Conditionals and Truth Functionality

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Introduction

The material interpretation of conditionals is commonly recognized as involving some paradoxical results. I here argue that the truth functional approach to natural language is the reason for the inadequacy of this material interpretation, since the truth or falsity of some pair of statements 'p' and 'q' cannot *per se* be decisive for the truth or falsity of a conditional relation 'if p then q'. This inadequacy also affects the ability of the overall formal system to establish whether or not arguments involving conditionals are valid. I also demonstrate that the Paradox of Indicative Conditionals does not actually involve a paradox, but instead contains some paralogistic elements that make it appear to be a paradox. The discussion of the paradox in this paper further reveals that the material interpretation of conditionals adversely affects the treatment of disjunctions.

Much has been said about these matters in the literature that point in the same direction. However, there seems to be some reluctance against fully complying with the arguments against the truth functional account of conditionals, since many of the alternative accounts rely on the material conditional, or at least on an understanding of the conditional as a function of antecedent and consequent in a similar sense as the material conditional. My argument against truth functionality indicates that it may in general involve similar problems to treat conditionals as such functions, whether one deals with theories of truth, assertability or probability.

1. The inadequacy of the material conditional

If natural conditionals[1] 'if p then q' have truth conditions that are truth functional, there seems to be no option to the material conditional interpretation of these truth conditions, namely that 'p ⊃ q' is defined as true whenever we have one of the following combinations of truth-values for 'p' and 'q': (TT), (FT) or (FF). This means that a conditional would be

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[1] I will use the term "natural conditionals" for expressions of the following kinds: 'if p then q', 'q if p', 'p unless q', 'p only if q', 'supposing p, q', and so on. That these expressions are "natural" should be taken to mean that they are expressions in our ordinary (natural) language. This should be understood as opposed to the material conditional that is merely defined as a function within a logical system. I thus distinguish between natural language expressions and logically defined terms and functions.

truth functionally defined as false only when the antecedent 'p' is true and the consequent 'q' is false; otherwise true. However, we do not normally consider a natural conditional 'if p then q' as true or false according to these truth functionally defined truth conditions. For instance, the following conditionals (though true within the material interpretation) seem all to be, at best, false: 'If all philosophers learn to swim, then there would be no war'; 'If eggs come from hens, then we can use them (the eggs) to make omelet'; 'If time is money, then Bill Gates can afford to go to the opera every day'; 'If I can't do without Beetle Bailey, then Mort Walker will make his sons continue his cartoon career'.

This kind of discrepancy between material and natural conditionals has caused an extensive debate, attracting both advocates and critics of the material conditional. The opening passage in Farrell's paper 'Material Implication, Confirmation, and Counterfactuals' illustrates the confusion that the material interpretation of natural conditionals can cause in the classroom:

> Students of truth-functional logic frequently regard material implication to be patently absurd. Most of us who teach elementary logic have encountered intelligent students who frustratedly exclaimed something to the effect that: Any logic which pronounces true a sentence such as, "If the moon is a green cheese, John F. Kennedy was the 35th President of the United States," is illogical. A great deal of printer's ink has been spilled in the attempt to rationalize away the paradoxes of material implication… I am at last inclined to throw in the towel and admit the endeavor is fruitless, that the paradoxes and problems generated by material implication are intolerable embarrassments.[2]

The main problem with the truth functional approach to conditionals is that we normally use conditionals for asserting or denying a kind of dependency relation between some facts or events, and not to claim a certain combination of truth-values for any pair of statements 'p' and 'q'. In natural conditionals, one obviously cannot infer a conditional dependency relation merely from the truth-values of an arbitrary pair of statements, since natural conditionals are in essence hypothetical, while the material conditional must have assigned truth-values in order to be determined as true or false.

It seems to be a general view that the case of counterfactuals represents the main problem for the material interpretation of conditionals. If the antecedent is false, the material

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[2] Farrell (1979), p. 383.

conditional is defined as true, and this *is* in fact a problem. In my opinion, though, this problem is no more serious than the fact that a true consequent results in a true material conditional, or the fact that two true or two false statements necessarily give a true material conditional. None of these problems will be solved if one treats counterfactuals as special cases. The conditional 'If I was born in 1711, then I was born the same year as David Hume' is true independently of the truth-values of the antecedent and the consequent. It is true because David Hume was born in 1711. Further, the conditional 'If I was born in 1887, then I was born the same year as David Hume' is false independently of the truth-values of the antecedent and the consequent. None of these aspects can be explained or accounted for in an extensional, truth functional approach.

