PRAGMATIC CONNECTIVES AS PREDICATES

THE CASE OF INFERENTIAL CONNECTIVES

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Abstract. This chapter investigates the linguistic description and formal representation of some pragmatic *inferential* connectives in French. We show that connectives expressing consequence, opposition or reformulation (like *anyway* in English) presuppose an abstract relation between propositional arguments of certain semantic types. We first contrast inferential and non–inferential connectives, then we turn to the semantic types of the propositional arguments to lay down some basic distinctions. Finally we substantiate the relations themselves. We use a version of generalized quantification over proofs to describe the inferential constraints which define the various relations presupposed by the connectives. The very possibility of such a description suggests that inferential connectives have a genuine (presupposed) predicative content.

1. Introduction

Although pragmatic particles (or 'discourse markers') such as *then*, *therefore*, *but* or *OK* for English, have been studied in different languages from a variety of points of view,[1] there is at this time no standard framework in which these analyses can be combined and compared. Syntactically, discourse markers fall into five main classes: sentential adverbs like *therefore*, subordination conjunctions like *because* or *if*, prepositions like *owing to*, parentheticals like *you know*, and interjection–like expressions like *yes!* or *good!*. Semantically, the first three classes impose a semantic connection between propositions or, more generally, intensional entities. That is why we will call members of these classes pragmatic *connectives* or PCs.

In this paper, we will be interested in some members of the first class of PCs in French,[2] that of sentential adverbs. By and large, they fall into three categories: inferential PCs like *however* exploit an inferential relation between propositions, type–based PCs like *even*, *also*, *for instance*, *first* or *next* point to various typing relations between sentences or discourse fragments, temporal PCs like *then* connect eventualities.

We claim that PCs are predicates or relations bearing on intensional arguments of various types. The difficulty is to substantiate the constraints which license such relations. While there has been some suggestive work in this direction for type–based and temporal PCs (see Bonomi & Casalegno 1993, Asher 1993, Glasbey 1993 for recent examples),[3] the treatment of inferential PCs has been less uniform, and we will focus on them in this paper. We show that they impose precise, although abstract and underspecified, requirements on their intensional arguments. These requirements can be divided into two categories: the nature of the relation between the arguments, which corresponds to the question 'how are the arguments linked?', and the typing of the arguments which corresponds to the question 'What are the semantic types of the arguments?'. More precisely, we propose to analyze inferential PCs as generalized quantifiers on sets of intensional entities, such as propositions or modal formulas. These sets are linked by the existence of certain *proofs*, which capture some aspects of the inferential properties exhibited by inferential PCs.

We begin by explaining intuitively the difference between inferential PCs and the other two classes (section 2). Turning to inferential PCs in

[1] See for example (Reichmann 1985; Schiffrin 1987; Knott 1996) for English, (Lang 1984; Grote & Lenke 1995) for English and German, (Roulet *et al.* 1985; Jayez 1988; Moeschler 1989) for French, (Rossari 1994) for French and Italian, (Ferrari 1995) for Italian, (Gil 1995; Fernandez 1996) for Romance languages. Note that the terminology is not fixed: in the literature, one can find *connectives*, *connectors*, *particles*, *markers* to designate the same lexical items. Also, some authors prefer *utterance* to *discourse* (cf. Fernandez 1996).

[2] To ease understanding, we will provide English examples and write the French connective in small capitals. We sometimes provide rough English equivalents for French connectives. Readers interested in translation issues should consult (Grieve 1996).

[3] See also (König 1981) for the German so–called *scalar* particles.

section 3, we first describe the essential properties of the inferential classes we study, consequence, oppositive, and reevaluation PCs (sections 3.1–3.3). Then, in section 3.4, we examine the semantic typing of arguments or semantic *scope*. Next, in section 4, we analyze the linking relation and distinguish between abductive and deductive constraints. Finally, we consider more sophisticated examples of generalized quantification behavior for some consequence and reevaluation PCs.

2. Basics

Most PCs belong to one of the classes illustrated in (1)–(8).

(1) If you don't understand such a simple point, then, you should drop linguistics
(2) He has dropped linguistics. Yet, he was really gifted
(3) He has dropped linguistics. Anyway, he could not understand even simple points
(4) He has dropped linguistics. EN EFFET he could not understand even simple points
(5) John fixed the vacuum–cleaner. Then, he started repairing the mower
(6) He has dropped linguistics. On the other hand, Mary keeps on studying formal semantics
(7) I won't go for a walk. The weather is not so fine; besides, I'm tired
(8) Some executives of the company do not consider favorably the new project. For instance, John is sure it will be a flop

For simplicity, we have kept a structure XCY, where C is the PC, throughout the examples.[4] (1) contains a consequence connective: X brings about Y or allows one to conclude that Y. In (2), we find an oppositive PC: X and Y are somehow incompatible. In (3), the relation is that of *rephrasing* or *reevaluation*: Y installs a new setting for evaluating X. (4) exemplifies an explanatory relation: Y is supposed to account for X. (5) is a typical example of a temporal relation (of sequencing in this case). (6) exploits a contrast between two states of affairs. (7) shows how arguments can be enumerated in intuitive reasonings. Finally, (8) illustrates exemplification. We did not attempt to classify *all* PCs. Some of them are hard to categorize. E.g. *et encore*[5] and *sinon* in French do not seem to fit naturally into one of the present classes. Moreover, borderline cases remain (some PCs belong

[4]We will refer to dialogue uses only marginally. For studying dialogue uses, extra parameters are required, but the bundle of basic parameters about linking and argument types would remain unchanged.

[5]See (Nemo 1992) on this PC.

to several classes). This was to be expected since what really classifies the PCs in our perspective is the set of precise semantic constraints assigned to them, while intuition–based classes reflect these constraints only partially.[6]

Granted that individual PCs are often difficult to classify because they can exhibit hybrid behavior, there are nevertheless some broad differences between temporal, type–based, and inferential PCs, which we explain briefly in the next two sections.

2.1. TEMPORAL PCs

Temporal PCs introduce constraints on temporal relations, promoting relations such as succession (*then*, *next*), simultaneity (*at the same time*, *meanwhile*), or anteriority (*previously*, *before that*). Their predicative character is obvious: the temporal relation bears on eventualities, which can be for instance viewed as events, or intervals in Allen style (Allen 1981). Note that temporal relations are independent from other relations but must be compatible with them. For instance, a causal relation of form x CAUSE y tends to be expressed temporally as a succession x *then* y. In this paper, we will not be interested in these PCs, since their predicative character is not open to question.

2.2. TYPE–BASED PCs

The behavior of items in this class is less clear. Such PCs exhibit the following basic property: they associate or contrast pieces of information sharing some informational type(s). As pointed out by Asher (1993), contrastive or parallel PCs, like *but*[7] or *too*, can be analyzed as morphisms between the propositional contents of the sentences they connect. For instance, a contrast like (6) above would get a representation similar to (6').[8]

[6] See König (1986) who says "There are many cases of overlap and neutralization so that a watertight system of classification and analysis does not seem to be possible." (Knott 1996) contains an interesting discussion of the classification problem and proposes an empirical method to address it.

[7] Note that there is more to *but* than just the idea of a contrast.

