DOCUMENT RESUME

ED 275 186 FL 016 128

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TITLE "Hence"--An Iconoclastic Study of Logic, Language and Argumentation.
PUB DATE 78
NOTE 19p.; In: Ostman, Jan-Ola, Ed. Cohesion and Semantics. Reports on Text Linguistics, see FL 016 125.
PUB TYPE Reports - Evaluative/Feasibility (142) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Connected Discourse; Discourse Analysis; Epistemology; *Inferences; Intellectual History; *Logic; Logical Thinking; *Persuasive Discourse; *Semantics

ABSTRACT

An analysis of the role of the word "hence" and its near-synonyms examines the relationship between logic as a science, as a natural language, and as argumentation. The analysis is done in the context of elementary propositional logic. The first section is a limited discussion of the standard logician's treatment relegating "hence" to the realm of non-truth-functionality: that is, the truth-value of the compound proposition is not simply a function of the truth-values of its components. The second section advocates treating "hence" as a propositional logical connective and outlines the argument, based on natural language-oriented semantics. The third section offers a partial explanation of why standard propositional logic has been accepted by generations of logicians and non-logicians despite the vagueness concerning its relation to natural language and reasoning. The lack of interest in and respect for the multi-faceted linguistic role of the word "hence" is unwarranted. (MSE)

"HENCE"
AN ICONOCLASTIC STUDY ON LOGIC, LANGUAGE AND ARGUMENTATION

by

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0. Introduction[*]

T o   s o m e   e x t e n t logic can be viewed as a partial description of natural language and the art of argumentation. Unfortunately just what the scope of the expressions "to some extent" and "partial" mean, is often left vague. In other words, the relation of logic to natural language and ordinary reasoning is often unclear. This remarkable state of affairs can be explained in various ways. Some logicians think that the clarification of this relation is very difficult. In their view, it is not all surprising that we have not come to grips with it. Other logicians -- the majority, I feel --are not interested in this relation. They feel that the

[*] This paper was presented at the 1977-1978 meetings of the Belgian Linguistics Circle and the Linguistics Association of Great Britain, to the Philosophy Department of the University of Warwick and the Linguistics Department of the University of Stockholm. A simplified Dutch version of this paper is Van der Auwera (1978a). Special thanks are due to the Belgian National Science Fund for the "ospitantschap" and for a travel grant for the trip to England.
I am indebted to Jens Allwood, David Holdcroft, Jan-Ola Östman and Frank Platteau for their comments. The responsibility for the heresies expressed in this paper is entirely my own.

problem is not all that relevant. Some of them would go so far as to deny that the problem exists. For the latter logicians there simply are no interesting relations between on the one hand, logic and, on the other, natural language and every-day argumentation. Thus logicians of the fore-mentioned types feel justified to concentrate on an entirely different program, namely that of the description and the construction of logical systems and the study of their potential use in the sciences.

D e s p i t e this peculiar vagueness and, no doubt, in part b e c a u s e o f its mystifying disconnection with empirical matters such as natural language and human inference patterns, logic has been exerting an enormous influence on the sciences, including linguistics. Thus, many linguists nowadays join in with the logicians in revering the latter's discipline and readily apply it. In this process, the peripheries of logic are modified, auxiliary hypotheses are introduced, but the empirical vagueness described above has so far largely escaped a critical scrutiny. This sharply contrasts with an expectation that linguists would have been very sensitive to the logician's disregard for natural language and that they would have seized an historical opportunity to repudiate the logician's nonchalance.

The spirit of the opening lines foreshadows the point of the paper. It will be my business to shed some light on the relation between logic, natural language and argumentation and I will embark on this project from the point of view of the linguist. There are two general restrictions here. First of all, I will limit myself to elementary propositional logic (PL). Secondly, I will focus my interests on a study of the word hence (and, implicitly, its near-synonyms[1] like therefore, thus, thence and so). Though the analysis allowed by these restrictions seems to me to be valuable in its own right, I will have to show why it can here serve as an illustration of some of my general ideas concerning the links between logic, natural language and human reasoning. As for the first restriction, elementary propositional logic simply is a most essential part of the whole logical enterprise. As for the second restriction, the preoccupation with the word hence, I claim that if logic has got anything at all to do with inferences, it must in some way deal with the word hence. Speaking on a pretheoretical,

[1] The difference between, on the one hand, hence, and, on the other, thus, therefore and thence is one of deixis. Hence is proximal (for t h i s reason). Thus, therefore and thence are distal (for t h a t reason). So is neutral in this respect (for s u c h a reason).

intuitive level, I believe it is obvious that it is precisely _hence_ or one of its near-synonyms that marks a random sequence of sentences as an argument. Compare (1), (2) and (3).