In his paper 'The Logic of Implication', Balzer stresses the point that conditionals are used to express a dependency relation between the antecedent and the consequent, while the assumption of such a relation is no part of the material conditional:

> The most puzzling aspect of implication is that of the relation between the antecedent and the consequent. It would seem natural to suppose there must be a connection of some sort between the antecedent and the consequent for a meaningful implication to be made. For example: "If this is water, then it contains hydrogen and oxygen", "If you touch a red-hot poker, then you will be burned" and "If this is lemon, then it will taste sour" would all be regarded as reasonable implications from antecedent to consequent. However, many logicians admit as true implications "If $2 + 2 = 5$, then New York is a large city" and "If a horse is a fish, then I can jump over the moon". These are implications without any apparent connection between the antecedent and the consequent.[3]

In Aristotelian logic, one did not have a truth functional account of language, where the contentual aspects were disregarded. This means that, within this logic, it is possible to treat the conditionals 'If Socrates is a man, then he is mortal' and 'If Socrates is mortal, then he is a man' as logically different, even though it is true both that Socrates was a man and that he was mortal. Since Aristotelian logic first of all is a system of syllogisms, it was an uncontroversial fact that the truth of a single, existential conditional of the form *If a is G, then a is H* is dependent on the truth of a corresponding categorical statement *All Gs are Hs*. The conditional 'If Socrates is a man, then he is mortal' is then true based on the truth of the categorical statement 'All men are mortal', while the conditional 'If Socrates is

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[3] Balzer (1990), p. 253.

mortal, then he is a man' is false because the categorical statement 'All mortals are men' is false.

In Fregean logic, however, not only conditionals that are derived from categorical statements are included, but also conditionals of the form 'if p then q', that are not singular instantiations of a corresponding categorical statement. Hence, other conditions had to be given for the truth of a conditional, namely the truth functional account. However, Garland, a Roman medieval logician, helps us illustrate how a purely truth functional account of conditionals is fruitless, since the same combinations of truth-values can give a true or a false conditional, dependent on the relation expressed:

> A consequence is true in four ways.
> 1 One is composed of two true propositions, as in 'If Socrates is a man, he is an animal'…
> 2 Another is composed of two false propositions, as in 'If Socrates is a stone, he is inanimate'…
> 3 Another one is composed of a false antecedent and a true consequent, as in 'If Socrates is an ox, he is an animal'…
> 4 Still another is composed of parts neither of which is true or false, such as you can discern in this example: 'If it were a man, it would be an animal'; for neither of these is true or false…
> On the other hand, a consequence is false in five ways.
> 1 One is false with both components being true, as in 'If Socrates is an animal, he is a man'.
> 2 Another consists of two false components, e.g. 'If Socrates is inanimate, he is a stone'.
> 3 Still another one is made of false antecedent and true consequent, as in 'If Socrates is a stone, he is a man.'
> 4 Another one is composed of two parts neither of which is either true or false, e.g. 'If Socrates were an animal, he would be a man.'
> 5 And still another one is false which has a true antecedent and a false consequent.[4]

We note that on Garland's account, if we assign different truth-values to the antecedent and the consequent, we can find more different kinds of circumstances in which a natural conditional can be false than it can be true. This is opposed to the definition of a material conditional, according to which a conditional is true unless the antecedent is true and the consequent false, which is merely one of Garland's five alternatives for false conditionals. As a result, the material conditional is true of more possible circumstances than the

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[4] Boh (1993), p. 4-5.

corresponding natural conditional, which implies that the material conditional is not an adequate representation of natural conditionals.

