using "since" rather than "if":

(6) If the butter had been heated to 150°F, it would have melted;
(7) Since the butter didn't melt, it wasn't heated (couldn't have been heated) to 150°F.

In this case, (7) is a backward factual, but forward factuals are just as common:

(8) Since Tom comes from Lunenburg he knows how to row a boat.

The word "since" marks the link between antecedent and consequent, indicating whatever it is that distinguishes (8) from

(9) Tom comes from Lunenburg and he knows how to row a boat.

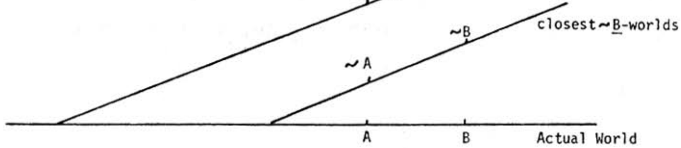
([4]) Another example: If Nelson got to town today, there'll be beer in the fridge; so if there's no beer in the fridge, Nelson can't have got to town.

It is "since", Goodman remarks, that "shows that what is in question is a certain kind of connection between the two component sentences; and the truth of statements of this kind – whether they have the form of counterfactual or factual conditionals or some other form – depends not upon the truth or falsity of the components but upon whether the intended connection obtains" (p. 5). The same would apply to the word "because", which could also be used to distinguish (8) from (9).

Now for semantics. The problem is to provide, for statements like (7) and (8), truth-conditions which are sensitive to the presence of a connection and do not automatically assign the value "true" to any conditional with true antecedent and consequent. The Stalnaker-Lewis semantics, of course, do assign $A \boxright B$ the value "true" whenever A and B are true, for in that case the closest A-world is the actual world, and the actual world is a B-world. These semantics verify conditionals like:

(10) If Hitler is dead then Mazzini unified Italy. [5]

Semantics for factual conditionals $A \boxright B$ which catch the idea of connection must require that not only the actual world (which might after all constitute an atypical case) but also many neighboring branches be $A \& B$-worlds. As in the case of counterfactuals, the crucial question concerns the presence of falsifying $A \& \sim B$-worlds. If $A \boxright B$ is to be true is virtue of a connection between A and B, how close should such worlds be? Since the actual world is $A \& B$, it would seem unwise to permit $A \boxright B$ to be true given that the closest $\sim B$-worlds were A-worlds, for in that case it might be only a happy accident that the actual world was $A \& B$ rather than $A \& \sim B$. The alternative is that the closest $\sim B$-worlds should be $\sim A$-worlds, yielding the following:



(5) See LEWIS [1973] p. 26, POLLOCK [1976] p. 38, and NUTE [1980] pp. 6-7.

As an illustration consider the following variant of Goodman's factual conditional:

(11) Since the butter was heated to 150°F, it melted.

Our truth-conditions require that the closest branches on which the butter does not melt are branches on which it is not heated to 150°F. This requirement accomplishes what is wanted, namely to characterize branches on which the butter is heated to 150°F and does not melt – branches which falsify (11) – as more remote from the actual world than branches on which the butter is neither heated nor melts. This is not to say that there are no branches at all on which the butter is heated to 150°F and fails to melt: branches on which the butter is treated with a hardening substance which raises its melting point would be examples. But if (11) is to be true, these branches must diverge from the actual world at an earlier time than branches on which the butter is neither heated nor melts. For a factual conditional $A \mathrel{\Box\!\!\rightarrow} B$ to be true, some $\sim A \,\&\, \sim B$-worlds must be closer than any $A \,\&\, \sim B$-worlds.

Exactly the same considerations apply to subjunctive conditionals and to indicative conditionals in the present or future tense:

(12) If the track were to be muddy, Sunny Dancer would win.
(13) If the track is muddy, Sunny Dancer will win.

For (12) and (13) to be true, what is needed? Presumably what faces us is an array of possible outcomes of four different types: (i) the track is muddy and Sunny wins, (ii) the track is not muddy and Sunny wins, (iii) the track is not muddy and Sunny loses, (iv) the track is muddy and Sunny loses. If (12) and (13) are true, then type (iv) outcomes must lie outside a cone of solid type (i) - (iii) outcomes. Furthermore, we must already have passed the point beyond which no type (iv) worlds are accessible. [6] They can form the shell of the cone, but not the interior.

