

CONDITIONALS AND THE DUAL OF PRESUPPOSITION

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Abstract

A proposal concerning the status of the semantic relation between the consequent clause of a conditional sentence and the conditional sentence itself is made: this relation corresponds to the dual of presupposition, in the technical sense. It holds not only for conditional declaratives but also for conditional questions, imperatives and exclamatives. Technically this is possible because conditional sentences are considered as categorially polyvalent modifications of the consequent clause by the conditional clause. This partially explains why many non-conditional constructions have conditional readings and gives a new answer to the question of what happens when the antecedent of a conditional is false.

1 Introduction

Although remarks about the complexities of conditional sentences, their varieties and the numerous problems one encounters in their semantic analysis might constitute a good introduction to the subject matter of this paper I will not start with them. In fact, strictly speaking, this would not be an easy task in general and for me in particular. Various interactions of conditional sentences with tense, mood, focus particles, quantifiers, adverbs, their presuppositions, etc. have been analysed (see for instance Beck 1997, Fillmore 1986, von Stechow 1997, Haegeman and Wekker 1983, Zuber 1975). In this paper I am basically interested in characterising more precisely the semantic status of conditionals and in particular the semantic relationship which exists between a conditional sentence and the sentence corresponding to its consequent clause. Moreover, the characterisation I am going to propose will apply not only to the case of declarative conditionals but also to various non-declarative conditionals. I will also try to understand why some constructions, in principle syntactically different from conditionals, nevertheless have conditional readings. This is for instance the case with some relative clauses or with comparative conditionals (cf. Beck 1997).

The above remark means that I will consider a formation of conditionals closer to polyvalent modification: in the prototypical cases the protasis of conditionals is the main component of a (categorially polyvalent) modifier which modifies the apodosis. In this respect my proposal is in opposition to the dominant current analysis of conditionals in which the protasis of conditionals is basically related to the operation of quantification. More precisely by the current analysis of conditionals I mean what Partee (1991) calls the Lewis-Kratzer-Heim analysis of conditionals. The quantificational nature of conditionals can be resumed in this analysis as follows:

- (i) Conditionals involve quantification. The restrictor of the quantifier corresponds to the protasis and the scope of quantifier is identified with the apodosis.
- (ii) Objects quantified are situations
- (iii) The quantificational force in conditionals is determined by various sentence level operators (in particular quantificational adverbs and focus particles). In their absence the universal force

of quantification is supposed by default.

In the analysis I am going to propose, the quantificational force, if any, of conditionals is a derived notion. Strictly speaking it will follow from the fact that conditionals involve a specific modification of the apodosis. Since in the definition of the modification supposed to be at the basis of conditional constructions the generalised notion of entailment is essential, the (generalized) entailment is the starting point in the analysis of conditionals.

Let us see some examples. As most logic textbooks indicate one should consider that (1) entails (2):

- (1) Leo will stay home
- (2) If it rains Leo will stay home

It seems indeed clear that any analysis of conditional sentences should be compatible with this fact: on any analysis (1) should entail (2). My contention is, however, that more should be said: the semantic relation between (1) and (2) is stronger than just an entailment. It should indicate that in some sense this relation is trivial or, in some sense, necessary or analytic. The purpose of this paper is to provide a stronger notion of entailment, such that the indicated semantic relation is a particular case of it. As we will see this notion is, strictly speaking, a classical notion of entailment satisfying some additional conditions. We will also see that the notion of entailment I am going to propose has two other, empirically important, properties: (1) it is a dual of the notion of presupposition and (2) it can also characterize a semantic relation which holds between conditional sentences with a non-declarative consequent and the non-declarative consequent itself. Probably it has not been sufficiently pointed out that the relation similar to the one which holds between (1) and (2) also holds between (3) and (4) or between (5) and (6):

- (3) Close the door!
- (4) If it rains close the door!
- (5) How happy Lea will be!
- (6) If Leo calls how happy Lea will be!

In fact I will suggest that the relation indicated above is the dual of presupposition which is a particular case of a generalization of the entailment. First, in the case of non-declaratives it is not correct to talk about entailments. This relation is classically defined as holding between declarative sentences. Furthermore, it should be stronger than just entailment even in the case of declaratives. For indeed, in the case of (1) and (2) it holds independently not only of the truth of the protasis but also of what the protasis is like. So, roughly, if the protasis is just a particular case of modification, as is the negation, then the analogy with presupposition is obvious: S dually presupposes T iff S entails T and S entails the presuppositional negation of T. We will see how such a definition can be made more precise.