2. The harmfulness of the material conditional

For reasons like these, it seems to be commonly accepted among most logicians that the material conditional is not an adequate representation of natural conditionals. Many will however still claim that this replacement is harmless. This means that one believes that tests for validity will judge arguments containing natural conditionals as valid if the corresponding arguments containing material conditionals are valid, though not necessarily *vice versa*.[5] In other words, one claims that formally valid inferences are also contentually valid, that is; true premises guarantee a true conclusion in a formally valid inference. Unfortunately, given the lack of adequacy, it is impossible for the material interpretation of conditionals to be harmless. In his article 'A Confusion About If..Then', Edwards demonstrates that if the material conditional 'p ⊃ q' is true of more possible circumstances than the corresponding natural conditional 'if p then q', it will be possible to construct material conditional expressions that are true of more, as well as expressions that are true of fewer, possible circumstances than their corresponding natural expressions:

> Copi claims that 'If p then q' may assert more than 'p ⊃ q'. Suppose that in a given case it does. This means that 'p ⊃ q' is true of more possible circumstances than is 'if p then q'. It is assumed by Copi that this means that a premise containing 'p ⊃ q' is true of more possible circumstances than the corresponding premise containing 'if p then q'. But this may or may not be the case, as a few examples will show. There is an equal chance that the premise containing 'p ⊃ q' will be true of *fewer* possible circumstances than the corresponding premise containing 'if p then q'.[6]

Edwards then gives examples of material conditional expressions that are true of, respectively, more and fewer possible circumstances than their corresponding natural expressions:[7]

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[5] That the material conditional interpretation of natural conditionals is harmless, seems to be the view of for instance: Barker (1997); Copi (1965), p. 17-22; Grice (1989); Jackson (1987) and (1991); Quine (1966), p. 12; and Richards (1969).
[6] Edwards (1973/74), p. 85.
[7] Edwards (1973/74), p. 86.

True of more possible circumstances	True of fewer possible circumstances
p ⊃ q	¬(p ⊃ q)
(p ⊃ q) ∨ r	¬[(p ⊃ q) ∨ r]
¬[(p ⊃ q) ⊃ r]	¬(p ⊃ q) ∨ r
¬(p ⊃ q) ⊃ r	(p ⊃ q) ⊃ r
r ⊃ (p ⊃ q)	r ⊃ ¬(p ⊃ q)
¬[r ⊃ ¬(p ⊃ q)]	¬(p ⊃ q) ∧ ¬r

This means that while 'p ⊃ q' is logically weaker than 'if p then q', asserting less than the natural expression, '¬(p ⊃ q)' is too strong in relation to 'not (if p then q)'. The negated material conditional is true when 'p' is true and 'q' is false, while the negation of the natural conditional can also be true under other circumstances. According to Edwards, this has serious implications for the validity of arguments. An argument is contentually valid if there is no possibility of the premises being true and the conclusion false at the same time. The replacement of natural conditionals with expressions containing material conditionals will then affect whether or not it is more, *or* less, likely that the argument containing them will get the combination of true premises and false conclusion. These matters will again necessarily affect the determination of the formal validity of the argument.

For instance, an argument containing '¬(p ⊃ q)' as premise will be formally valid of more possible circumstances than an argument containing 'not (if p then q)' as premise, since the material conditional expression is true of fewer possible circumstances than the corresponding natural expression. This means that the argument containing the material expression will have true premises in fewer possible circumstances than the argument containing the natural expression. Likewise, an argument containing '¬(p ⊃ q)' as conclusion will be formally valid of fewer possible circumstances than an argument containing 'not (if p then q)' as conclusion. This is because one in the argument containing the material conditional expression will have a true conclusion in fewer possible circumstances than the corresponding argument containing the natural expression.

When expressions containing material conditionals get more complex than the ones above, it will be difficult, if not impossible, to know beforehand whether they are true of *more or fewer* possible circumstances than their corresponding natural expressions. Moreover, whether they appear as premises or conclusions also affects the formal validity of the

argument, and makes it even more complicated to control the outcome of the test. One example that I think clearly demonstrates Edwards' point, is the following proof of God's existence:[8]

P1   If God does not exist, then it's not the case that if I pray, my prayers are heard
P2   I don't pray
C   God exists

Given a plausible formal interpretation where the natural conditional is interpreted as a material conditional, this argument is *formally* valid; i.e. valid according to the rules of formal logic.