[8] We use x, y etc. as variables for non–temporal entities, e and s for events and states, *now* for the time of utterance, $\circ$ for temporal overlapping. We stick uncritically to Asher's DRT notation and assume that events and states are comparable entities.

$$
(6') \quad \begin{array}{|l|}
\hline
\\
\hline
\mathit{K1} = \begin{array}{|l|}\hline x\ y\ e \\ \hline e < now \\ person(x) \\ linguistics(y) \\ e\text{-}drop(x,y) \\ \\ \hline \end{array}
\qquad
\mathit{K2} = \begin{array}{|l|}\hline z\ u\ s \\ \hline s \circ now \\ named(z, Mary) \\ formal\text{-}semantics(u) \\ s\text{-}keeps\_study(z,u) \\ \\ \hline \end{array} \\
\\
\mathit{contrast(K1,K2)} \\
\hline
\end{array}
$$

In the DRT–based representation of (6'), the two DRSs *K1* and *K2* are opposed with respect to the two pairs of conditions[9] $\{linguistics(y), e\text{–}drop(x,y)\}$ and $\{formal\text{–}semantics(u), s\text{–}keeps\_study(z,u)\}$. This opposition is licensed by the information contained in a background knowledge base, from which we can extract the fact that the two pairs of conditions have opposite *polarities*. Polarity opposition extends the traditional concept of Boolean contradiction, by allowing more pragmatic oppositions to be taken into account. For instance, oppositions between verbs like *assert* and *prove* (Ducrot 1980), *say* and *do*, or modifiers like *clever* and *very clever*, can be used in a contrast relation. Parallelism relations are defined on sets of conditions which exhibit the same polarity. Roughly speaking, for two–sentence connections of the form we examine in this paper, Asher's model predicts that any contrast or parallelism relation has to be licensed by identifying a subset of conditions in the DRT representation of each sentence, and observing that these two subsets have opposite or similar polarities. Then, clearly, the treatment offered is relational: connectives like *too* and *but*, or the like, are relations (contrast and parallelism) on subsets of conditions. Two points should be noted to clarify the status of such connectives.

First, in a more detailed study of this class, one would have to substantiate the *admissible* subsets of conditions which can constitute the arguments of the contrast/parallelism relation. Consider for example temporal adverbs like *today* and *yesterday*. While they can provide a basis for oppositive polarities, as in (9), with the French connective *par contre*, they are unable to do so with the stronger connective *au contraire*, as evidenced by (10).

(9) Mary went skiing yesterday, PAR CONTRE Paul went skiing today
(10) ??Mary went skiing yesterday, AU CONTRAIRE Paul went skiing today

[9]Remember that, in DRT, a predicative assertion of form $R(x_1 \ldots x_n)$ is a condition.

Second, the inferential status of these connectives is open to discussion: in some cases the contrast or parallelism relation makes use of an inference which provides the missing term of the relation. Consider (11) and (12).

(11) Mary had her dinner, but Paul is hungry
(12) Mary is hungry, Paul did not have his dinner either

In (11), we can oppose two kinds of themes. One is the hunger: if Mary had her dinner she is (normally) not hungry, in contrast with Paul. The other is 'having had his/her dinner': if Paul is hungry, he probably had no dinner, in contrast with Mary. A similar remark holds for (12). In both cases, the contrast/parallelism relies on propositions which are *inferred* from the explicit sentences rather than asserted by the sentences themselves. In this respect, inferencing is crucial for interpreting the connection. However, the connectives we study here are not inferential in this weak, derivative, sense, but in a stronger one: inferential connectives do not only occasionally make use of inference, they give information on how to combine which kind of inference to obtain interpretations.

Exemplification PCs (*for instance*, *in particular*, etc.) also make use of inferential relations in a limited way. They cannot access the whole range of inferences. Basically, a PC like *for instance* selects a member from a set: when a sentence describes a situation which can be realized in several ways, or a property which can manifest itself in several ways, it can be connected by *for instance* to a sentence which expresses one of these ways, as in (13) or (14).

(13) Give him a newspaper, the Herald for instance (from Manzotti 1995, ex. 2/30)
(14) Mary is grumpy, for instance she did not even have a look at Paul this morning

In (13), an instance of a given class of entities (newspapers) is selected and presented as an illustration. In (14), an instance of a general behavior or disposition is similarly selected and used as an illustration. In the two cases, there is a type or subsort relation between the class/property and its instance: the instance is a particular case subsumed by the class/property. This instantiation relation is subject to many restrictions examined in detail for Italian in (Manzotti 1995), but its general sense is clear and seems rather stable across, for instance, French, English and Italian: an exemplification relation is an instantiation and remains quite distinct from an inferential link. Due to the possibility for instantiation of mentioning the symptoms or manifestations of a given state/situation, there is some crossover in causal cases. E.g., (14) can be perceived as causally relating a state of mind to one of its consequences. Similarly, (15) conveys a causal relation.

(15) It was very hot here in summer. For instance, the tar melted on the roads, even in the morning

However, the causal relation is not essential to the instantiation relation, as shown by (13) and by the impossibility of cashing the exemplification PCs on causal relations when they do not support instantiation, as in (16).

(16) ??It was very hot here in summer. For instance, we decided to move to less stuffing climates

The last two classes of PCs, contrast/parallelism and exemplification, rely on the fact that the connected sentences share an informational type: for contrast/parallelism relations, it must be a *theme*, that is, minimally, a *skeleton* in Asher's sense, or, more generally, some structured subset of conditions; for exemplification, the type is defined as the set of conditions of the sentence to be illustrated. Let $cond(X)$ be the set of conditions associated with X in a sentential form $X\ C_{exempl}\ Y$, where C_{exempl} is an exemplification PC. Possible sets of conditions $cond(Y)$ for Y include the following (see Manzotti 1995 for a more detailed and better motivated analysis):

- if $cond(X)$ conveys a non–assertive propositional attitude of the speaker with respect to some propositional content p, $cond(Y)$ conveys the same attitude of the speaker with respect to a propositional content q which is a subsort of p.
- If $cond(X)$ conveys an assertive propositional attitude of the speaker with respect to some propositional content p, $cond(Y)$ conveys the same attitude of the speaker with respect to some propositional content q which is a symptom or manifestation of q.

An example of the first case is (13), represented as (13').

$$
(13')\quad
\begin{array}{|l|}
\hline
x\ y\ z \\
\hline
\mathit{speaker}(x) \\
\mathit{hearer}(y) \\
\mathit{designated\_by}(z, \text{‘}\mathit{him}\text{’}) \\
\\
\mathit{K1} = \begin{array}{|l|}
\hline
e_1 \\
\hline
e_1 \circ \mathit{now} \\
e_1\text{-}\mathit{wants}(x, \begin{array}{|l|}
\hline
e_2\ u \\
\hline
e_2 > \mathit{now} \\
\mathit{newspaper}(u) \\
e_2\text{-}\mathit{give}(y, u, z) \\
\hline
\end{array}\ ) \\
\hline
\end{array} \\
\mathit{K2} = \begin{array}{|l|}
\hline
e_3\ v \\
\hline
\mathit{named}(\text{‘}\mathit{The\ Herald}\text{’}, v) \\
e_3\text{-}\mathit{wants}(x, \begin{array}{|l|}
\hline
e_4 \\
\hline
e_4 > \mathit{now} \\
e_4\text{-}\mathit{give}(y, v, z) \\
\hline
\end{array}\ ) \\
\hline
\end{array} \\
\\
\mathit{exemplification(K1,K2)} \\
\hline
\end{array}
$$

In (13'), the two structures *K1* and *K2* are parallel: they represent the propositional attitude of the speaker ($wants(x, \_)$) concerning two propositional structures, the second being a subsort of the first under the assumption that the thing named ‘The Herald’ is a newspaper. In addition to providing a simple case of exemplification, (13) and (13') feature the central scope distinction between propositional attitude and propositional content to be used below in section 3.4.

The last category of non–inferential PCs, enumeration PCs (*first(ly)*, *on one hand*, etc.), exhibits a pretty different behavior than contrast/parallelism and exemplification PCs. Enumeration PCs ‘live on’ the discourse relations that are available from the discourse structure and/or from other PCs. Consider the next contrast.

(17) a. I won't go to the party. First, I am tired, second, I can't stand the hectic bunch of people who are likely to come

b. ??I won't go to the party. First I am tired, second I worked too hard yesterday

c. I have just two things to say. First, it's true that Janice sings very well, but, second, we really don't need a contralto in the choir by now

In (17a), the two sentences introduced by *first* and *second* are perceived as explanations or justifications of the first sentence. In (17b), no such connection is available: the third proposition sounds as an explanation for the second one. Although there is an explanatory connection between the two sentences, there is no connection between those sentences and a third, different, one. (17c) merges the two preceding cases: there is an oppositive connection between the two sentences introduced by *first* and *second*, but there is also an elaborative connection between those sentences and the first one. Such observations suggest the following constraint on enumeration PCs: for a form $C_{enum}X, C'_{enum}Y$ to be admissible, it is necessary that X and Y share a common discourse function with respect to some third sentence Z. This condition might not be sufficient: for instance, some discourse functions might be more appropriate than others to license enumeration PCs, or might differ according to Z's position (before or after X and Y). But we will not discuss these problems further, since we will not be interested here in this kind of PCs.