(1) The sea is deep. The river is shallow.

(2) If the sea is deep, the river is shallow.

(3) The sea is deep. Hence the river is shallow.

(3) is an argument. (1) and (2) are not, though (2) could be the warrant of an argument. Compare also (4) and (5).

(4) If, first of all, the sea is deep and, secondly, the river is shallow if the sea is deep, then the river is shallow.

(5) The sea is deep. If the sea is deep, the river is shallow. Hence the river is shallow.

The theoretical agenda of the paper is the following. The first section is a very limited discussion of the standard logician's strategy of relegating _hence_ to the realm of non-truth-functionality. In the second section I will advocate treating _hence_ as a propositional logical connective after first having given the sentential calculus an alternative and radically natural language oriented semantics. The third section offers a partial explanation of why standard propositional logic, despite the vagueness concerning its relation to natural language and reasoning and despite its lack of interest for the word _hence_, has nevertheless been found respectable by generations of logicians and non-logicians. This respect, however, will be seen to rest on very shaky foundations.

1. _Hence_ as a non-PL connective

The connectives of standard elementary propositional logic are t r u t h - f u n c t i o n a l . This means that the truth-value of the compound proposition or assertion -- I will here use these terms as synonyms -- is a function of the values of its components, to the extent that if one knows the truth-values of the simple propositions and if one has identified the connectives, there can be no doubt as to the truth-value of the compound. How this computation works, can be shown in the so-called "truth-tables". (6) to (9) are the most important ones, those of the conjunction, the disjunction, the material implication and the negation.

(6)

p	$\wedge$	q
T	T	T
T	F	F
F	F	T
F	F	F

(7)

p	v	q
T	T	T
T	T	F
F	T	T
F	F	F

(8)

p	$\supset$	q
T	T	T
T	F	F
F	T	T
F	T	F

(9)

$\neg$	p
F	T
T	F

If one wants to study the relation of propositional logic to natural language and reasoning, each of these tables is quite problematic. That of the material implication is perhaps the most troublesome. The closest ordinary language connective for the horse-shoe ($\supset$) would be <u>if...then</u> or at least the primary use of <u>if...then</u> that expresses an i n d i c a t i v e conditional, as exemplified in (2).

(2) If the sea is deep, the river is shallow.

If one accepts the first (horizontal) line of table (8), one would have to say that the truth of both antecedent and consequent is sufficient for the truth of the indicative conditional. A deep sea and a shallow river would guarantee a true assertion that this river is shallow if this sea is deep. This is clearly counterintuitive.

The last two lines of table (8) are vexing as well. Assuming that $\supset$ stands for an <u>if...then</u> like the one in (2), then (2) would be true for a situation in which the sea is not deep, whether the river is shallow or not.

A typical solution is the following. The material implication only p a r t i a l l y renders the indicative <u>if...then</u>. From a classical truth-functional point of view, the material implication is the best the logician can some up with, and, at least, he successfully describes that the indicative conditional is certainly false whenever the protasis is true and the apodosis false. That a conditional could have non-truth-functional properties, such as some causality or relevance linking up protasis and apodosis, that would not be of his concern.

This already allows for a simple, but important conclusion: connectives can be only p a r t i a l l y truth-functional to enjoy the truth-functional account of propositional logic.

But there are less fortunate connectives: those that simply do not qualify for a truth-functional treatment. One such connective is hence.

(3) The sea is deep. Hence the river is shallow.

For concluding that (3) is true, Quine (cp. Quine 1965:23) might say that one has to be convinced of a causal connection between the depth of the sea and the shallowness of the river. It would not be sufficient that the sea is deep and the river shallow. Does this point of view imply that there is nothing truth-functional about hence? No, I believe. Hence or at least the use of hence exemplified in (3), which one could call the "indicative" hence, parallels the indicative if...then in that a compound proposition is false when the first proposition is true and the second false. Both (2) and (3) are false when the sea is deep and the river is not shallow. So why, one wonders, did Quine flatly call hence "non-truth-functional"? What is the reason for excluding hence from the set of orthodox PL connectives?