1. $\neg p \supset \neg(q \supset r)$ P1
2. $\neg q$ P2
3. $q \supset r$ 1, 2, T
4. $\neg\neg(q \supset r)$ 3, T
5. $\neg\neg p$ 1, 4, T
6. p 5, T

This particular argument has its main weakness in the first premise. First of all, it contains a negated material conditional in the consequent, which is false of more possible circumstances than its corresponding natural expression. This means that when we introduce '$\neg q$' as the second premise, we must negate '$\neg(q \supset r)$', and thus also '$\neg p$'. The other weakness in this argument is that the first premise contains nested material conditionals, which makes the outcome even more unpredictable. It seems clear, then, that Edwards is justified in his conclusion that the material interpretation of natural conditionals is not and cannot be harmless on the assumption that the former is true of more possible circumstances than the latter.

3. The paradox of indicative conditionals

I will now argue that this inadequacy and harmfulness of the material conditional also affects the treatment of other connectives, and in particular disjunctions. To demonstrate this point, I will present and discuss Jackson's Paradox of Indicative Conditionals (PIC), which is supposed to demonstrate that it is impossible to deny the equivalence between

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[8] The example is found in Edgington (1991), p. 187.

natural and material conditionals.[9] The PIC is constructed with the help of the following principles:

1. **The Truth Functionality Principle**: The material conditional 'p ⊃ q' is equivalent to the disjunction 'not-p or q'.

2. **The Uncontested Principle**: The indicative conditional 'if p then q' implies the material conditional 'p ⊃ q'.

3. **The Passage Principle**: The disjunction 'p or q' implies the indicative conditional 'if not-p then q'.

All these principles seem plausible, but together they allegedly prove that the material conditional is equivalent to the corresponding natural conditional:

1. p ⊃ q ↔ not-p or q (the Truth Functionality Principle)
2. p or q → if not-p then q (the Passage Principle)
3. not-p or q → if p then q (from substitution in 2 and the rules for negation)
4. p ⊃ q → if p then q (from 1 and 3)
5. if p then q → p ⊃ q (the Uncontested Principle)
6. if p then q ↔ p ⊃ q (from 4 and 5)

This equivalence between material and natural conditionals is hard to accept given the account of adequacy and harmlessness above. However, a paradox is said to occur when we reject the equivalence and introduce a fourth principle:

4. **The Principle of the Paradox of Material Implication**: 'not-p, therefore, if p then q' and 'q, therefore, if p then q' are invalid forms of inference.

If one assumes that the first three principles hold, then the inferences mentioned in the fourth principle must be valid. The fourth principle supports the plausible impression that they do not seem to be valid. It is then impossible for all these four principles to be true together. But which of the principles may be rejected?

The source of the problem seems to be the disjunction in the Truth Functionality Principle, which appears to be formulated as a natural disjunction 'not-p or q', but simultaneously gets treated as purely truth functional. While the conditional is presented both with a

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[9] Jackson (1987), p. 4-6.

natural and a formal form in the PIC, namely 'if p then q' and 'p ⊃ q', the disjunction is only given with a natural form 'p or q'. But in fact, the disjunction is treated differently in the Truth Functionality Principle from how it is treated in the Passage Principle. In the truth functional treatment of the disjunction in the Truth Functionality Principle, what is actually stated is the occurrence of certain combinations of truth-values for the antecedent and the consequent of the material conditional. This means that we do not thereby assert anything about the facts or events referred to by 'p' and 'q', but only about their truth-values.

In the Passage Principle, however, the disjunction cannot be treated as a truth functional expression like in the Truth Functionality Principle. In order to imply the indicative conditional, we need to treat the disjunction as stating something about the objects and events that the disjuncts are about, since the indicative conditional certainly is intended to be about these objects and events.

Hence, the PIC demands that we identify different level of communication, thus producing a phenomenon that Place calls linguisticism; the "equating of the existence of a situation with the proposition it makes true."[10]

Now consider the following formulations of a disjunctive expression:

(1) 'not-p or q'
(2) 'Either "p" is a false sentence or "q" is a true sentence.'
(3) 'Either it is false that p or it is true that q.'