As for contrast/parallelism and exemplification PCs, we note that enumeration PCs do not rely crucially on inference for setting up a connection. They connect sentences with a common discourse function type. So, the three classes of PCs reviewed in this section require that the sentences they connect be somehow *comparable*: they must share an informational type or a discourse function type. In this respect, the corresponding PCs do not hierarchize sentences but rather associate them on the basis of an information or discourse–based similarity.

3. Inferential PCs

We will consider here only three classes of inferential PCs: consequence PCs, like *so* or *therefore* in English, and *alors* or *donc* in French, oppositive PCs, like *but* or *yet* in English and *mais* or *pourtant* in French, and reevaluation PCs, like *anyway* in English and *de toute façon* or *en tous cas* in French.

3.1. CONSEQUENCE PCs

Consequence PCs[10] can introduce causal (18a) or causally abductive relations (18b).[11]

(18) a. John had forgotten his passport. So he was delayed at the frontier

[10]See (Hybertie 1995) for an introduction to their descriptive properties in French.

[11]We will call a relation *causally abductive* when it amounts to deduce some causal explanation of a state of affairs.

b. John was delayed at the frontier. So, he must have forgotten his passport

In the two cases, there is a consequence relation, from a cause to its effect in (18a), and from a belief to an entailed belief in (18b). Usually, the explicit reasoning is enthymematic and the speaker expects the hearer to provide for missing additional premises. Interestingly, this abduction process is not unconstrained: in (Jayez & Rossari 1996) it is noted that the French *donc* ($\approx$ *therefore*) may not link a conclusion to a conditional sentence, while *alors* ($\approx$ *then*) may.

(19) a. ??If the weather is fine, DONC I will go out

b. If the weather is fine, ALORS I will go out

This contrast is not predictable if consequence connectives are insufficiently parameterized, which is typically the case when consequence is simply equated with a form of necessary entailment (Iatridou 1994). We will propose a more complex analysis in section 5.1.

3.2. OPPOSITIVE PCs

The use of oppositive PCs[12] revolves around three types of properties.
(a) The geometry of opposition. In a form $X\ C_{opp}\ Y$, X and Y can be directly opposed, as in (20a), or point towards opposite conclusions ('indirect opposition') as in (20b).

(20) a. It is raining, however, nobody in the street has an umbrella

b. It is raining, but I need a walk

Note that, in (20b), there is no clash of intuition between the two facts. Rather, they favor different opposite conclusions ('I will take a walk' vs 'I will not take a walk').
In addition to the direct–indirect distinction, there is a difference between 'backward' and 'forward' connectives in the case of direct opposition, as illustrated by:

(21) a. John was late, yet he did not specially hurry up

b. John was late, but he did not specially hurry up

(21a) can be reversed ('John did not specially hurry up, yet he was late'), while (21b) cannot in general.[13]
(b) The strength of opposition. In French, an oppositive PC like *pourtant*

[12] See (Morel 1996) for an introduction to their descriptive properties in French.

[13] The reverse form is possible when it stands for an answer to a dialogue opponent who somehow denies that John was late. This and similar observations show that backward opposition must be contextually primed in the case of *mais*.

is direct oppositive and presents the terms it associates as strongly incompatible.
(c) Scalar opposition. Some indirect oppositive PCs[14] allow for restriction moves on a scale, in the style of (22).

(22) John is intelligent, but he is not a genius.

3.3. REEVALUATION PCs

The prototypical member of this class[15] in English is *anyway*. These PCs have quite a few properties, of which we will mention only the following two.
(a) The ability to weaken or cancel the effect of the first proposition. In (23), the second proposition Y makes a potential conclusion (such as 'there was no meeting this afternoon') true, no matter whether X is true or not.

(23) (X) John did not feel like going to a meeting this afternoon. Anyway, (Y) the idea was abandoned

(b) The possibility of a scalar connection, on the model of (24).

(24) John is probably a genius, anyway he is extremely clever

3.4. SEMANTIC SCOPE

Inferential PCs highlight inferential relations between intensional entities. Consequence PCs point to causal or deductive relations between beliefs or speech acts, oppositive PCs to the potential clash between some proposition and the negation of some of its consequences, reevaluation PCs rely on inferential updating, i.e. the operation of drawing various conclusions from some new information. Intuitively, the 'inferences' we allude to here can be viewed as some form of logical deduction of a given (set of) conclusion(s) from a set of premises, but the status of the intensional entities which are used as premises or conclusion(s) is less accessible to intuition.

It has been generally recognized in the pragmatic (Searle & Vanderveken 1985) or semantic tradition (Bierwisch 1980) that the basic elements of discourse units are: (i) illocutionary forces, such as assertion or question, (ii) propositional attitudes, such as belief, desire, etc., and propositional content, which corresponds to the basic predicative structure of a sentence.

[14] The category 'indirect oppositive' will be assigned to PCs which tolerate indirect oppositions. Some of them also allow for direct opposition, while 'direct oppositive' PCs, like *pourtant* in French, are not compatible with indirect opposition.
[15] See (Rossari 1994) for an introduction to their descriptive properties in French, and (König 1986) for preliminary remarks on *anyway*.

Analogously, Halliday and Hasan (1976) have proposed a distinction between *external* and *internal* conjunction, which seems to correspond in part to the illocutionary vs (attitudinal + propositional) distinction. Knott discusses various presentations of this distinction in his 1996 thesis (sections 6.2.1 and 6.2.9).

More recently, elaborating on (Bierwisch 1980), Ferrari (1995) proposes that any utterance has a structure:[16]

$$IF(ATT(pc))$$

where IF is the illocutionary force, ATT the attitude, and pc the propositional content. If X is a surface form, we will note $IF(X)$ (resp. $ATT(X)$, $pc(X)$) its illocutionary force (resp. attitudinal content, propositional content). Starting from a different tradition, Knott (1996) discusses the semantic/pragmatic distinctions

There is no general agreement as to which entities (force, attitude, propositional content) are necessary to describe sentential adverbs or PCs. We show below that the distinction between force/attitude, on one side, and propositional content on the other provides a sufficient approximation of a number of phenomena. Yet, we agree with Knott (1996) that it is necessary to move to a more complex position to explain certain other observations. Knott proposes to take into account perlocutionary effects, in (Rossari & Jayez 1997) we describe attitudes as transitions between information states in a dynamic semantic framework. However, a dynamic treatment of attitudes complicates substantially the inferential system and we will abstract here from the dynamic dimension for that reason.

In the static treatment to follow, PCs may connect semantic objects like forces, attitudes and propositional content. We will use the term *semantic scope* or *scope* to denote the entities connected by PCs. In a form X C Y, the term *left scope* will refer to the entities associated with X in the connection, and similarly for *right scope* and Y.

3.4.1. *Basic properties*

The basic observation is that, while all PCs can connect assertions, many of them cannot felicitously connect other illocutionary forces in monologues. There are many variations and borderline cases, especially when dialogue is taken into account, but we will limit ourselves to the following three clear–cut structures.

In a form X C Y, some PCs prefer assertions (or equivalent illocutionary

[16] We change and simplify the notation of Ferrari for intuitive readability: Ferrari would probably consider the illocutionary force as a communicative elaboration over a more elementary cognitive attitude (called *Satzmodus* after Pasch 1989). Doing justice to these distinctions would require working out a complex system of semantic and pragmatic features, a task we will not undertake here.

forces) in X and Y. This is typically the case for the consequence PCs *du coup* and *de ce fait*.

(25) This machine is dangerous. DU COUP/DE CE FAIT (you must not touch it vs ?? don't touch it)

Other PCs have a mixed behavior: they accept illocutionary forces different from assertion in Y, but not always in X. The consequence PCs *donc* and *alors* illustrate this case.