Part of the answer will be reserved for the third section of this paper. Another part might be that, if integrated into standard PL, hence would create a big problem. Let us try to construct a truth-table for hence and see what happens.

We already know how to write the second line. If the first constituent is true and the second false, we get the value 'false'. When both propositions are true, the compound proposition seems to be true, whether one credits this value to a similarity of hence and a simple conjunction -- note the optinality of the word and in a hence construction -- or to its resemblance to if...then -- both constructs seem to share the element "causal connection".

(10) The sea is deep and hence the river is shallow.

From both the conjunctive and the implicative point of view, the truth of the constitutive propositions guarantees the truth of the whole. For the third and the fourth line the affinity with the conjunction seems to outweigh the correspondence with the implication. That is, the intuitively most satisfying solution, so it appears to me, is to say that when the sea is not deep, the compound The sea is deep. Hence the river is shallow. is plainly false. The resulting hence table is (11). The symbol for hence is the turnstile (⊢).

(11)

p	⊢	q
T	T	T
T	F	F
F	F	T
F	F	F

Should one, for some reason or other, want to emphasize the correspondence with the conditional and consider the falsity of the first proposition as sufficient for the truth of the whole proposition, one ends up with the table in (12).

(12)

p	⊢	q
T	T	T
T	F	F
F	T	T
F	T	F

Either way, one is confronted with an interesting problem. The <u>hence</u> table is identical with that of another connective, either the conjunction or the material implication.

This difficulty can be removed by claiming that indicative <u>hence</u> and either <u>and</u> or indicative <u>if...then</u> only differ on something like a "rhetorical" level. This is the type of explanation that is sometimes (e.g. Quine 1965:15-17, and Mates 1972:81) given for the distinction between, on the one hand, <u>and</u> and, on the other, <u>but</u> and <u>although</u>.

Yet a logician who wants to give a partial, truth-functional description of the truth-conditions of indicative <u>hence</u>, but who is also, as much as possible, trying to save the traditional viewpoints, should not turn to this type of explanation. The reason for not following up this strategy is that, while a <u>but</u> case rests on the idea that <u>but</u> and <u>and</u> have identical truth-conditions, all of which are truth-functional, the initial observation for <u>hence</u>, which prompted the decision to call it "non-truth-functional", is that it has quite special truth-conditions, different from indicative <u>if...then</u> and <u>and</u>, both of which get truth-functional counterparts.

Let me sum up some important problems: (i) there is a fairly strange procedure to force <u>if...then</u> into truth-functional shackles;

(ii) there is, to my knowledge, no real justification for why hence is not given this treatment;
(iii) if hence should receive the type of formalisation that if...then has come in for, one is confronted with a somewhat disturbing coalescence of the tables of different connectives.

This catalogue suggests:
(i) that one could venture to try out an alternative analysis for if...then;
(ii) if this would be successful, one should use this new perspective to look at hence again;
(iii) if this would be successful as well, one should see what is left of the problem of the identity of truth-tables.

Before turning to this three-fold task it is worth looking at one more proposal for how to deal with hence, the very influential initiative of Grice (1975:44-45). In order to account for the non-truth-functional character of hence, Grice relies on his distinction between the meaning that is expressed in a direct and explicit way and the meaning that is only suggested, implied or, to use his own term, "implicated". Grice would say that the speaker of (3) expresses or says that the sea is deep and that the river is shallow but not that the second follows from the first. This consequence relation would only be implied, though it would be implied in a very specific way. This "implicit" meaning -- the term is my own -- is carried by the conventional meaning of the word hence. This kind of explicit implicit meaning is called "conventional implicature".

I have the impression that this concept is a result of Grice's logical orientation. The best that can be said in the framework of classical propositional logic about the truth-conditions of hence, is that they are identical with those of and. If two expressions have the same truth-conditions, according to this logic, they have the same meaning. At first sight, this would be unacceptable, since, clearly, and and hence are far from synonymous. Maybe this is what Grice has in mind when he comes up with a solution that accounts for the semantic difference between and and hence and that saves logic. He stipulates that these connectives have the same explicit meaning but that hence suggests some extra, implicit meaning. The heart of the matter is that Grice relegates the non-truth-functional aspects of hence to a level of suggestion. I doubt whether this strategy, which is presumably prompted by purely theoretical motives, still reflects empirical reality. Is it not contradictory to consider some meaning as implicit in the presence of a sufficient overt sign? If one could solve the three-fold task mentioned above, it might well earn a higher degree of credibility, since Grice's solution seems to be inveracious. Notice how my account would be simpler, too, if integrating indicative hence into propositional logic would amount to no more than to enlarge the scope of a type of analysis that has been argued for on distinct grounds, thus eliminating the need, as felt by Grice when he studied a word like hence[2], for an additional concept of "conventional implicature".