In (1) we assert a disjunctive relation between whatever is represented by 'p' and 'q', i.e. we are stating something about the relations between the states of affairs signified by 'p' and 'q'. In (2) and (3), however, we assert a disjunctive relation between the truth-values of an arbitrary pair of statements 'p' and 'q', i.e. we are stating something about the allowed combinations of truth-values associated with arbitrary 'p' and 'q'. We are thus *not* saying something (directly) about the relations of the states of affairs signified by 'p' and 'q'. Rather, we are defining the truth functional conception of the disjunction. Thus (1) on

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[10] Place (1996), p. 106-107.

the one hand, and (2) and (3) on the other hand, are by no means the same statements. They may be related in a determinate fashion, but they are actually stating something about (usually) different kinds of objects.

To make the distinction explicit between the disjunction in the Truth Functionality Principle and the disjunction in the Passage Principle, then, the disjunction in the Truth Functionality Principle ought to be given a different expression than 'not-p or q', namely one that expresses a relation between truth-values, as in (2) and (3) above. The disjunction in the Passage Principle must, on the other hand, be one that corresponds to (1), where the relation expressed is between events or facts referred to by 'p' and 'q', and not between truth-values. Accordingly, one of the following principles should replace the Truth Functionality Principle:

> **TTP'**: The material conditional 'p ⊃ q' is equivalent to the disjunction 'either "p" is false or "q" is true'.

> **TTP''**: The material conditional 'p ⊃ q' is equivalent to the disjunction 'either it is false that p or it is true that q'.

When this difference between the two disjunctions in the PIC is not explicitly marked, we are led to believe that the disjunction in the Truth Functionality Principle and the disjunction in the Passage Principle are identical, hence the paradox. In the Truth Functionality Principle, the disjunction is treated as truth functional, in the sense that there is no need for a contentual relation between 'not-p' and 'q' to take place in order to make the disjunction true: One is truth functionally allowed to infer 'p or q' from the truth of 'p'. I can for instance on the knowledge that 'I am going straight home after work' infer that 'I'm going straight home after work or I am meeting the King at the pub'. In the Passage Principle, however, the disjunction is treated as non-truth functional. It must then be understood as stating that there is a relation between the state of affairs referred to by 'p' and the state of affairs referred to by 'q', in order to avoid that the disjunction in the Passage Principle is based on the truth of one of the disjuncts. – Or worse, that it follows from the truth of one disjunct and the independent falsity of the other. Otherwise, the passage from 'p or q' to 'if not-p then q' would not be a valid inference.

So even though I am going straight home after work, and not meeting the King at the pub, I can truth functionally infer the disjunction 'I'm going straight home after work or I am meeting the King at the pub'. From this the Passage Principle allows me to infer that 'If I'm not going straight home after work, I am meeting the King at the pub', which is false, even though the disjunction, *if* it is understood truth functionally, is true, as is the corresponding material conditional.[11] It is therefore necessary, in order to avoid this kind of formally valid – but contentually invalid – inferences, to insist that the natural expression 'p or q' is understood non-truth functionally in the passage principle, in a sense that justifies the inference to a natural conditional. The disjunction in the Passage Principle must then be a natural non-truth functional disjunction, in order for the principle to be valid, while the disjunction in the Truth Functionality Principle is truth functional, and thus not the kind of natural disjunction that would make the passage in the Passage Principle valid.

Since the disjunction in the Truth Functionality Principle now differs from the disjunction in the Passage Principle, step 1 in our proof above of the equivalence between 'if p then q' and 'p ⊃ q' must be rejected. And since the disjunctions in the first and the third principle now differ, step 4 must also be rejected. The validity of the inference from the material conditional to the natural conditional is hence not established.

Place's distinction also elucidates the distinction between natural and material conditionals. While the natural conditional is used to assert (or deny) a kind of dependency relation between two events or facts, the material conditional asserts that 'if 'p' is true, then 'q' is true', provided that we are allowed to use a natural conditional to define or give meaning to the material conditional. So at best we can say that a material conditional expresses a kind of dependency relation between a pair of truth-values. But then we have already interpreted the material conditional according to our natural conditional understanding of sufficient and necessary conditions, and of dependency or causal relations. This means that we can at least not say that a natural conditional can be reduced to or explained by means of the truth functionally defined material conditional.

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[11] Edgington uses examples of this kind in her discussion of truth-functionality of conditionals in her (1991) paper. According to Grice, such examples demonstrate the distinction between what is false and what is misleading.