(26) a. This machine is dangerous. DONC/ALORS don't touch it

b. ??Don't touch this machine. DONC/ALORS you must obey me

Last, some PCs do not seem to impose restrictions on the illocutionary force of the terms they relate. The reevaluation PC *de toute façon* illustrates this case.

(27) a. This machine is dangerous. DE TOUTE FAÇON don't touch it

b. Don't touch this machine. DE TOUTE FAÇON it does not work

Interpreting observations of this kind is in general difficult. We will not carry out a detailed discussion here, but will instead summarize the two factors which affect scoping.

[1] Scoping is 'hierarchical': a PC with scope on attitude bears also on propositional content, a PC with scope on illocutionary force bears also on attitude, and, therefore, on propositional content. E.g., one may not issue an order (illocutionary force) without communicating at the same time that the speaker desires (attitude) that some state of affairs (propositional content) hold.[17] To illustrate this point, consider *donc*. There are two possible cases: in a form X *donc* Y, either $pc(X)$ is the cause of $pc(Y)$ (see (18a)), or $pc(Y)$ is the cause of $pc(X)$, in which case the link between X and Y is causally abductive, as in (18b). In the abductive case, the connection between forces and attitudes is cashed on the causal relation from $pc(Y)$ to $pc(X)$. Considering (26b) from this perspective, we observe that the propositional content is not used by the epistemic and illocutionary dimensions: if there is any causal relation between propositional contents, it goes from the obligation (the hearer must not touch the machine) to the

[17] Of course, the link between force and attitude is probably non–monotonic, since, for instance, one might issue an order without any desire that the situation mentioned in the command obtain. This is not the case in most current situations, however, and, anyway, the command can be considered as satisfied only when the relevant situation is created or brought about by the hearer. This suggests that the modality of 'desire' is too strong and should be replaced by a more neutral one, expressing the conditions under which a command would be considered as obeyed, irrespective of the psychologically plausible correlates of the command.

situation (the hearer does not touch the machine). But this possible causal link does not provide a ground for desires, beliefs, command and assertion. More precisely, the fact that the obligation to do p can cause doing p for the hearer, has nothing to do with the fact that issuing the order that p in front of the hearer creates for her an obligation to do p, or with the fact that desiring that the hearer do p favors the belief that the hearer is under an obligation to do p. The importance of propositional content is also suggested by contrasts like the following.

(28) a. I was not at the meeting. DONC/ALORS I don't know whether John came

b. #I was not at the meeting. DONC/ALORS did John come ?

(28b) is acceptable (for some speakers) only if the speaker's absence at the meeting is perceived as influencing John's presence or absence at the same meeting. If the question is (literally) understood as a request for information, the connection is not natural. This is readily explained by noting that, in the latter interpretation, there is no causal link between the speaker's absence at the meeting and John's presence or absence. In contrast, (28a) is perfect because there is clearly a causal link between the speaker's absence at the meeting and his ignorance of John's presence or absence at the same meeting.

[2] In general, the intensional entity on which a given PC has scope must be 'true'. E.g., if a PC bears on some propositional content pc_i, pc_i must be 'true' in the world of the speaker. More precisely, there are some admissible degrees of likelihood for the intensional object, in a present or future state of the world of the speaker. We may not use an intensional object as the value of the scope if the object has not got one of these admissible degrees. This is illustrated by the following contrast.

(29) a. ??My car broke down, DU COUP call a taxi

b. My car broke down, DU COUP would you call a taxi?

Forces and attitudes determine degrees of likelihood in such cases. This does not mean that they constitute the scope, however, since, in this case, (29a) would be as normal as *My car broke down, so I want you to call a taxi* (scope on attitude). Imperatives tend to present the propositional contents on which they bear as false in any situation in which the addressee controls her own behavior (without any external influence). This is not the case for more polite requests, which do not presuppose that the addressee could be uncooperative, hostile, or unconcerned. While such distinctions could be represented in an appropriate modal setting, we will ignore them in the rest of this paper, and focus on the simple binary truth–conditional cases, in which an intensional object is or is not in (some temporal slice of) the world of the speaker.

To illustrate these two aspects, we will turn to the case of consequence PCs.

3.4.2. *A case study: the scope of consequence PCs*

There are three reasons for assuming that *donc* and *alors* have scope on attitudes or forces, while *du coup* and *de ce fait* have scope on propositional contents.

[**1**] While *donc* and *alors* can introduce imperatives and questions, this is not possible for *du coup* and *de ce fait*, except for questions which are covert or hedged assertions. This was illustrated by the contrast between (25) and (26a), which we repeat below, adding a variation for *du coup*.

(25) a. This machine is dangerous. DU COUP/DE CE FAIT (you must not touch it vs ?? don't touch it)

b. This machine is dangerous. DU COUP/DE CE FAIT wouldn't it be better to keep it in a locked room?

(26) a. This machine is dangerous. DONC don't touch it

We can explain the contrast between (25a), on one side, and (25b) and (26a) on the other, by noting that the intensional entities which form the right scope of the PC must be compatible with the truth–conditional 'effect' of the PC. For consequence PCs (and probably oppositive ones), the intensional entity is presented as *true*. This was to be expected since consequence PCs draw consequences from a given set of premises, that is, present them as *true* given the premises. Let $X\ C_{cons}\ Y$ be a consequence connection. When C_{cons} has right scope on force or attitude, that is on $IF(Y)$ or $ATT(Y)$, their exact nature is irrelevant. When it has scope on $pc(Y)$, the force is preferably (some form of) assertion, because imperatives and questions bearing on $pc(Y)$ imply at least that the speaker ignores whether $pc(Y)$ is true. On the other hand, in a sentence like *This machine is dangerous,* DU COUP *you must not touch it*, there is a relation between two states of affairs, that of the machine being dangerous and that of the obligation of not touching it, thus between a factual and a deontic state of affairs. In a sentence like (26a), we can represent the consequence relation as: 'the speaker believes that the machine is dangerous, then she desires that the addressee not touch it' (relation between attitudes), or 'the speaker believes that the machine is dangerous, then she orders that the addressee not touch it' (relation between attitude and force).

[**2**] The second reason for distinguishing the scope of *donc/alors* and *du coup/de ce fait* is the impossibility of causal abduction with the latter two

PCs, as shown by the contrast between variants of (18b).

(18) c. ?? John has been delayed at the frontier. DU COUP/DE CE FAIT he must have forgotten his passport.

d. John has been delayed at the frontier. DONC/ALORS he must have forgotten his passport.

Such contrasts are easily explained if we assume that consequence PCs promote links between a premise and a conclusion. Under this hypothesis, (18c) is anomalous because there is no premise–conclusion directed link from the first propositional content to the second (the link has the reverse direction). In contrast, (18d) exploits a directed link between two beliefs (and their corresponding assertions).[18]

[3] The interaction between consequence (premise–conclusion directed link) and scope allows one to explain other impossibilities which are not cases of causal abduction, such as:

(30) ?? Could you terminate this work very quickly, DONC I'm in a hurry

Assuming that *donc* has scope on attitudes, (30) has the following abnormal consequence structure: 'I want you to terminate this work very quickly, so I believe (know, etc.) I'm in a hurry'. Of course, one expects the reverse order, which indeed can host a *donc*.

So, given some plausible assumptions, observations are clearly in favor of a difference of scope. This does not imply, however, that *donc* and *alors* are insensitive to propositional content. In fact, PCs are all the more natural as they are licensed by connections at *all* the levels (attitude and propositional content, or force and propositional content) which are semantically relevant. This is why (28b) sounds strange: *donc* and *alors* cannot be supported only by attitudes or forces. Not unexpectedly, there is variation among speakers when the relation between propositional contents is not clear. For instance, consider (31).