2. Hence as a PL connective

In this section indicative hence will be given the status of a PL connective. Its truth-table will differ from that of and and if...then. Indicative if...then will be given an unorthodox PL table. All this is based on a radically natural language oriented semantics. I cannot here present or defend this semantics in all its details and with respect not just to the classical semantics but also other non-standard interpretations, but, in order to fight the risk of idle allusiveness, I must sketch some essentials.[3]

First, a terminology is needed. Part of it can be obtained from the well-known distinction between necessary, sufficient and necessary and sufficient conditions. Take (2) again.

(2) If the sea is deep, the river is shallow.

According to this assertion, the depth of the sea guarantees the shallowness of the river. The former is sufficient for the latter. But it is not necessary. It is consistent with (2) that the river is shallow if the ocean is deep. The shallowness of the river, however, is necessary for the

[2] This qualification is necessary because I do not want to rule out that there are reasons that do not depend on the analysis of hence for introducing a concept of "conventional implicature".

[3] This note replaces a large set of notes that could be attached to many of the claims made in the rest of the paper. I first presented this type of semantics at the 1977 California Linguistics Association Conference. Some aspects of it are treated in Van der Auwera (1977; 1978b; 1978c). The most comprehensive account will be found in my 1979 doctoral dissertation called The refutation of meaning. Conjectures on the semantics and pragmatics of natural language.

sea to be deep. But it is not sufficient. It is consistent with (2) that it would take a shallow river and a deep ocean to make the sea deep. This illustrates the difference between a condition that is necessary though not sufficient and one that is sufficient though not necessary. These properties do not exclude each other. Should the conditional start out with an additional <u>only</u>, it would tell us about a necessary and sufficient condition for a shallow river.

(13) Only if the sea is deep, the river is shallow.

In a second stage this distinction is brought to bear on the idea of u n f a l s i f i a b i l i t y . An assertion may be unfalsifiable with respect to a particular world or state of affairs for various reasons. Take the assertion in (14)

(14) There is a black swan sitting on an epistemologist.

The world that (14) is supposed to refer to, could be such that there is indeed a black swan sitting on an epistemologist. There is no way to say that (14) is false. As a matter of fact, the world has all that is necessary and sufficient to call the assertion a true one.

Suppose now that the world has t w o black swans sitting on the epistemologist. Again (14) is irrefutable, yet the constitution of the world is no longer necessary, but only sufficient for the truth of (14). We do not need two swans in order to truthfully say that there is one. Yet, twoness is enough for oneness.

Finally, suppose that the world with the one black swan is being approached with assertion (15).

(15) There is a black swan sitting on a surprised epistemologist.

Now, whether the epistemologist is surprised or not in the world under consideration, is undetermined. He may be, or he may not. The problem concerns one of the "p o i n t s o f i n d e t e r m i n a t i o n" of this world. Like any other world, it has got lots of these points. It is not clear e.g. whether the beak of the swan has two white dots on it, whether it is sitting on the epistemologist's head or arm, whether he even has arms or whether the universe of this person is, astronomically speaking, expanding or not. One might object, of course, and say that worlds are fully determined and that our knowledge is defective. This is a metaphysical question concerning which I do not take a stand, partially because I do not know an answer and partially because it does not matter here anyway. I am not interested in the correspondence between language and worlds such as they really are, since I do not know how they really are and I think that any claim on their nature is an interpretation such that one would no longer be confronted with the real worlds but only with epistemic constructions, that is, our views of these worlds. In a different jargon still, my worlds are epistemological and I think that necessarily all talk about ontological worlds reduces them to epistemological ones. Let me conclude this digression with the claim that the worlds I am speaking about are not the potentially fully determined and as such unknown and only partially understood, but the equally partially known and hence partially undetermined worlds. To come back to the truth-value of (15) in the world in which there is one black swan sitting on an epistemologist, we cannot call the assertion false, yet the world does not fulfill sufficient or sufficient and necessary conditions to call it true either. As it happens, it just contains a necessary condition for its truth. In order to truthfully say about a state of affairs that there is a black swan sitting on a surprised epistemologist, it must be sitting on an epistemologist.