Concerning non-declarative cases, my proposal will lack an important element: no unified analysis of various types of non-declaratives will be given or assumed. At the pre-theoretical level, however, we observe that the application of the antecedent clause to non-declaratives preserves the type of non-declarative: an *if*-clause applied to a question gives a question, applied to an imperative gives an imperative and applied to an exclamative gives an exclamative. Even if resulting sentences are semantically in some sense conditional they preserve the type of non-declarative force of the argument. In that sense conditional clauses are taken to be modifiers.

The paper is organised as follows: in the next section theoretical tools needed for the analysis of modifiers in general and for the dual of presupposition in particular are provided. Then in the next section some arguments are given to show that *if*-clauses are categorially polyvalent modifiers involving the dual of presupposition. Finally in the concluding section some general consequences of the proposed analyses are drawn.

2 Formal preliminaries

The theoretical tools which will be used in what follows are those of Boolean semantics as developed by Keenan (Keenan 1983, Keenan and Faltz 1985), including a simple version of a categorial grammar. This means, briefly, the following. To every expression of English is associated at least one grammatical category. Grammatical categories are of two types: basic categories, among which is the category *S* of sentences, and derived, or functional categories. Functional categories are of the form B/A : it is a category of an expression which when applied (by functional composition) to an expression of category *A* gives a (complex) expression of category *B*. For semantic interpretation we assume that every category *C* is associated with its denotational type D_C , or denotational algebra D_C , which is a set of possible denotations of expressions of category *C*. The denotational type D_S for sentences is the algebra $\{0, 1\}$. Denotational types D_C form atomic (and complete) Boolean algebras. An algebra is atomic iff any of its elements, different from the zero element, contains an atom. An atom is an element which contains no element but itself and the zero element. A co-atom is the Boolean complement of an atom. Given an atom of an arbitrary element of an atomic algebra it is always true that the atom is contained in this element or in its complement. It follows from this that the meet of two arbitrary atoms equals to the zero element. By contraposition any element *a* of an atomic algebra or its complement a' is contained in a co-atom. The partial order in denotational algebras is interpreted as a generalized entailment. Thus it is meaningful to say that an entailment holds between two NPs, between two nominal determiners, between two VPs, etc. In particular it is meaningful to say that expressions (of a given category) denoting atoms entail other expressions (of the same category).

In fact even more can be said. We can also talk about an intercategory entailment, or *IC-entailment*, (Zuber 2002), i.e. an entailment which holds between expressions of different but functionally related categories. Two categories are functionally related if they terminate in the same category. For instance two Boolean categories are functionally related (since they have as resulting category the category *S* of sentences). Thus in the type-category notation, the expression of type $(a_1 \rightarrow (a_2 \rightarrow \dots (\dots t)))$ IC-entails the expression of type $(b_1 \rightarrow (b_2 \rightarrow \dots (\dots t)))$ iff for all possible categorial values a_i, b_j the sentences thus obtained stand in the relation of classical entailment (between sentences). So, in particular we have an IC-entailment between NPs and sentences. For instance the NP in (7) IC-entails the sentence in (8):

(7) Every student but Leo and Lea

(8) Leo and Lea are students

The reason is that any sentence in which the NP in (7) occurs as the subject NP entails (8).

I will consider denotational algebras for modifiers. A modifier is a functional expression of category C/C for various choices of *C*. Thus by varying *C* we get, syntactically speaking, different modifiers. It is an interesting property of many lexical items one finds in natural languages (for instance *only*, *in particular*, *even* that they are *categorially polyvalent* in a regular way. We will see that it is also the case for the conditional clause.

Although all modifiers are of category C/C , various semantic restrictions can be imposed on them. We will also consider that these restrictions are such that they always allow the members satisfying them to have the Boolean structure. The typical, empirically justified restriction, is the restriction forming the set $REST(C)$ (Keenan and Faltz 1985), which is a subset of the set of functions from D_C onto D_C . The set $REST(C)$ of *restrictive functions* $f_c \in D_{C/C}$, is the set of functions satisfying the condition $f_c \leq id_c$ (where $id_c(x) = x$, for any $x \in D_C$), or equivalently, the set of functions satisfying the condition $f_c(x) \leq x$, for any $x \in D_C$. The set of restrictive functions forms a Boolean algebra:

Prop 1: Let B be a Boolean algebra. Then the set of functions f from B onto B satisfying the condition $f(x) \leq x$ forms a Boolean algebra R_B with the Boolean operations of meet and join defined pointwise and where $0_{R_B} = 0_B$, $1_{R_B} = id_B$, $f'(x) = x \cap (f(x))'$

Prop 1 shows how to form the restrictive Boolean algebra R_B from the algebra B . If $B = D_C$ for a fixed C , R_{D_C} will be denoted by $REST(C)$. This means that we have a family $RESTR(C)$, for any category C , of Boolean algebras formed as indicated in Prop 1. These algebras are atomic (Keenan 1983).

There is an important sub-algebra $ABS(C)$ of $REST(C)$ (relative to a given denotational algebra D_C). Elements of $ABS(C)$ are the so-called *absolute functions* (Keenan 1983). By definition, $f \in ABS(C)$ iff for any $x \in D_C$, we have $f(x) = x \cap f(1_{D_C})$. One can show the following property:

Prop 2: If D_C is atomic so is $ABS(C)$. For all atoms α of B , functions f_α , defined by $f_\alpha(x) = \alpha$ if $\alpha \leq x$ and $f_\alpha(x) = 0_{D_C}$ otherwise, are the atoms of $ABS(C)$

From the fact that $ABS(C)$ is a sub-algebra of $REST(C)$ it follows that absolute functions are restrictive ones. However, not all restrictive functions are absolute. In particular absolute functions are monotone increasing whereas restrictive non-absolute functions need not be monotone. For the case where $C = CN$ the two classes are related to the difference between relative adjectives and absolute adjectives. Roughly speaking, relative adjectives, in opposition to absolute ones, are those which can occur in comparative constructions and which can be modified by intensifiers like *very*. One observes then that relative adjectives denote restrictive non-absolute functions and absolute adjectives denote absolute functions. For instance, if we consider that the unit element of the algebra of properties is the denotation of *individual/entity* there is an equivalence between (9a) and (9b), where the absolute adjectives occur and there is no equivalence between (10a) and (10b) where relative adjective occurs:

- (9a) Leo is a male/bold student
- (9b) Leo is a student and a male/bold individual
- (10a) Leo is a tall student
- (10b) Leo is a student and a tall individual

More interestingly, restrictive relative clauses, which modify common nouns, denote absolute functions. For instance (11a) is, rightly represented by (11b):

- (11a) students who danced
- (11b) $STUDENT \cap OBJECT \text{ WHO DANCED}$

So *WHO DANCED* denotes an absolute function, a member of $ABS(CN)$. Similarly non-restrictive relative clauses, which modify NPs, denote absolute functions, members of $ABS(NP)$. An important question is whether there are modifiers for which other restrictions are necessary. It has been suggested in Zuber (1997) that there are "negative" modifiers which denote "negatively restricting functions", i.e. functions f such that $f(x) \leq x'$. Whether indeed such functions are needed remains an empirically open problem. In this paper I want to suggest for the analysis of conditional sentences we need functions dual to the restrictive or rather of the absolute, functions. A notion dual to a given one (formulated in the language of Boolean algebras) is, roughly, the one obtained from the given one by replacing all Boolean operations by their duals, where this last notion is recursively defined. In particular the dual of the meet operation is the join operation and the dual of the unit element is the zero element. From this it follows for instance the following: if A entails, in the generalized sense, B , then B dually entails A . The reason is that the generalized entailment (between elements of the same category) corresponds to the partial order in the corresponding denotational algebra. So we have $A \leq B$ which is equivalent to $A \wedge B = A$. The expression dual to this last expression is $A \vee B = A$ which is equivalent to $B \leq A$ which means that B entails A .

We can now introduce the duals of $REST(C)$ and of $ABS(C)$. Consider first the set $DREST(C)$ of d-restrictive (dually restrictive) functions. By definition $f \in DREST(C)$ iff for all $x \in D_C$, $x \leq f(x)$. This set forms a Boolean algebra in which the zero element equals to the identity function. The complement operation is relativised to this zero element. Thus $f'(x) = x \vee (f(x))'$. By analogy we define the set $DABS(C)$ of functions dual to the absolute functions (for a given algebra D_C). By definition $f \in DABS(C)$ iff for all $x \in D_C$ we have $f(x) = x \vee f(0_{D_C})$. The set $DABS(C)$ forms a sub-algebra of $DREST(C)$. The complement in this sub-algebra is defined as: $f'(x) = x \vee f(0_C)'$. Moreover, if D_C is atomic, $DABS(C)$ is also atomic. Atoms of $DABS$ are defined as follows: for an α , atom of D_C the function $f_\alpha(x) = x \vee \alpha$ is an atom of $DABS$.