(31) # I already told you to go to bed. I'm your father, DONC/ALORS turn this TV off

Speakers do not rate (31) uniformly. Under the present assumption, this can be explained by noting that (i) the force/attitude link is supported by (31) ('I know I am your father, so I order you to turn off the TV'), (ii) the propositional content link is supported only under the interpretation 'The fact that I am your father will cause the future event of turning off the TV', that is, under an interpretation which makes the social situation the

[18] See (Sweetser 1990) for a similar analysis.

cause of an event, as in *C'est son père qui le lui ordonne, du coup Jean va éteindre la télé* ('It is his father who ordered it, DU COUP John is going to turn the TV off'), when issued in the same context. Note that (31) would be quite odd with *du coup* or *alors*: this is predicted by the hypothesis introduced in (3.4.1,[**1**]) above, according to which the intensional entity on which consequence PCs have scope must be 'true', a condition which is not fulfilled by propositional contents introduced by imperatives.

Other differences[19] are not amenable to scope problems, but pertain to individual differences between consequence PCs, a topic which we will not consider further here. The reader will note that we have not tried to decide between force and attitude in scope assignment. Our observations tend to show that scope on attitudes is sufficient in many cases to account for possible or impossible linkings. However, a careful answer to this question would require a thorough investigation of the relation between forces and attitudes, which is well beyond the scope of this paper.

4. Inferential relations

In all the previous examples, interpretation relies on an inferential linking between a proposition–like entity, considered as a *premise*, and another entity which plays the part of the *conclusion*. This is obvious in the case of consequence PCs. For oppositive ones, opposition between X and Y depends on having X 'entailing' $\neg Y$ or Y 'entailing' $\neg X$ in some sense, or on having X 'entailing' some Z while Y 'entails' $\neg Z$. In most cases, the entailment presupposes implicit premises. We will note this situation $(\Sigma), X \vdash Y$, where Σ is a (possibly empty) set[20] of additional implicit premises, and $\vdash$ some consequence relation. Now, the question comes up naturally of which constraints we are to put on entailment to provide more precise representations.

4.1. ABDUCTIVE CONSTRAINTS

Interpolating additional premises is an *abductive* process, by which we postulate facts which could explain some other given fact *via* some inference rule. This phenomenon has been known for long and appears in the classical theory of syllogisms under the guise of so–called *enthymematic* reasoning. Its importance for natural language understanding has been recently underlined (Hobbs *et al.* 1993)

[19] Such as that which is revealed by the contrast *I happen to realize that you should not attend this meeting,* DONC/ALORS/DE CE FAIT VS ?? DU COUP *I ask you to leave.*

[20] In this paper, we consider only consistent sets of propositions. So any mention of a 'set' means 'consistent set'.

Our basic tool will be a consequence relation $\vdash$ between premises and conclusion. $\Sigma \vdash p$ means that p can be deduced from Σ modulo the rules of the logic which characterizes $\vdash$. We will not discuss the detailed properties of $\vdash$ in this paper, but we need to distinguish between two possible interpretations of $\Sigma \vdash p$. In the first interpretation, which we will adopt here, the formula means that any state of information in which we have only Σ and its consequences contains p. This interpretation, which is an unordered version of Veltman's validity$_1$ (Veltmann 1996) amounts to say, that, in a world, that is, in a set of propositions, we might have conjointly (i) Σ, (ii) $\Sigma \vdash p$, without having p. This is so because the interpretation in question only requires that p be deducible from Σ when there is no other information available, apart from Σ and its consequences. If some world contains additional information, it might block the derivation of q. The second interpretation is much stronger: it requires that p be true in any information state where Σ is true. This is typically the monotonic interpretation of the deduction symbol $\vdash$.

Let p, q be propositions and $\vdash$ a consequence relation, we define:
${}^{\vdash}\!p =_{df}$ the set of finite non–empty sets Σ such that $\Sigma \vdash p$.
We call ${}^{\vdash}\!p$ the set of *antecedents* of p.

Let us see how antecedents come into play by considering the following example.

(32) John has just gulped down two big glasses of beer, yet (POURTANT) he had refused to drink ten minutes ago

This example can be understood *via* the reconstruction of the following underlying logical structure, where $t \ll t'$ notes the fact that t is prior but near to t', t and t' are time variables, θ and *now* are time constants.
1a. John refuses to drink at θ,
1b. $\theta \ll now$,
2a. John is not thirsty at θ,
2. John is not thirsty at $t \vdash$ John refuses to drink at t,
3. John is not thirsty at t, $t \ll t' \vdash$ John is not very thirsty at t',
4. John is not very thirsty at $t \vdash$ John does not drink much at t,
5. John drinks two glasses of beer at $t \vdash$ John is very thirsty at t.
Note that the second sentence of (32) should be represented by the conjunction 1a $\wedge$ 1b. We have the following proof schema, where $\phi\{u = v\}$ designates the result of substituting v for u in ϕ:
from 2a, $2\{t = \theta\}$, 1b **deduce** 1a $\wedge$ 1b
from 2a, 1b, $3\{t = \theta, t' = now\}$, $4\{t = now\}$ **deduce** 'John does not drink much at *now*'.

This schema delineates a proof from 2a and 1b to a conclusion 'John does not drink much at *now*', which is contradictory to the explicit sentence

John has just gulped down two glasses of beer. The use of 2a as a premise shows that we have to take into account propositions obtained by causal abduction, that is, propositions which are causes of the explicit proposition(s) mentioned in the first sentence. More generally, a relation $POURTANT$ between p and q will be licensed by any situation which consists of (i) a set of propositions which allows one to derive p, (ii) a set of propositions which, conjointly with some subset of the previous set allows one to derive $\neg q$; that is, in any situation in which we have: a set of premises Σ which is a member of $^{\vdash}p$, a set of premises Σ' which, conjointly with some subset of Σ is a member of $^{\vdash}\neg q$. Intuitively, the speaker communicates that (i) she imagines some situation Σ in some world w which licenses p and (ii) in her world ($w_{speaker}$), this situation would entail $\neg q$. As we run mentally through situations imagined by the speaker, we obtain a more familiar paraphrase: *p pourtant q* is 'true' whenever we get $\neg q$ in every minimal reasonable situation where we would have p, from the speaker's point of view. In short, every p-situation is a $\neg q$–situation for the speaker.[21] *Pourtant* will also be licensed in the symmetric situation, where two sets of propositions entail respectively q and $\neg p$, as in *John refused to drink ten minutes ago, yet he has just gulped down two glasses of beer.* We will allow for sets Σ and Σ' from different situations or worlds, indexing them accordingly: the notation Σ_w will designate a set of propositions Σ which are true (in particular) at w.[22] The world $w_{speaker}$ refers to the set of propositions which are true from the speaker's point of view (the world 'of' the speaker). We can now define the relation $POURTANT_{p,q}$.

(33) $POURTANT_{p,q}(\Sigma_w, \Sigma'_{w_{speaker}})$ iff there exists a non–empty set $\Sigma'' \subseteq \Sigma$ such that:
(i) $\Sigma'' \cup \Sigma'$ is consistent, and
(ii) $\Sigma \vdash p$ and $\Sigma' \cup \Sigma'' \vdash \neg q$ or $\Sigma \vdash q$ and $\Sigma' \cup \Sigma'' \vdash \neg p$.

Three points should be noted. First, this definition covers the cases where p (with, possibly, some additional premises) entails $\neg q$ (or q entails $\neg p$). Let $\{p\} = \Sigma_w = \Sigma''_w$, $\Gamma, p \vdash \neg q$ and $\Sigma'_{w_{speaker}} = \Gamma$. Then $\Sigma \vdash p$, since $p \vdash p$, and $\Sigma' \cup \Sigma'' \vdash \neg q$. We can accommodate in this way examples such as *He worked very hard, yet he is not tired* or *He is not tired, yet he worked very hard.* Second, the definition does not say that p and $\neg q$ are true in the same world: it requires only that the speaker believe that p 'entails' $\neg q$

[21] This formulation is intended only to help intuition. In fact, *matching* readings (Rothstein 1995) are infelicitous with many PCs: ?? *Each time John is hungry,* POURTANT *he does not eat enough*, ?? *each time John is hungry,* ALORS *he eats much*, etc.