4. A triviality result for the material conditional

Brandom offers a triviality result of the material conditional in his paper 'Semantic Paradox of Material Implication'. The paradox is based on conditionals with a simplistic structure, that is, sentences of the form 'p ⊃ q' for primitive 'p' and 'q'. This is opposed to in the classical paradoxes of the conditional, he says, that often involve the embedding of one conditional in another or the use of some connective other than the conditional. In Jackson's PIC, for instance, we have '¬ p ⊃ (p ⊃ q)' and 'q ⊃ (p ⊃ q)'. Brandom's triviality result is that given the truth functional material interpretation of natural conditionals, we get that any consistent assignment of truth-values to conditionals determines the truth-values of all the primitive sentences 'p', 'q' and so on: "This is absurd, because no set of purely *hypothetical* facts should determine all of the *categorical* facts."[12] However, as already mentioned, the material conditional cannot represent the hypothetical character of natural conditionals since the material conditional 'p ⊃ q' will only have an assigned truth-value if both its components 'p' and 'q' have assigned truth-values. Brandom's paradox demonstrates the reverse problem, namely that (consistent) assignments of truth-values to a set of material conditionals involve assignments of truth-values to their components. I will not go into details of his paradox here, but merely notice that these results are not unexpected considering the discussion in this paper.

Many philosophers agree that the material conditional is not a perfect (or anyway, exhaustive) interpretation of natural conditionals. It seems however to be a widespread view, in particular after Grice, that the material conditional expresses the truth conditions of natural conditionals, at least of the indicatives, while some conditions of assertability or probability must be recognized in addition. This is for instance the view of Jackson, who finds that the material conditional lacks robustness with respect to the truth of the antecedent, a property that he finds necessary for the assertability of a natural conditional, but not for its truth. Furthermore, Lewis claims that the material conditional holds between all true statements within a possible or actual world, even though it cannot be used to account for counterfactual or subjunctive conditionals. Adams and Edgington, on the other hand, deny that conditionals have truth conditions at all, and maintain that they only have probability conditions, that are found by considering the probability of 'p', 'q' and 'p & q'.

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[12] Brandom (1981), p. 129.

In this connection it can also be mentioned that Jackson determines robustness in terms of conditional probability.

Any account of natural conditionals that in one way or the other relies on the material conditional, is dependent on a valid and sound proof of the equivalence between the material and natural conditionals. Considering all the problems involved in insisting on this equivalence, including Brandom's triviality result, the burden of proof now lies with its advocates.

5. Concluding remarks

I have argued here that the material conditional is not an adequate or harmless interpretation of natural conditionals, and that the main problem with this interpretation is that it is truth functional. Truth functionality is, when you come down to it, an approach to natural language that is concerned merely with different combinations of truth-values of statements or sentence elements. My main objection to this is that natural language is not truth functional; it does not have a truth functional structure.

The truth functional material conditional is founded on an understanding of natural conditionals, but only with focus on combinations of truth-values. In principle, it is totally correct to say that "in a true natural conditional, if the antecedent is true, then the consequent must be true as well". But this differs from the conditional relations that we claim to hold between facts, events and states of affairs. Within a truth functional logical system, conditionals are represented as "relations" between linguistic entities. A linguisticism occurs when we say that "in a true conditional, the antecedent is a sufficient condition for the consequent and the consequent is a necessary condition for the antecedent". Again we find ourselves talking about relations between linguistic entities, not between situations or events in our world.

So it seems that one underlying problem that affects conditionals, is to keep track of when we talk about the world and when we talk about truth of linguistic entities. In examining the logical properties of a conditional, we move without noticing from the first to the second. Even though we use and understand conditionals on the first level, when we try to analyze them within a logical system, we find ourselves operating on the level of linguisticism. This is why we are led to believe that we talk about natural conditionals

when we characterize them as expressing "a relation between the antecedent and the consequent". However, in claiming or expressing a natural conditional, we do not really say anything about its truth-values, or even about the relation between the antecedent and the consequent. Rather, the conditional itself expresses a relation between facts, events or states of affairs in our world. We seem to forget that what we are interested in when we assert, investigate or hear a conditional, is the world in which we find ourselves exploring, understanding, stating, communicating and, even sometimes, trying to find out what is true and what is false.

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