Dually absolute functions differ from dually restrictive non-absolute functions with respect to iteration. First, an iteration of a d-absolute function is idempotent: if f is d-restrictive then $f(f(x)) = f(x)$. This is not the case with d-restrictive non-absolute. Furthermore if $f, g \in DABS$ then $f(g(x)) = g(f(x)) = f(x) \vee g(x)$.

The last point I want to mention in this section concerns the notion dual to the notion of presupposition. Although the phenomenon of presupposition appears most clearly at the sentential level, it is useful to consider that it is a cross-categorical, or even inter-categorical notion. In particular we know that some non-sentential categories can also presuppose (other non-sentential categories). There are various lexical presuppositions: for instance the common noun *student* presupposes (the common noun) *human being*. Similarly, the NP *Leo also* presupposes *Someone different from Leo*. An example of inter-categorical presupposition is probably given in (7) and (8) above: there are various reasons to consider that the NP in (7) presupposes the sentence in (8).

One way of looking at the notion of presupposition involves the restriction on the unit element in the corresponding denotational algebra. The unit element is maximal in the sense that every element "entails" it. So if this unit element is the "ordinary" (non-restricted) unit then one gets only trivial presuppositions, precisely equal to this unit. If one considers the algebra with the restricted unit element one gets non-trivial presuppositions corresponding precisely to this restricted unit element. This is because the complement operation, used to form a specific negation in the definition of presupposition, is restricted in this case. Consider for instance the algebra $D_{CN:H}$ which is the algebra of all properties D_{CN} restricted to the property H denoted by *human being*. This algebra is defined as: $D_{CN:H} = \{P : P \leq H\}$. Since in algebras restricted in this way the complement operation is relativised to the restricting element, we see that in $D_{CN:H}$

any element and its complement entails (is included in) H . In that sense *student* presupposes *human being*. This is in agreement with the classical definition of presupposition according to which, ignoring the language-metalanguage distinction, A presupposes B iff $A \leq B$ and $A' \leq B$. Now we see how we get the dual of presupposition, d-presupposition. Instead of restricting the unit element we should restrict the zero element according to the principle of duality. The zero element is a minimal element in the sense that it "entails" any other element. So in particular it entails an element and its complement. Consequently we can define the notion of d-presupposition (dual of presupposition) as follows:

(12) S d-presupposes T iff S entails T and S entails not- T

So trivially a necessarily false sentence d-presupposes any (declarative) sentence. Of course we have to specify in general which negation corresponds to "neg- T ". By the duality principle we can just say that this is the presuppositional negation. It can vary depending on the categories we are interested in. There are some reasons to consider that in the case of NPs, i.e. when the presupposition is induced by the NP, this negation corresponds to the post-negation. Thus we can say that (13a) presupposes (13b) because (13a) and its post-negation both entail (13b):

(13a) Every student except Leo danced

(13b) Leo is a student

Applying the principle of duality to this example we get an example of d-presupposition: (14a) d-presupposes (14b):

(14a) Leo is not a student

(14b) It is not true that every student except Leo danced

(14c) It is not true that every student except Leo did not dance

Indeed, since post-negation (of the subject NP) preserves presuppositions it is easy to check that (14a) entails (14b) and its post-negation, (14c).

Another example, more useful for the analysis of conditional sentences concerns modifiers. Given the semantics of modifiers defined above we can say that they induce specific presuppositions and specific d-presuppositions. If we consider that in some cases the presuppositional negation corresponds to the negation of functional expression then we get the following general pattern: a functional expression which denotes a restrictive function F presupposes its possible argument. This is because $F(A)$ entails A and $F'(A)$ entails A . We can make a similar reasoning for d-presuppositions. Whether this is exactly a presupposition probably depends on the type of F . It seems that when modifiers are of the category S/S they may induce (non-trivial) presuppositions and d-presuppositions. As an example of such presuppositions one can probably mention the so-called factive predicates. They behave semantically as sentential modifiers denoting restrictive functions. As an example of d-presupposition we can mention precisely the case of conditional sentences: if the conditional clause of the form *IF S (THEN)* is a modifier denoting a d-restrictive function (in the algebra $D_{S/S}$), then (15a) d-presupposes (15b):