[22] As usual, we assume that sets of propositions extracted from the same world or situation are consistent. However, we do not reject the possibility of inconsistent worlds, that is, worlds containing two mutually inconsistent sets of propositions.

(viz. that some proof of p leads to a proof of $\neg q$, modulo the additional premises Σ''). This reflects the intuition that speakers endorse oppositions or entailments, that is, the consequence relation itself, while they not necessarily endorse the premises or the conclusions which are linked by this relation. This is particularly clear in *if ... then* sentences, where speakers are only responsible for the consequence relation from the *if*–sentence to the *then*–sentence. This can happen also in ironical sentences, where the speaker draws conclusions from a premise she obviously does not approve. Third, the definition does not say that the speaker has contradictory beliefs or that its world is contradictory, but that she can deduce $\neg q$ from p modulo additional premises (Σ''). This problem is more visible when the premise is an assertion. When a sentence is an assertion, we can assume that the world in which the proposition associated with it is interpreted is the world of the speaker, $w_{speaker}$.[23]

(34) If p is associated with X and $IF(X) = assertion$, then every set Σ_w which provides premises for p is such that $w = w_{speaker}$.

In an example like (32), we are in the speaker's world ($w = w_{speaker}$). So, (i) p and $\neg q$ might be true in $w_{speaker}$, and (ii) q might be true in $w_{speaker}$. If the relation $\vdash$ is monotonic, the speaker's world is contradictory: $p \vdash \neg q$ means that $\neg q$ is true in any situation where p is true, in particular in $w_{speaker}$. If $\vdash$ is non–monotonic, it is not necessarily so, because additional information in $w_{speaker}$ could block the derivation of $\neg q$. Recall that we chose a non–monotonic deduction relation. There is anyway a 'local' contradiction, defined with respect to Σ and Σ'. This is as it should be, since *pourtant* is considered as expressing surprise in French: this agrees with the speaker's belief that the two assertions connected by *pourtant* create a local inconsistency: somehow, every reasonable p–situation is a $\neg q$–situation in this part of $w_{speaker}$ which includes only Σ'.

This example introduces a recurring theme in the study of PCs: their *Generalized Quantification* behavior. Many determiners and adverbs have been analyzed as Generalized Quantifiers (GQs) in the past fifteen years by several authors elaborating on Barwise and Cooper (1981) initial insights and proposals (see Keenan & Westerståhl 1997 for a recent survey). In what follows, we will assume that a PC can be represented as a GQ of form:

$$R_{p^{type1},q^{type2}}(\Sigma_1, \ldots, \Sigma_n),$$

where *type*1 and *type*2 are the intensional types (propositional content, attitude, force, or disjunction of such types) which are possible in view of the PC's semantic scope(s). The Σ_i are sets of propositions (usually indexed w.r.t. worlds). The relation $\vdash$ can associate propositions of various types

[23] This is a default rule, but we will not be concerned here with its non–monotonic properties.

(e.g. forces and attitudes). We will omit the type restrictors *type*1 and *type*2 for readability.

Under the form of the previous definition for $POURTANT_{p,q}$, *pourtant* is a GQ of type <1, 1> (Lindström 1966), that is a relation between sets. Although this representation is much simplified (it does not use particular properties of $\vdash$), it allows one to distinguish between oppositive PCs of various 'strengths'. It has been noted (Jayez 1988) that the French indirect oppositive PC *mais* ($\approx$ *but*) is in a sense weaker than *pourtant* ($\approx$ *yet*), even when it conveys a relation of direct opposition. Compare:

(35) a. John is intelligent and reliable, POURTANT Microsoft did not hire him

b. John is intelligent and reliable, MAIS Microsoft did not hire him

While these two pairs of sentences describe the same situation, (35a) would suggest to a French speaker that this situation is somewhat strange or surprising, in contrast with (35b) which just points to a direct opposition. By using (35a), a speaker implies that, as far as she knows, there is no clear explanation for the decision of Microsoft.

To account for this difference, we recast the analysis of Jayez (1988) in the present GQ–based approach, by defining a relation $MAIS_{dir.op.}$, for the direct oppositive use of *mais*.

(36) $MAIS_{dir.op.:p,q}(\Sigma_w, \Sigma'_{w_{speaker}})$ iff there exists a non–empty set $\Sigma'' \subseteq \Sigma$ and a set $\Omega \supseteq \Sigma'$ such that:
(i) $\Sigma'' \cup \Omega$ is consistent,
(ii) $\Sigma \vdash p$,
(iii) $\Omega \cup \Sigma'' \vdash \neg q$.

This definition selects pairs of sets in which the first member entails p while the second member can be extended to a set (Ω) which supports a proof of $\neg q$ modulo some additional premises (Σ''). In the case of *pourtant*, the second set Σ' allowed by itself the construction of a proof of $\neg q$. In the present case, Σ' has not necessarily these resources: this reflects the intuition that *mais* conveys the idea of a possible opposition (modulo some additional information), while *pourtant* conveys the idea of a necessary opposition. Intuitively, the definition says that, in every reasonable situation where p is true, the speaker can imagine some reasons (Ω) for having $\neg q$. In short, every p-situation is a potential $\neg q$-situation for the speaker. When *mais* connects assertions, as in (35b), p and q are in the speaker's world. However, $\neg q$ is not necessarily in the speaker's world, even in the part of this world limited to Σ', since the set Ω might contain propositions outside this world. In consequence, contrary to *pourtant*, there is no impression of contradiction. We will not consider the other uses of *mais* here.

Turning to consequence connectives, we can assign to *donc* and *par conséquent* the following GQ form.

(37) $DONC_{p,q}(\Sigma_w, \Sigma'_{w_{speaker}})$ iff there exists a non–empty set $\Sigma'' \subseteq \Sigma$ such that:
(i) $\Sigma'' \cup \Sigma'$ is consistent,
(ii) $\Sigma \vdash p$,
(iii) $\Sigma' \cup \Sigma'' \vdash q$.

So, a pair $<\Sigma_w, \Sigma'_{w_{speaker}}>$ licenses a consequence from p to q whenever Σ proves p and Σ' augmented with some elements of Σ proves q.

In French, a distinction similar to the difference between *pourtant* and *mais* exists for *donc* and *alors*. *Donc* is modally 'stronger' than *alors*, which is more 'circumstantial' (the consequence is not presented as necessary). Once again, this can be reflected by relaxing the condition on *alors* in the manner of that for *mais*.

(38) $ALORS_{p,q}(\Sigma_w, \Sigma'_{w_{speaker}})$ iff there exists a non–empty set $\Sigma'' \subseteq \Sigma$ and a set $\Omega \supseteq \Sigma'$ such that:
(i) $\Sigma'' \cup \Omega$ is consistent,
(ii) $\Sigma \vdash p$,
(iii) $\Omega \cup \Sigma'' \vdash q$.

Intuitively, the relation $ALORS$ says that every reasonable situation where p is true can be extended to a q-situation, from the speaker's point of view.

The present approach is very 'weak' because it does not require that there be a special form of connection between p and q: what it says is simply that we can distinguish two sets Σ_w and $\Sigma'_{w_{speaker}}$ which prove p and q or $\neg q$ respectively, when Σ' is enriched with some elements of Σ. This seems compatible with most approaches on conditionals and informational entailment (see Veltman 1986 for a discussion), but it remains to make more precise which sort of consequence relation $\vdash$ we have in mind, a topic which is the subject of the next section.

4.2. DEDUCTIVE CONSTRAINTS

4.2.1. *General relevance requirement*

It is well–known that material implication $\Rightarrow$ and its associated deduction relation is in some cases inadequate for capturing linguistic entailment, because it does not require that there be any special link between premises and conclusion. We could assume that $\vdash$ corresponds at least to *relevant* *entailment* $\rightarrow$ (Anderson & Belnap 1975), which requires that every premise be effectively used in a deduction. This would forbid situations $\Sigma, p \vdash q$ in which p is simply added to Σ but is completely dispensed with in the proof of q. Note that the relevance constraint is a general pragmatic one, and is not inherited from the set of constraints on PCs.

