

MATERIAL IMPLICATION AND NATURAL LANGUAGE CONDITIONALS

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In this paper we shall look at the problems involved in giving an account of the meaning (i.e. semantics) of natural language conditionals of the form *If p then q*. More specifically, we shall reject the claim that their meaning is to be captured in truth-functional terms only. The classical instance of this kind of analysis is provided by those who equate natural language conditionals with the material implication operator semantically. We shall mainly compare English conditionals with the logical connective in order to show that the compositional kind of truthfunctional analysis is at best insufficient to account for our understanding of and reasoning with conditionals. We shall claim that some way of incorporating the notion of an asymmetric relation between antecedent and consequent is needed. We shall try to show this by reviewing the main results obtained in various experimental psychology tasks with conditionals. The criticism above holds good for other similar truth-functional proposals (i.e. those who advocate a biconditional or defective truth-table approach).

Conditionals have traditionally been equated semantically with the material implication logical operator \rightarrow . A common definition of the logical connective says: «Given any two propositions *p* and *q*, the *conditional* with *p* as *antecedent* and *q* as *consequent* (denoted $p \rightarrow q$) is a proposition that is false when *p* is true and *q* is false; otherwise, it is true». On this account then, the meaning of conditionals is built up compositionally from the truth value of the component clauses, in the way shown in the diagram below (which also shows other proposed truth tables):

(1)			Material implication	Biconditional	Defective
	<i>p</i>	<i>q</i>	$p \rightarrow q$	$p \leftrightarrow q$	$p \leftrightarrow q$
(i)	T	T	T	T	T
(ii)	T	F	F	F	F
(iii)	F	T	T	F	?
(iv)	F	F	T	T	?

This means that both the antecedent and the consequent in a conditional should be truth evaluable, and that language users choose between just «true» and «false» when assigning truth values to propositions. In actual fact, as Johnson-Laird (1986, also for (2) below) has pointed out, a formulation of the semantics of conditionals just in terms of truth conditions seems to be too restrictive where the consequent serves an illocutionary function other than asserting. This can be seen from the following examples:

- (2) If you give her the ring, are you married to her?
- (3) If you didn't know, why didn't you ask?
- (4) If you want to find out about that, go and ask her.

It is not at all clear how the consequents in these sentences should be assigned a truth value, so a characterisation of the meaning of the conditionals above in terms of just truth conditions does not seem to be appropriate.

The main difference between \rightarrow and natural language *if* is that propositions joined by \rightarrow may be entirely unrelated in meaning, as in (5) to (8) below, which correspond to lines (i) to (iv) of the truth table:

- (5) If Paris is the capital of France, two is an even number.
- (6) If Paris is the capital of France, two is an odd number.
- (7) If Paris is the capital of Spain, two is an even number.
- (8) If Paris is the capital of Spain, two is an odd number.

In natural language conditionals with *if*, antecedent and consequent are thematically related, in that there is a link or connection between them. In (9) to (13) at least a part of the intended connection is shown between brackets after each of the sentences:

- (9) If Tom comes tomorrow, I will give him the books (temporal).
- (10) If you buy those stocks, you will lose your money (causal).
- (11) If you wash this sweater in hot water, it will shrink (causal).
- (12) If today is Sunday, the priest is in church (logical or inferential).
- (13) If John says that, he was a hypocrite (evidential).

People who have studied the discourse functions of conditionals find the *if* \rightarrow analysis of conditional meaning inadequate because it takes no account of content, and hence of the connection between antecedent and consequent. Akatsuka (1986), for instance, argues against a simple truth-conditional approach to conditionals. In her view, discourse context, speaker attitude and prior knowledge should all be taken into account, as well as the fact that there is always a connection between antecedent and consequent, in giving the semantics of conditionals. According to Akatsuka, «every construction with the meaning *if p then q* shares an abstract grammatical meaning similar to *correlation/correspondence between p and q*». McCawley has observed that in all English conditionals, *p* is temporally

and/or causally and/or epistemologically prior to q . Our proposal is that the notion of correlation/correspondence between p and q should be included in the description of the meaning of natural language conditionals. Any adequate characterisation of this meaning should also specify that the connection, relation or correlation between antecedent and consequent is an asymmetric one (a fact which cannot be captured in a truth table).

The claim that there is always an asymmetric connection between antecedent and consequent in a natural language conditional squares well with our intuitions that an utterance of the form *If p then q* amounts to a recognition by the speaker that any observation of p must be accompanied by an observation of q . Whenever we produce an utterance of that form, it is this kind of asymmetric relation *from p to q* that we intend to communicate.