I described three world-statement pairs. Whether the world contained necessary and sufficient, only sufficient or only necessary conditions, the statement could never be called 'false'. In the first two cases it is actually 'true'. On the basis of this typology, three types of non-falsity will be defined. An unfalsifiable statement is 'T_{ns}' if the correspondence concerns necessary and sufficient conditions for its truth. It is 'T_s' with respect to a world of conditions that are sufficient but not necessary for its truth. It gets 'T_n' in comparison with a state of affairs of necessary but insufficient conditions for truth. T_{ns} and T_s statements are true.

To sum up: I took the standard distinction between necessary, sufficient, and necessary and sufficient conditions and used it to define three types of non-falsity. But tradition is not good enough this time. This four-way distinction between falsity and three types of non-falsity is not exhaustive. Consider the following situation. The world contains a child and the assertion is (16).

(16) There is a human being and there is an elephant.

The presence of a child is sufficient for the presence of a human being. But the latter is only a necessary part of the presence of both a human being and an elephant. So there are conditions that are only sufficient for a necessary condition for truth ("s_n-conditions"). Compare the world with the child with statement (17), too.

(17) There is a boy or an elephant.

Is it necessary to exist as a child in order to enjoy potential elephanthood? The answer is negative. The same response should go to the question whether childhood is at least sufficient. Childhood is really only necessary for one of the sufficient conditions for an existence that is either boyish or elephantish. So we arrive at a fifth type of condition: the one that is necessary for a sufficient condition ("n_s-condition") (cp. Mackie 1965).

As it stands, every n_s-condition can also be looked upon as s_n-condition. Take (17) again. It is necessary that there is either a child or a large animal, for which it is sufficient that there is a child. This would obviously make the distinction between n_s-conditions and s_n-ones entirely useless. To take care of this problem, s_n-conditions will be given a narrower definition. The necessary conditions they are sufficient for, should only be the ones that by c o m p l e m e n t i n g each other make up a ns-condition. Since there is no such necessary condition for an existence that is either boyish or elephantish, there is no s_n-condition either. So the presence of the child ceases to be s_n. It remains s_n, though, for the presence of both a human being and an elephant.

This account should make one wonder whether this search for conditions could not go any further. I do not think it could. In other words, I believe that this typology is exhaustive. But since I do not need any potential extra type of condition in the rest of this paper anyway, I can here leave this claim unargued for.

Since the world with the one child falsifies neither (16) nor (17), these conditions allow for two more types of non-falsity. An unfalsified statement will be called 'Ts_n' iff the world provides a condition that is neither sufficient nor necessary nor necessary for a sufficient condition for the truth of the statement, but one that is only sufficient for a complementary necessary condition for truth. A non-false statement is 'Tn_s' with respect to a world of conditions that are neither sufficient nor necessary nor sufficient for a complementary necessary condition but only necessary for a sufficient condition for truth. Neither T_{n_s} nor T_{s_n} statements are true.

Notice that the stipulation that a T_{n_s} statement cannot also be T_{ns}, T_s, T_n, T_{s_n} is of particular relevance here. Without this restriction n_s-conditions would be unique in that all other types of conditions can be looked upon in this way. So, in a sense, all other types of conditions would be special cases of n_s-conditions. But these other types do not exhaust the typology of n_s-conditions. There are still those that are o n l y necessary for a sufficient condition and only these are the ones which I make the term "n_s-condition" refer to.

I have now described five types on non-falsity. Whenever I find the opposition between false and non-false, I could try to subcategorize the non-falsity. This procedure will now be applied to the standard truth-tables of propositional logic. 'F' and 'T' will be taken to refer to "false" and "non-false", respectively. In a bivalent logic "non-false" equals "true" but in my logic T will be interpreted in terms of five types of non-falsity, i.e. T_{ns}, T_s, T_n, T_{s_n} and T_{n_s}. The result is a six-valued logic.[4]

I shall here only investigate the computation of compound propositions of which the components are, if T, T_{ns}. This means that the truth-tables that will be shown in this paper are far from complete. This is a strategical restriction. As will be shown later on, these fragmentary truth-tables will be sufficient to show the differences between the natural language connectives under consideration.