However, this hypothesis would lead us to reject so–called *disjunctive syllogism* as a valid form of reasoning (Anderson & Belnap 1975, pp. 164–166): relevance logics based on the rejection of weakening also block disjunctive syllogism.

$$\text{(Weakening) } A, B \vdash A$$

$$\text{(Disjunctive syllogism) } \neg A, A \vee B \vdash B$$

This is clearly unwanted, since many PCs use disjunctive syllogism: *It's you or Sam who wrote the letter. You tell me it's not you, so it's Sam.*

We observe that disjunctive syllogism is dangerous because it can be used in a proof of weakening, but this proof needs $\vee$–introduction as a crucial step:

$$(\vee\text{–introduction) } A \vdash A \vee B$$

$\vee$–introduction is notoriously problematic as it is not really 'relevant' in any intuitive sense (Schurz 1991). We could adopt here, at least in the case of $\vee$–introduction, the proposal of Sperber and Wilson (1986) that there be no introduction rule in natural inference systems. Forbidding $\vee$–introduction is sufficient to avoid the derivation of weakening when disjunctive syllogism is maintained, as can be shown by a proper Gentzenization of the system (Thistlewaite, McRobbie, Meyer 1988).

Accordingly, we will assume in the following that our deduction relation $\vdash$ does not obey weakening and does not support $\vee$–introduction. However, we will not take a firm position as to whether other introduction rules must also be dismissed, as suggested in relevance theory (Sperber & Wilson 1986), or a quite different notion of analytic deduction should be preferred (Tzouvaras 1996).

4.2.2. *The two forms of connection*

There are two main forms of connection used by PCs, that between two distinct propositions (e.g. (18a) or (20b)), which we will call *discrete connection*, and that between two propositions expressing different degrees of the same quality (e.g. (22)), which we will call *scalar connection.* Another form of scalar connection is shown in (39).

(39) Most students have registered, but not all of them yet

Are examples like (22) and (39) amenable to a case of *semantic opposition* (Lakoff 1971), as *Peter is tall but Bill is short*? Semantic opposition is a form of contrast in which two symmetric predicates (*tall* vs *short*) are predicated of two distinct entities (*Peter* and *Bill*). We could relax the condition on the distinctness of entities and hypothesize that semantic opposition is sufficient to account for (22) and (39). However, there are two reasons to reject this move. First, as noted by Lakoff, semantic opposition is not compatible with *although* (?? *Although Peter is tall, Bill is short*). But we have:

(40) Although John is intelligent, he is not a genius
(41) Although most students have registered, not all of them have done yet

Second, in some cases, X is used to concede something akin to Y, in a form X *but* Y.

(42) A– All students have probably registered by now
B– No. True, most of them have registered, but not all of them

So, even if one sees (42) as a case of semantic opposition, it has still to be explained in which sense a form *most* x P can be 'akin' to a form *all* x P. Therefore, we need to provide a representation for scalar connection, since we cannot simply eliminate it in favor of semantic opposition.[24] In the next section, we address the problem of defining the consequence relation for scalar connection.

4.2.3. *Scalar connection*

The basic idea in this section is that a judgment like 'John is intelligent' means that John's intelligence is superior to a certain intelligence degree that we call the intelligence *threshold.* This information does not determine the exact degree of John's intelligence, which could be specified by adding information. It is natural to represent intelligence degrees on a scale (total order), and to consider consistent information states which define possible positions on this scale. Let l be an arbitrary 'intelligence threshold': we consider any individual whose intelligence degree is greater than l to be intelligent. So, if x^i is the degree of intelligence of x, 'x is intelligent' will correspond to $x^i > l$. We assume also that there is a 'genius threshold' $L > l$. 'x is not a genius' will be reflected as $x^i < L$.
The initial information state s_0 is just the set $\{x^i > l, L > l\}$. By adding information stepwise, we obtain sequences of information states. A piece of information is any expression $t_1 > t_2$ or $t_1 < t_2$, where t_1, t_2 can be l, L, x^i, or any variable from a fixed domain.

[24]In a very interesting discussion, Blakemore (1987, pp. 125–141) argues in favor of a unified analysis of *but*, which would merge the contrast and opposition categories. In French, semantic opposition licenses the use of *par contre*, but *par contre* would be clumsy in the mentioned examples. So, we cannot extend Blakemore's proposal to French in a simple way.

A finite sequence is a *proof* of an expression if (i) its last member is consistent and (ii) one of its states allows for a proof of this expression. Every state in a sequence can be *revised*, in the sense of (Gärdenfors 1988). We will consider here what we call *proper* revisions: a proper revision amounts to replace a proposition by the contradictory proposition, here $x > y$ by $x < y$ and make all the necessary alterations to preserve consistency. In the revision process, some expressions can be *protected*, that is, may not be modified by the revision. The only expression we will protect is $L > l$: it expresses a default preference (the threshold of intelligence is most naturally conceived as inferior to the genius threshold). A proper revision must leave the protected expressions untouched.

We now define the notion of *admissibility* for a proof. A proof of an expression A is admissible whenever it satisfies the following constraint: if A becomes provable at s_{i+1} and $s_{i+1} = s_i \cup \{r\}$, r must not be consistent with any proper revision of s_i.

Our proof system will be a mini Gentzen–style system with just the two following axioms:
$x > y, y > z \vdash x > z$,
$x > y \dashv\vdash \neg(y > x)$.
The definition of proof and consistency are standard.
We now prove the following: no proof of $x^i < L$ ('John is not a genius') is admissible, while some proof(s) of $x^i > L$ ('John is a genius') is (are).

Suppose that we have some proof of $x^i < L$, $s_0 \ldots s_n$. This means that $s_0 \cup s_1 \cup \ldots \cup s_{n-1} \cup \{r\} \vdash x^i < L$. Assume that r is inconsistent with every revision of s_{n-1} where $x^i > l$ is replaced by $x^i < l$. Observe now that the set $\{x^i < l, l < L, r\}$ is consistent. In the contrary case, we would have that $l < L, r \vdash x^i > l$. This is only possible if $r = x^i > l$. So, our proof has actually the form $s_{n-1}, x^i > l \vdash x^i < L$. But it can be shown by induction on the length of the proof that every proof $\Sigma, x > y \vdash x < z$ can be reduced to a proof $\Sigma \vdash x < z$, which indicates that $x^i < L$ was already established in s_{n-1}. So, the set $\{x^i < l, l < L, r\}$ is consistent and can be extended to a consistent set including for each A of s_{n-1} either A or its negation. This amounts to say that we have constructed a proper revision of s_{n-1} including r.
On the other hand, consider the sequence:
$s_0 = \{x^i > l, l < L\}$,
$s_1 = s_0 \cup \{x^i > L\}$.
This sequence is an admissible proof (any attempt to construct a proper revision will lead to inconsistency).

This construction is motivated by the relevance requirement mentioned above: no previous information can be 'useless', in the sense that replacing it by contradictory information would not matter for the proof's result. In other words, only proofs of 'John is a genius' from 'John is intelligent' can obey relevance.[25] Proofs of 'John is not a genius' from 'John is intelligent' always imply producing and subsequently turning out some information.

The present treatment uses only indirect properties of the phenomenon of scalar inference. For space reasons, we will not discuss here other solutions, which link scalar inference to *argumentative* monotony. The interested reader is referred to (Anscombre & Ducrot 1983; Ducrot 1995; Elhadad 1993; Jayez 1988; Merin 1994) for further discussions.

4.2.4. *Discrete connection*

When no scale is implied, the situation is simpler. Viewed as sequences of information states, chains of premise sets are automatically admissible in the family of relevance logics. Suppose increasing sets of premises $\{p_1\}$, $\{p_1, p_2\}$, ..., $\{p_1 \ldots p_n\}$. If adding p_{n+1} allows one to prove q and p_{n+1} is consistent with a proper revision of $\{p_1 \ldots p_n\}$, then either the proof is not relevant or the information state is inconsistent. As an illustration consider the following strange variant of (18a).

(43) ?? John had forgotten his passport. So they did not delay him at the frontier.