Now the actual world (consistent with the truth of (12) and (13)) will

[6] But what if Sunny is leading by four lengths a few yards before the finish on a muddy track and drops dead of a coronary thrombosis? Perhaps we could allow a few freakish type (iv) worlds within the cone, but so few that their measure relative to the type (i) - (iii) worlds would be zero or almost zero.

be either type (i) or type (ii) or type (iii), it doesn't matter which. Once the race is over, certain factual conditionals will become true, e.g. "Since the track was muddy, Sunny won", or "Since Sunny lost, the track can't have been muddy". Now for *these* conditionals to be true, as we saw earlier, the worlds which satisfy their antecedents and consequents cannot be "next" to falsifying type (iv) worlds, but must always be isolated from them by other closer type (i) or (iii) worlds. The interior of the cone of verifying worlds, therefore, must form an open set, with every type (i) world being separated from the surface of the cone by a type (iii) world and vice versa. If is upon such topological features of the branched structure of possible worlds that the truth conditions for connexive conditionals depend. (7)

So far we have discussed counterfactual conditionals (false antecedent and consequent) and factual conditionals (true antecedent and consequent), but we have not yet considered what Goodman calls "semifactuals" (false antecedent and true consequent). The examples of this kind that Goodman introduces are all "even if" conditionals:

(14) Even if the match had been scratched, it still would not have lighted.

Conditionals in which the consequent is true irrespective of the truth of the antecedent can always be stated, and are perhaps always best stated, in "even if" form:

(15) Even if the US renounces the use of nuclear weapons, the earth will be struck by a comet in 1997.

For Goodman, semifactuals have the force of denying what is affirmed by counterfactuals; thus (14) has the force of denying

(16) If the match had been scratched, it would have lighted.

In his words, "full counterfactuals affirm, while semifactuals deny, that a certain connection obtains between antecedent and conse-

(7) Another way of putting the matter might be this: regardless of which world within the cone becomes the actual world, it will always seem to the inhabitants of that world that they are at the cone's centre, with lots of worlds of different types separating them from the walls. Compare in special relativity the world-line of an observer relative to the walls of the light-cone within which he travels.

quent'' (p. 6). Stalnaker, on the other hand, regards Goodman's relegation of ''even if'' conditionals to a different category from counterfactuals as an ''*ad hoc* manœuvre'', designed to save the analysis by paraphrasing the counterexamples(8), and treats it as a virtue of his own semantics that they can deal with counterfactuals and ''even if'' conditionals in the same way.

The approach adopted here will be somewhat different. If we look closely at the category of semifactuals, we see that they fall into two distinct types. First there are ''even if'' conditionals, the consequents of which are true regardless of the truth of their antecedents, and for which no connection between antecedent and consequent exists. Secondly there are semifactuals for which such a connection does exist, which (roughly and broadly) cite the antecedent as an alternative way, not used in fact, of bringing about the consequent. For example, suppose little Sophie has a fever which is brought down with a sponge bath. The doctor may then say:

(17) If Sophie had been given aspirin, her fever would have gone down.

This semifactual is true, and its truth depends on a link between antecedent and consequent, although it is not of the ''even if'' variety. In what follows we shall say no more about ''even if'' conditionals, but confine the discussion to semifactuals which require that such a connection exists. They differ from the others in that they resist translation into ''even if'' form; thus (17) means something quite different from:

(18) Even if Sophie had been given aspirin, her fever would have gone done,

or for that matter from:

(19) If Sophie had been given aspirin, her fever would still have gone down.

Truth-conditions for semifactuals are determined in the same way as those for ''since'' conditionals. What would falsify the conditional

(8) STALNAKER [1968], p. 174.

"Since A, B" is an $A \& {\sim}B$-world, hence the truth of the conditional requires that the closest ${\sim}B$-worlds be ${\sim}A$-worlds. (The actual world is $A \& B$, hence it is trivially true that the closest A-worlds are B-worlds). Similarly in the case of semifactuals, worlds which falsify (17) are worlds in which Sophie is given aspirin and her fever does not go down. Hence (17)'s truth requires both that in the closest worlds in which Sophie is given aspirin her fever goes down, and also that in the closest worlds in which Sophie's fever does not go down, she is not given aspirin. $A \mathrel{\Box\!\!\rightarrow} B$ is a true semifactual, therefore, if some $A \& B$-worlds and some ${\sim}A \& {\sim}B$-worlds are closer than any $A \& {\sim}B$-world.

It is worthwhile mentioning at this point that while the truth of (17) may in some complicated way rest upon the truth of a general causal law relating the administration of aspirin to fever abatement, or (more plausibly) upon other more fundamental laws of which the aspirin-fever abatement linkage is a consequence, (17) itself is not an instance of a general law, nor are any of the other conditionals whose truth-conditions we have been considering. Although it may well be that giving Sophie aspirin will bring down her fever in this case, giving other people aspirin may not bring down their fevers, nor may giving Sophie aspirin on another occasion if her illness is more severe. The A's, B's and C's which occur in our truth-conditions relate to particular historical events, even if our branched model structures allow the same historical event to occur on different branches. Although the antecedent of (17) can be regarded as asserting the instantiation of the event-type "Sophie being given aspirin" on a particular occasion, and the consequent the instantiation of the event-type "Sophie's fever coming down", and although (17) if true asserts a connection between these two instantiations on this occasion, (17) does not assert that the two event-types will always be instantiated together, or even that they will be co-instantiated the next time. The beauty of the truth conditions furnished for conditionals by possible-world semantics is that they are sensitive to context, allowing a given conditional to be true when uttered on one occasion and false when uttered on the next.