(15a) Leo is happy

(15b) If it is raining, Leo is happy

Thus the traditionally recognized entailment between a consequent of a conditional sentence and the conditional can be seen from a somewhat different point of view, if we assume that conditional clauses are modifiers. The reason is that if such modifiers denote d-restrictive functions then an entailment between the argument of such a function and the value of this function at this argument precisely is a definitional property of d-restrictive functions. In the next section I will give some empirical arguments to show that such an entailment also holds in the case of non-declarative conditional sentences.

3 Conditionals as modifiers

Since the conditional clauses are supposed to denote d-absolute functions which form Boolean algebras, we have first to show that conditional clauses have Boolean behaviour, in particular that they have complements and can be composed of operations corresponding to joins and meets.

Even if the data are somewhat subtle we observe first that indeed conjunctions and disjunctions of if-clauses "distribute" over the consequent clauses preserving appropriately the truth conditions. Thus (16a) is equivalent to (16b):

- (16a) If Leo has called and if the door was open, Lea is happy
 (16b) If Leo has called Lea is happy and if the door is open Lea is happy

This example shows that if-clauses act with respect to conjunctions like homomorphic functions and take their arguments pointwise. Concerning disjunctions the data are more complicated but it seems also that in this case if-clauses have a similar behaviour. Thus (17a) is probably equivalent to (17b):

- (17a) If Leo called or if the door was open Lea is happy
 (17b) If Leo called Lea is happy or if the door was open Lea is happy

The use of the conjunction *or* is very often considered as not being very clear and probably for this reason the above examples may give rise to some doubts. Such examples may change their grammatical and logical status by changing various elements in them. My point is that in general the Boolean properties are at least compatible with the empirical observations.

There remains the problem of negation of the Boolean complement of if-clauses. There seems to be a general agreement that there is no "natural" negation or denial of conditional sentences. Horn (1989), after having reviewed and criticised various proposals, concludes that one can speak only about the metalinguistic negation of conditionals. Of course he is basically looking at the "expressibility" of such negation: a natural way to express it by linguistic means proper to English with at the same time proper semantics. Our problem here is somewhat different. We are interested in the formal counterpart of negation of the conditional clause even though it may not be easily expressible in natural language. Of course the fact that negations of conditionals are not easily expressible is important but is not of immediate interest here.

So it seems to me that it is possible, although not easy, to get the negation of the conditional clause, at least formally: (18a) is ambiguous (in the same way as are ambiguous *because*-clauses). With an appropriate intonation it can have the meaning in which the antecedent clause is negated and which is related to (18b) and (18c):

- (18a) Leo will not be happy if Lea calls
 (18b) ? It is not if Lea calls that Leo will be happy but if Sue calls
 (18c) Leo will be happy but not necessarily if Lea calls

In (18a) we have a negation whose scope is not determined. As (18b) shows this negation can have in its scope the whole antecedent clause. In addition (18c), although also ambiguous, indicates, on one of its readings, that the condition expressed by the antecedent clause can be negated. We can thus say that it is possible to negate also the antecedent clause. So the above examples suggest that the antecedent clause has a Boolean behaviour. Furthermore, the semantic relations one has between the consequent clause of a conditional and the conditional itself suggest that the antecedent clause denote d-restrictive functions. Indeed as indicated in the introduction logicians generally accept that there is an entailment between the consequent clause of a conditional and the conditional itself. But such an entailment is just the definitional property of d-restrictive functions if the antecedent of a conditional denotes such a function and the consequent clause denotes its argument. More can be said, however. Since complements of d-restrictive functions are d-restrictive functions we have an additional entailment: the consequent clause of a conditional entails also the conditional in which the antecedent clause is negated. Thus the semantic relation which exists between a consequence of a given conditional and the conditional itself is the relation of d-presupposition: (19a) not only entails (19b) but also d-presupposes it:

- (19a) Leo will be happy
 (19b) If Lea calls, Leo will be happy

Furthermore, but here we are more speculative, since (20a) entails, in the generalized sense, or in the sense of the IC-entailment, (20b), we can say also that (20a) d-presupposes (20b). For the same reasons (21a) d-presupposes (21b) and (22a) d-presupposes (22b):

- (20a) Will you drink?
 (20b) If it rains, will you drink?
 (21a) Close the window!
 (21b) If it rains, close the window!
 (22a) How happy Leo will be!
 (22b) If Lea calls, how happy Leo will be!