Let us turn to the material implication, first. How, then, are the T's to be interpreted according to my six-valued logic? The question regarding the first line could be put as follows: what type of condition does a world in which it is T_{ns} that the sea is deep and the river is shallow exhibit with respect to a T_{ns} indicative conditional that the river is shallow if the sea is deep? This juxtaposition of the depth of the sea and the shallowness of the river is certainly not sufficient. A fortiori, it is not necessary and sufficient. It is not even necessary. The conditional relation between the depth of the sea and the shallowness of the river d o e s n o t f o r c e the sea to be deep and the river to be shallow. But what is absolutely necessary for this conditional to be T_{ns} is that it is at least p o s s i b l e for the sea to be deep and the river to be shallow. Observe that if this possibility is doubtful or non-existent, subjunctive conditionals are to be used.

(18) If the sea were deep, the river would be shallow.

(19) If the sea had been deep, the river would have been shallow.

I take it for granted and I do not argue the case here that the necessity of the possibility for the sea to be deep and the river to be shallow

[4] This is one of the many simplifications of this paper (cp. note 3). If a similar interpretation is worked out for F, one will find that we actually need a s e v e n - v a l u e d FL.

belongs to the set of necessary conditions that complement each other and turn up a ns-condition. Now, for this complementary n-condition the state of affairs of the first line of the truth-table, i.e. the one in which the sea is deep and the river is shallow, is obviously sufficient, though not necessary. So a conjunction of the depth of the sea and the shallowness of the river provides a s_n-condition for the truth of the conditional. Since it clearly does not falsify the conditional, the latter will be judged T_{s_n}.[5]

A more complicated argument will yield the same value for the third and the fourth lines. It is a complementary necessary condition for the river to be shallow if the sea is deep that it is possible that the sea is deep and the river shallow. Observe that it may well be necessary. For a world in which the sea is necessarily deep and the river necessarily shallow, it would be perfectly possible that the latter depends on the former in a manner indicated by the indicative conditional. However, this necessity, though possible, is itself n o t n e c e s s a r y . The non-necessity of the necessity of the depth of the sea and the shallowness of the river is again, I would claim, a complementary necessary condition for the truth of the indicative conditional. Sufficient conditions for this condition are provided when the sea is not deep and/or the river is not shallow, that is, the states of affairs of the second, third and fourth lines of the implicative table. So, these states of affairs indicate s_n-conditions for the truth of the indicative conditional. That of the second line, however, is very different from the others. The second falsifies the conditional. The third and the fourth do not. The second, therefore, correctly gets the F and the third and the fourth get a T_{s_n}.

This gives the following implicative table:

[5] If the reader does not accept that the necessity of the possibility for the sea to be deep and the river to be shallow is one of the c o m p l e m e n t a r y necessary conditions for the truth of the conditional, what I have considered to be obvious, he will conclude that the appropriate value for the first line is T_{n_s}. For the purpose of this paper, this is equally good. A similar qualification is due for my analysis of the third and the fourth lines.

(20)

p	$\supset$	q
T_{ns}	T_{s_n}	T_{ns}
T_{ns}	F	F
F	T_{s_n}	T_{ns}
F	T_{s_n}	F

Let me, for the purpose of this essay, add a very brief discussion of the negation, the conjunction and the disjunction. The point is simply to suggest that my analysis of non-falsity can be made useful for the other connectives, too. For standard conjunctions and negations of elementary propositions, the T of the compound will simply be interpreted as T_{ns}.

(21)

p	$\wedge$	q
T_{ns}	T_{ns}	T_{ns}
T_{ns}	F	F
F	F	T_{ns}
F	F	F

(22)

$\neg$	p
F	T_{ns}
T_{ns}	F

Standard disjunctions are more interesting. Take an ordinary language example.

(23) The sea is deep or the river is shallow.

For its T_{ns} non-falsity it is sufficient, but not necessary that e.g. the sea is deep. (24) is the T-interpreted table.

(24)

p	$\vee$	q
T_{ns}	T_s	T_{ns}
T_{ns}	T_s	F
F	T_s	T_{ns}
F	F	F

It is time to draw explicit attention to the relevance of this analysis for the three difficulties of the preceding section. To begin with the problem of the classically interpreted material implication. What it shows about some uses of if...then is only that such assertions are false, if protasis is true and apodosis false. The horseshoe table itself does not even show that there are non-truth-functional aspects to if...then. Furthermore, that a material implication is true in case both constituents are true or when the first is false, is in contradiction with the properties of the common indicative conditional. So there are at least two problems. The alternative semantics solves the second problem entirely, the first at least partially. A transformation of the uninterpreted T -- implicitly known to be either T_{ns} or T_s -- into T_{sn} is enough to take care of the correspondence with the natural language indicative conditional. As to the first problem, the presence of T_{s_n} is an absence of a stronger type of T, a sure indication of the importance of truth-conditions that cannot be captured with truth-functional means. Thus, in the alternative semantics, at least the non-truth-functional aspects are clearly avowed to exist.