Before looking at the results obtained in experiments where subjects reason with conditionals, we shall make clear how we conceive of meaning and inference here. In our opinion, communicators draw inferences from conditionals not by invariably relying on their knowledge of a truth table for *if*, but by selectively using the meaning of *if* in context in such a way that only relevant information (i.e. inferences) will arise. The inferences allowed by this combination of selected context plus semantic characterisation may well then coincide with the set of inferences licensed by one of the truth-table characterisations of the meaning of the conditional given above, if those inferences prove to be relevant in the context (for the broader issues of relevance, the choice of context and relevance in a context, see Sperber & Wilson, 1986).

We shall propose a semantic description of conditionals which does make use of truth values, but in a restricted way, and which also incorporates the directionality or asymmetry component, which is not truth-functional. Essentially, what every conditional *says* is that the truth of what is conveyed in the antecedent clause is a sufficient reason for the truth of what is conveyed in the consequent clause. The inference is then licensed that whenever the antecedent appears in a set of other assumptions which you currently hold, you are being «instructed», so to speak, solely by virtue of the meaning of *if*, to infer that the consequent is true, if this is relevant in the context. This inference then is an integral part and a direct consequence of your knowledge of the meaning of *if*, and will standardly be drawn. This is because of the fact that a speaker who knows the meaning of *if* the way we defined it is communicating, in simply uttering the conditional, that this inference is relevant in the context. This basic inference then follows from our saying that the antecedent is a *sufficient* reason for the consequent and, as can be observed in (1) above, has been included in every characterisation of the conditional. This will also be shown below with the data from psychological experiments. The directionality or asymmetry component of conditionals is closely connected with knowledge and use of bare truth values, in that saying that p is sufficient for q is not at all like saying that q

is sufficient for p . In this way, the *If p then q* construction is specialised, so to speak, in forward directionality (from p to q), while there may be other closely related constructions (see *p only if q* below) which seem to encode backward directionality primarily. Now it is very often the case that speakers may want to go on extracting valuable information from the conditional uttered, may try to optimise its relevance in the context, in which case they will have to combine the information encoded in the conditional (say, sufficiency from p to q) with other information more or less easily accessible in the context. This process will presumably lead to other inferences (e.g. see «affirming the consequent» and «denying the antecedent» below) which, while not truth preserving out of context, may well be valid in the current context. This tendency to optimise the relevance of conditional utterances may lead to our inferring that p is not only sufficient but also necessary for q , or that some other assumptions r or s are also sufficient for q and so on.

Some support for our proposal comes from experimental psychology. The idea of an asymmetric relation between antecedent and consequent helps explain directionality effects in reasoning. Defenders of the equation of natural language conditionals with material implication find it hard to maintain their classical explanation of conditional meaning when they are trying to give a compositional account of the meaning of *if*-compounds, such as *only if*. The traditional account of the meaning of *p only if q* as truth-conditionally equivalent to *if p then q* can be illustrated by the following pairs of sentences (from Evans, 1982):

- (14) a If all men are mortal then Aristotle is mortal.
b All men are mortal only if Aristotle is mortal.
- (15) a If he is a policeman then he is over 5' 9" in height.
b He is a policeman only if he is over 5' 9" in height.

It is claimed that the a. examples are equivalent to the b. examples, since they can only be falsified when the antecedent (p) is true and the consequent (q) false, and because in each case p implies q . However, the two sentences in each pair do not appear to be linguistically equivalent, as the following examples (from McCawley) show:

- (16) a If Mike straightens his tie once more I'll kill him.
b Mike will straighten his tie once more only if I kill him.

Experimental reasoning data confirm our linguistic intuitions: more *Modus Ponens* inferences (inferring the truth of the consequent from the overall truth of the conditional and the truth of the antecedent) occur with *If p then q* sentences, and more *Modus Tollens* inferences (inferring the falsity of the antecedent from the overall truth of the conditional and the falsity of the consequent) are drawn with *p only if q* sentences. Evans (1982) has suggested that these *directionality effects* might be related to temporal or

causal factors. His explanation of the evidence says that the natural linguistic function of *If p then q* conditionals would be to encode an asymmetric relation between two propositions where *forward* (i.e. from *p* to *q*) thinking is appropriate, and hence Modus Ponens. On the other hand, the function of *p only if q* conditionals would be to encode a situation where *backward* (i.e. from *q* to *p*) thinking, and hence Modus Tollens, is appropriate. This explanation is confirmed by the fact that when one attempts to convert one structure into the other when there is a clear temporal order between the events described, the sentence becomes semantically anomalous, as in:

- (17) a If it rains on Tuesday I shall go swimming.
b ?? It will rain on Tuesday only if I go swimming.
(18) a The match will take place only if the weather improves.
b ?? If the match takes place the weather will improve.

Thus, experimental data seem to lend some support to the claim that an adequate characterisation of natural language conditionals should include the notion of an asymmetric relationship going from *p* to *q*.