The above examples explicitly involve non-declarative sentences: in (20a) we have a question, in (21a) - an imperative and in (22a) -an exclamative. If we suppose, what have been often explicitly proposed, that is that different non-declarative belong to different categories and, consequently denote in different types, then the above examples show that the conditional clause is a categorially polyvalent modifier (with the additional assumption that a conditional non-declarative and the corresponding "straight" non-declaratives denote in the same type). Notice that this claim is in some sense independent on the exact type of specific non-declaratives.

It is interesting to note that the categorial polyvalency of the conditional clause and of the other "classical" boolean connectives do not coincide. It does not seem, in opposition to the logical connectives, that *if*-clauses can apply to non-sentential categories (see, however, Lasersohn 1996). Furthermore, non-declaratives cannot easily occur with classical Boolean connectors. When they do, the whole construction is not a conjunctive one but usually has the force of the non-declarative part or the meaning of a conditional. As the first case consider for instance (23):

(23a) Lea called and is Leo happy ?

(23b) ? Lea called and how happy Leo is

The question in (23a) is probably the so-called *given that*-question (Belnap and Steel 1976), a particular case of *inclusive questions* (Zuber 2000b), and the conjunction in (23b) has clearly the meaning of *because*.

In the following well-known examples the whole sentence (24a) although being a disjunction of an imperative and of a declarative has the meaning of a conditional similar to (24b):

(24a) Close the window or I will leave.

(24b) If you do not close the window I will leave

There are also conjunctions which give rise to conditional readings, although their status as conjunctions is not clear (Culicover and Jakendoff 1997). Of course a complete analysis of constructions giving rise to non-declarative readings necessitates also a semantic analysis of non-declaratives and this is out of scope of this paper.

Another interesting case of conditionals are the so-called comparative conditionals. Here we can mention not only "simple comparative conditionals" as in (25a), studied for instance in Beck (1999) but also "double comparative conditionals" as in (25b) and (25c):

(25a) The longer Leo sleeps, the angrier he (Leo) gets

(25b) The longer Leo sleeps, the angrier Lea gets

(25c) The angrier Leo gets, the angrier Lea gets

Again the full semantic analysis of all such constructions remains to be done but we observe that all of them involve, directly or indirectly, modifications of their specific constituents. So an analysis of them will use the tools used in my proposal. Before any such extension can be tried, however, the suggestion made here concerning standard conditionals should be further carried out. For indeed, the main drawback of my proposal concerns the semantic contribution of the protasis of conditionals. It has to be specified how the semantics of the protasis forms a d-absolute function. At this point the following can be said. We observe that given a Boolean algebra B and an element $a \in B$, the function $f(x) = x \vee a$ is a d-absolute function. Furthermore, any d-absolute function (relative to the algebra B) determines an element of B which is $f(0_B)$. In other words the algebra $ABS(C)$ is isomorphic to the algebra D_C . So if propositions form a Boolean algebra, any proposition determines a d-absolute function. Moreover, there are some reasons to consider that the *if*-clauses denote co-atomic (i.e. complements of atomic) d-absolute functions. One argument for such an analysis is based on the relationship between *unless*-conditionals and *if*-conditionals. This relationship is illustrated in (26), where all the sentences are supposed to be equivalent:

(26a) Lea will be happy unless it rains

(26b) Lea will be happy except if it rains

(26c) If it does not rain Lea will be happy

Since denotations of *except*-clauses are related to atomic functions (Keenan 1993, Zuber 1998b, Zuber 2000a) *unless*-clauses should also be analysed as atomic functions. Given that *if*-clauses are related to *unless*-clauses by the negation, very likely *if*-clauses denote co-atomic d-absolute

functions. If it is the case, then, given the definition of the co-atom, the *if*-clause would denote the function $f_{\alpha}(x) = \alpha' \vee x$, where α is the atom (of the algebra of propositions) determined by the protasis of a conditional. It should probably be not surprising that this function is very reminiscent of the definition of material conditional. The full development of this idea and of its consequences is possible only if the algebra of propositions is fully defined. The task of developing this idea should be postponed for the moment.