I now come to hence. Table (11), intuitively more satisfying than (12), had just one T. Let it be T_n, since, indeed, for the truth of (3) it is not sufficient, but still necessary that the sea is deep and the river shallow. This gives us table (25).

(25)

p	$\vdash$	q
T_{ns}	T_n	T_{ns}
T_{ns}	F	F
F	F	T_{ns}
F	F	F

At the same time the third problem is disposed of. The tables for and, if...then, and hence are no longer identical.

To sum up:

(i) hopefully, this analysis is one step towards a conception that is more explicit and precise than the traditional one, of how propositional logic can be seen as a description of argumentation and natural language;

(ii) from this point of view, material implication no longer serves any purpose and the horseshoe simply becomes a symbol for the indicative if...then;

(iii) this approach allows for an interpretation of the word hence, that seems to refer to a central aspect of reasoning and for which I have not seen a justification as to why it would not be entitled to a propositional logical counterpart.

3. Towards explaining conservatism

In this final section I will briefly deal with two very important and related questions. Why is it, first of all, that propositional logic is so highly respected despite its fairly strange account of if...then and, more generally, the vagueness concerning its relation to reasoning and natural language. At least part of the answer is, I believe, that it is an authentic, but insufficiently realized task of logic to study f a l s i f i c a t i o n , the problem of w h e n assertions are false and non-false. H o w they are non-false, in other words, whether they are T_{ns}, T_s, T_n, T_{s_n} or T_{n_s} is not to the point, or at least much less so. For the study of falsifiability the differentation into five types of non-falsity can to a large extent be neglected. This is also what logicians do. It does not imply that it can be disregarded for all purposes. Unfortunately, this, too, seems to be the practice of logicians.

Secondly, why can propositional logic live without hence? At least part of the reason, I claim, is that the types of hence constructions that interest the logician, are those that derive something that can be called "validity" from their own structure and the structure of the assertions that normally precede the hence construction, and that this structural element can to some extent be reflected with a description in terms of horseshoes. Take (5) again.

(5) The sea is deep. If the sea is deep, the river is shallow.
Hence the river is shallow.

This is a set of assertions that fascinates a logician. What is so remarkable about it is that the conjunction of the implication and the third assertion has the very same truth-functional truth-conditions as the hence construction of the whole conjunction and the fourth assertion. Relying on the full machinery, which I have not defended here, this is shown in (26).

(26)

((p	$\supset$	q)	$\wedge$	p)	$\vdash$	q
T_{ns}	T_{s_n}	T_{ns}	T_{s_n}	T_{ns}	T_{s_n}	T_{ns}
T_{ns}	F	F	F	T_{ns}	F	F
F	T_{s_n}	T_{ns}	F	F	F	T_{ns}
F	T_{s_n}	F	F	F	F	F

Yet, this same phenomenon is demonstrated with the proof that ((p q) q) is never false. It is a so called "logical implication".

(27)

((p	$\supset$	q)	$\wedge$	p)	$\supset$	q
T	T	T	T	T	T	T
T	F	F	F	T	T	F
F	T	T	F	F	T	T
F	T	F	F	F	T	F

This is the procedure of the "tautological corresponding conditional".

Thus, to render this very interesting property of hence, it seems that one does not have to introduce hence itself into propositional logic. But, first of all, this does not mean that there are not any other reasons for doing so. Secondly, the fact that the "corresponding conditional" method of (27) at least sometimes coincides in results with the explicit hence method of (26) does not mean that they always coincide. In particular, they *do not* with respect to so-called "logical paradoxes"!

However, -- to end this paper in an allusive but hopefully at least still polemic note -- the subject of "the proper treatment of logical paradoxes" would be beyond this paper, as well as, clearly, a full-scale account of "*a six-valued propositional semantics for natural language*", which, I think, is actually *seven-valued* (see note 4), which is not even a semantics but a *pragmatics*, and which includes a *modal* fragment.

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