One important way in which natural language conditionals with *if* differ from propositions joined by \rightarrow is that the inferential patterns which can be associated with the former may not be allowed by the latter. There is also the fact that reasoning with natural language conditionals is affected by problem content, and this is something that the definition of material implication cannot reflect. Let us look at two examples:

- (19) If it is a cat then it is an animal.
It is not a cat.
Therefore, it is not an animal.
(20) If you mow the lawn I will give you five dollars.
You do not mow the lawn.
Therefore, I will not give you five dollars.

These are instances of what is known in logic as the «fallacy» of *denying the antecedent*, an inferential pattern which is not allowed by material implication. In reasoning experiments, there are few subjects who will accept (19) as a valid argument, but most think (20) is sound. As Geis and Zwicky (1971) observed, denying the antecedent is often a very reasonable inference to make in communication, not only when promises are involved —as in (20)— but also commonly with conditional threats, predictions and law-like universals. Let us look at some of their examples:

- (21) If you come any closer, I will hit you.
(22) If John leans out of the window any further, he will fall.
(23) If you heat iron in a fire, it turns red.

Defenders of the traditional approach (*if* = \rightarrow) to the semantic characterisation of conditionals account for this deviation in terms of conver-

sational maxims or pragmatic principles, and consider the deviant bit to be an *implicature*. Fillenbaum (1986), for instance, assumes that the right analysis of this type of case when the conditional is being used as a promise or a threat consists in describing *if* as the material implication semantically, and explaining what would appear to be faulty reasoning pragmatically, in terms of implicature. Smith & Smith (1988) also consider this «invited inference» $Cp \rightarrow Cq$ an implicature. According to them, by saying «*if p then q*» a speaker implies «*if not p then not q*», since if he didn't, that is if he thought that both «*if p then q*» and «*if not p then q*», he could have spared his hearer some effort by putting his message across more economically and simply saying «*q*». So the inference above is an implicature which hinges on a conversational maxim of the kind proposed by Grice. For Levinson, the inference, which he calls the *iff implicature*, also counts at the pragmatic level only. It is an implicature that can be explained by his I-heuristic, a kind of principle of informativeness which leads us to enrich an utterance in line with stereotypic expectations. In the case of a promise, for instance, you cannot expect a reward unless you carry out the action for which the reward has been offered. As pointed out by Carston (1990), however, contradictory predictions can be made in Levinson's system regarding the implicatures of conditional sentences, perhaps because the implicature analysis itself is wrong.

Other natural language conditionals, for example those used in definitions, seem to license patterns of inference that differ from those allowed by \rightarrow , as the following example from Johnson-Laird (1986) shows:

(24) If a woman has a husband, then she is married.

This conditional not only sanctions the Modus Ponens and Modus Tollens inferences, allowed by material implication, and Denying the Antecedent, which is called an implicature by many, but also *Affirming the Consequent*, another fallacious inference according to logicians. A full explanation should be offered of how this latter inference is made, possibly based on the fact that it is an analytic-type sentence. The account proposed here could easily deal with this problem. Those who might want to explain this type of inference as an implicature would have to explain why it does not arise in the following similar case (from Johnson-Laird):

(25) If a man has a suit, then he has a jacket and trousers.

The only inferences supported by our interpretation of (25) are Modus Ponens and Modus Tollens.

We have seen some examples which show that natural language conditionals with *if* differ from propositions joined by \rightarrow in that inferential patterns are observed with the former which are not licensed by the latter. There is also the opposite case, where material implication licenses an

inferential pattern that sometimes does not appear in communication with certain natural language conditionals. Let us look at the following examples, given by Johnson-Laird (1983):

(26) If Norman is in town, he is staying at the Grand Hotel.

(27) If you want to meet Norman, he is staying at the Grand Hotel.

The Modus Ponens inference seems to be warranted by (26), but not (27). In (27), the truth of q is asserted, but is not contingent on that of p . So this type of conditional (*pragmatic or relevance conditional*) is also problematical for the traditional characterisation of $\text{if} = \rightarrow$. Liliane Haegeman (1983) has suggested that this kind of conditional, peripheral as opposed to central syntactically, makes no obvious contribution at the level of truth conditions, but is relevance related and instructs the hearer in processing: reference assignment, specification of ambiguous or vague phrases, concept accessing, accessing of background assumptions and context selection can all be guided by peripheral conditionals, as shown in:

(28) The story, if so it may be termed, is weak and loose.

(29) If you are hungry, there is food in the fridge.

An account of conditionals in terms of truth conditions, and hence as material implication, seems insufficient for this kind of case, since protases here, though linguistically encoded, make no contribution to truth conditions (hence they are not a part of representational knowledge) but to utterance processing (hence they are a part of procedural knowledge).

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