4 Conclusive remarks

There are also ways of studying conditional constructions. The classical and still vivid approach is the logical one where in general all possibilities of using material implication as basis are explored (for a review of this work see Edington 1995). This "logical" approach has been extended in many ways, in particular to cover various conditional constructions not expressed by *if*-clauses (see Lycan 2001 and various papers referred to there). or to make use of more sophisticated tools of logical semantics (von Stechow 1997, 1998, 1999). Another important approach to conditionals is one in which pragmatics plays an essential role in explicating varieties of conditional constructions (Fillmore 1986, McCawley 1995) Conditional constructions may differ cross-linguistically and also formally within the same language. The approach to conditionals which I have taken in this article is very general and made at an abstract level. Although the examples illustrating claims made in this paper are drawn from English I was not interested in conditionals in English as such but rather in their general properties supposed to be language, and even syntax, independent (for conditionals in English see Declerck and Reed 2001). From the syntactic point of view I considered basically standard conditional sentences with the protasis introduced by *if*. One could say that, roughly speaking, I was interested in conditional meanings and not in conditional constructions. There were two starting points, or hypothesis, for this paper. First, given the fact that syntactic modification is one of very few means used in natural languages to form complex constructions from simpler ones, a natural question to ask was whether there is a general, but not too abstract, semantic correlate of syntactic modification, in particular at non-sentential level. A related sub-question concerned the semantic status of categorial polyvalency of modifiers, since it is precisely modifiers that can be "naturally" categorially polyvalent. The second hypothesis was that conditional meanings, though not necessarily expressed by syntactically conditional expressions, are very widespread and often ambiguous one of its readings being precisely conditional. Expressions which are often ambiguous are relative clauses: they can have existential and conditional or generic readings. This is the case with (27) for instance:

(27) The man who hates artichokes is not happy

This sentence has a reading in which the subject NP refers to a specific man and a reading in which this NP has a generic reading, naturally expressible by a conditional. Similar examples concern *when*-clauses (Declerck 1988).

The analysis proposed in this paper gives a hint as to the answer to the question in what sense relative clause are related to *if*-clauses conditionals and to *when*-clauses: in all clauses are modifiers but sometimes they denote restrictive functions and sometimes dually restrictive ones.

Another general question touched upon by some results of my proposal concerns the status of the so-called *conditional assertion*. Some philosophers claimed the existence of such entities and some logicians tried to formalise its logic (Belnap 1973, Holdcroft 1971). A related question concerns the "propositional status" of conditional sentences: do they express propositions, and

moreover, what happens when the antecedent of a conditional is false? Examples with non-declarative sentences presented above extend this question to denotations of non-declaratives: what are conditional orders, questions and exclamations and what "happens" when antecedents of conditional non-declaratives are false?

Without making any precise proposal concerning these two questions we can observe that the notion of the dual of presupposition may be used to shed a new light on these problems: the status of conditionals with false antecedents is comparable to the status of propositions with violated presuppositions; in the case of conditionals it is the dual of presupposition which is false.

The last general point related to my proposal I want to mention concerns the conditionals modified by "algebraic" particles like *only*, *also*, *even*, *in particular*, *especially*, *let alone*, etc. Such particles are categorially polyvalent and in particular, as the following examples show, they can combine with *if*-clauses:

- (28a) Lea is happy, in particular if Leo called
- (28b) Even if Leo calls Lea is happy
- (28c) Lea will not be happy if it rains, let alone if it snows

This property makes that at least some of these particles have been often analysed in the context of conditional sentences (Lycan 1991, 2001, McCawley 1995). We observe that semantically they denote restrictive functions since there is an entailment between sentences containing these particles and the corresponding "particle-less" sentences. In that sense they can be considered as (categorially polyvalent) modifiers. The fact that their denotations are taken in atomic Boolean algebras allows us to explain their polyvalency. For indeed there are some reasons to consider (cf. Zuber 2001) that *only* for instance denotes atomic absolute functions. Similarly *even* is also related to atomic restrictive functions. This is clear in the case when *even* modifies a simple NP (cf. Zuber, unpublished but available). For instance (29a) can be "algebraically" analysed as (29b):

- (29a) Even Leo danced
- (29b) There is a (non-trivial) property, pragmatically considered as unfavorable for dancing, such that the only dancer who has it is Leo

The existence of unique property referred to in (29b) is related to the atomicity. Such an analysis can be extended to cases where other than NPs categories are modified. What is important is the algebraic character of involved denotations. Consequently my proposal can be naturally extended to modified conditionals as well.

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