Before concluding, one more question remains to be discussed, that of contraposition. Up to now there has been rough agreement among logicians that counterfactuals do not contrapose, that we cannot argue in all cases from $A \mathrel{\Box\!\!\rightarrow} B$ to $\sim B \mathrel{\Box\!\!\rightarrow} \sim A$. (9) Certainly this is true in the case of "even if" conditionals. As Goodman notes, we cannot argue as follows:

(20) Even if the match had been scratched, it still would not have lighted. Therefore, even if the match lighted, it still wasn't scratched.

But in cases where there exists a connection between antecedent and consequent, contraposition holds:

(21) If Steve had known he was going to Vancouver, he would have packed his bag last night. Therefore, since Steve didn't pack his bag, he couldn't have know he was going. (10)

It is true that in the example just given the original conditional is a forward counterfactual, while the contrapositive is a backward factual. Plainly one counterfactual cannot be the contrapositive of another. But if the proper constraints are observed, it will be seen that conditionals which are based on a connection between antecedent and consequent all do contrapose, the result being a conditional of a different type which still preserves the vital connection. Thus the contrapositive of a forward counterfactual is a backward factual, that of a forward factual is a backward counterfactual, that of a forward semifactual is a backward semifactual, and that of a forward subjunctive or indicative conditional is a backward subjunctive or indicative conditional. Furthermore, all these forms preserve their truth-values under contraposition according to the truth-conditions given for them above.

Take as an example the case of forward and backward semifactuals:

(17) If Sophie had been given aspirin, her fever would have gone down.

(22) If Sophie's fever had not gone down, she couldn't have been give aspirin.

(9) Stalnaker [1968] p. 173; Lewis [1973] p. 35. Pollock [1976] p. 36 states that even his strong necessitation conditionals do not contrapose.

(10) The reader will note that many of the examples in this paper involve travelling. Like Socrates we must be ready, our bags packed, to go wherever the argument leads us.

Representing (17) as $A \,\Box\!\!\rightarrow B$, its truth-conditions require that some $A \& B$-worlds and some $\sim A \& \sim B$-worlds are closer than any $A \& \sim B$-world. But these are precisely the conditions required for the truth of the backward semifactual (22) $\sim B \,\Box\!\!\rightarrow \sim A$. Hence, under these semantics, contraposition holds.

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Summary

Conditionals like "If Sophie is given aspirin, her fever goes down" seem to depend for their truth upon a connection between antecedent and consequent, while others, such as "If the US does not renounce the use of nuclear weapons, the earth will be struck by a comet in 1997", do not. Using a branched courses-of-events version of possible world semantics, truth-conditions are provided which verify conditionals that reflect such a connection and which falsify those that do not. These truth-conditions apply to counterfactuals (false antecedent and consequent), factuals (true antecedent and consequent), and semi-factuals (false antecedent and true consequent), as well as to subjunctive and indicative conditionals in general. If the required connection between antecedent and consequent is present, it is shown that we can in all cases argue from "If A then B" to "If not B, then not A".

REFERENCES

Aune, Bruce, [1967] Article on "If", *Encyclopaedia of Philosophy*, ed. Paul Edwards, New York.

Goodman, Nelson, [1955] *Fact, Fiction, and Forecast*, London.

Kneale W. and M., [1962] *The Development of Logic*, Oxford.

Lewis David, [1973] *Counterfactuals*, Blackwell, Oxford.

Lewis David, [1979] "Counterfactual dependence and time's arrow", NOUS 13, pp. 455-476.

McCall Storrs, [1976] "Objective time flow", *Philosophy of Science* 43, pp. 337-362.

McCall Storrs, [1982] "Counterfactuals based on real possible worlds", typescript, forthcoming in NOUS.

Nute Donald, [1980] *Topics in Conditional Logic*, Reidel, Dordrecht.

Pollock John L., [1975] "Four kinds of conditionals", *American Philosophical Quarterly* 12, pp. 51-59.
Pollock John L., [1976] *Subjunctive Reasoning*, Reidel, Dordrecht.
Ryle Gilbert, [1950] "If", "So", and "Because", in *Philosophical Analysis*, ed. Max Black, pp. 302-318.
Stalnaker Robert, [1968] "A theory of conditionals", in *Studies in Logical Theory*, ed. N. Rescher, reprinted in *Causation and Conditionals*, ed. E. Sosa, Oxford 1975, pp. 165-179.