No classical theory of enthymematic reasoning can explain why (43) is odd: one has only to add a premise such as 'the custom officers did not notice John' to get the unwanted conclusion. Relevance simply says in this case that the first premise 'John had forgotten his passport' is no longer used in the reasoning, which is then not admissible (although correct in classical logic).

Inferential PCs differ as to whether they support scalar connection: consequence PCs do not, while some opposition and reevaluation PCs do, within some limits. For space reasons, we will not discuss their detailed behavior nor propose a systematic account of these variations. We simply assume that the deduction relation $\vdash$, which was parameterized for discrete connection has a sibling $\vdash_{><}$ for scalar inference. E.g., the definition for *mais* given in section 4.1 is now changed to the following.

$MAIS_{DOPP:p,q}(\Sigma_w, \Sigma'_{w_{speaker}})$ iff $MAIS_{dir.op.:p,q}(\Sigma_w, \Sigma'_{w_{speaker}})$ or,
$\Sigma_w = \{p\}$, $\Sigma'_{w_{speaker}} = \{q\}$ and $p \vdash_{><} q$.

[25] There are several kindred senses of the term *relevance*. An admissible proof of form $x^i > l, l < L, x^i > L \vdash x^i > L$ is 'relevant' because the unprotected expression $x^i > l$ cannot be negated. However, this proof is not 'relevant' on relevance logic's account, since the two premises $x^i > l$ and $l < L$, are not used in the proof, which is just an instance of the axiom $A \vdash A$. It seems that the basic intuitive notion behind all these cases is that of information's usefulness.

5. More GQ behavior

In this section, we will refine and extend the model presented in section 4.1, by considering first consequence PCs, then reevaluation PCs.

5.1. CONSEQUENCE PCs AND *SI*–SENTENCES

It has been proposed that forms *if* X, Y introduce a very weak form of implication (Veltman 1986). *Si* has been analyzed along similar lines by de Cornulier (1985) who equates *si* X, Y with 'in a situation where X, Y'. If consequence PCs such as *then* presuppose only such weak conditions, it explains their well–known compatibility with conditional sentences. However, it does not explain why *donc* is incompatible with such sentences, as evidenced by the contrast in (19), which we repeat below.

(19) a. ??If the weather is fine, DONC I will go out
  b. If the weather is fine, ALORS/DU COUP/? DE CE FAIT I will go out

At first sight, we just have to assume that *donc*, in contrast with other consequence PCs, must introduce an 'absolute' attitude or force, that is, an attitude or force which holds independently of the protasis, whence an incompatibility with *si*. In other terms, while consequence PCs in general require that the intensional entity associated with Y be true whenever that associated with X is, *donc* requires that the intensional entity associated with Y be true in the speaker's world $w_{speaker}$, or, at least, in the restriction of the speaker's world to the premises Σ'' and Σ' of the definition (37). However, in a conditional structure *if* X, Y, Y is not necessarily true in the speaker's world, since its truth depends on that of the protasis X, which is only presented as possible.

While this seems reasonably simple and plausible, it raises a technical problem. Up to now, the approach we followed is essentially *static*: definitions are built over a deduction relation $\vdash$ between premises and conclusions(s). If we just say, for capturing *donc*, that the conclusion must be true in any world containing the necessary premises (Σ'' and Σ' in the definition 37) and their consequences, we do not add anything to the definition (37). What we must require is that the conclusion q be true whenever the material used in the proof of p (i.e. Σ'' in the definition 37) is added to Σ' *with its epistemic status*. Suppose, for simplicity, that this material is only p itself. If p is asserted, we have only to add p, since p belongs to the speaker's world. If p is conditional, we may add either that p is possible, or that p is impossible (as in counterfactuals). Intuitively, we may not obtain q if we add the possibility of p, let alone the impossibility of p. To take possibilities and impossibilities into account, we must add three definitions. First, we must adapt the condition (34).

(44) Let $\Sigma = \{p_1 \ldots p_n\}$ a set of propositions which constitute the premisses of p in a proof of $\Sigma \vdash p$, and let p be associated with the sentence X, we define $COND(\Sigma)$ to be:
(i) Σ itself if $IF(X) = assertion$,
(ii) $\{$ *Might* $p_1 \ldots$ *Might* p_n $\}$ if $IF(X) = supposition$,
(iii) $\{$ $\neg$*Might* $p_1 \ldots \neg$*Might* p_n $\}$ if $IF(X) = counterfactual$.

The $COND$ operator returns the initial set of propositions if we have an assertion, and a set of possibilities (resp. impossibilities) if we have a supposition (resp. a counterfactual). The next step is to define the interaction between the possibilities or impossibilities and the premises in the speaker's world. Using Veltman's notion (Veltman 1996) of *update*, we define the addition of *Might* p. In update models, an information state is a set of worlds. A proposition holds or is true in an information state iff it holds in each of the worlds which make up this information state. Let $\sigma + p$ denote the result of adding a proposition p to an information state σ. This operation amounts to consider only the subset of worlds in σ which contain p. If p was already true in σ, adding p to σ produces nothing. If p is incompatible with other information in σ, $\neg p$ holds in every world of σ. So $\sigma + p$ is the empty set, or absurd information state. If p is true in some worlds of σ and false in some others, $\sigma + p$ denotes the subset of worlds in σ where p is true. The case of possibility formulas is essentially the same.

(45) Let σ be an information state, the information state σ + *Might* p is:
(i) the absurd state if $\sigma + p$ is the absurd state,
(ii) σ itself if $\sigma + p$ is not the absurd state.

The addition of $\neg$*Might* p is similar. Adding $\neg$*Might* p to σ produces the absurd state if σ contains p or is compatible with p and σ itself if p is not compatible with σ. Finally, we devise a new definition of *donc*.

(46) $DONC_{p,q}(\Sigma_w, \Sigma'_{w_{speaker}})$ iff there exists a non–empty set $\Sigma'' \subseteq \Sigma$ such that:
(i) $\Sigma'' \cup \Sigma'$ is consistent,
(ii) $\Sigma \vdash p$,
(iii) $\Sigma' \cup \Sigma'' \vdash q$,
(iv) if σ is the minimal information set containing Σ', q holds in $\sigma + COND(\Sigma'')$.

This definition simply enriches the previous definition (37) for *donc* with the condition (iv). If p corresponds to an *if*–sentence, $COND(\Sigma'')$ will be a set of possibilities or impossibilities. The addition of this set to σ will produce σ or the absurd state of information. In the first case, q does not necessarily hold, because (iii) makes the truth of q depend of the truth of Σ' *and* Σ'' (which must be non–empty). In the second case, no proposition holds. An analogous reasoning applies to the counterfactual value of the *if*–sentence.

However, certain facts invite a more flexible analysis.[26] Consider:

(47) a. ??Every rectangle is four–sided. If A is a rectangle, DONC A is four–sided

b. A is even. If B = 2A, ? DONC B is even

c. A is superior to B, if B is superior to C, ? DONC A is superior to C

These data suggest that *donc* is better when an asserted *factual* premise occurs in the reasoning. There are variations across speakers about the nature of the reasoning (logical, empirical, etc.) which licenses *donc* in such cases. There are also variations as to whether one asserted factual premise is sufficient. By and large, for *donc* to be tolerated in examples such as (47a–c) it is necessary that (i) the reasoning be sufficiently explicit, (ii) at least one asserted factual premise occur in the reasoning. This combination of preferences stems from the general constraint on *donc*, that the conclusion q be provable. We do not pretend to explain these facts, but we can dissipate some of the feeling of mystery which they evoke.

The reason why, other things being equal, (47a) is worse than (47b) and (47c) is that the only asserted premise is a rule, not a fact. While facts can be strictly idiosyncratic, rules cannot in general. Technically, this means that facts can be true in only one information state, and false outside, while rules must hold 'more generally'. We will not discuss the different options for measuring the degree of generality, and will simply assume that rules must hold in a set of information states which may not be a singleton. In consequence, if we update the same information state σ with a rule r and with a fact f, we have, in general, $\sigma + f \subset \sigma + r$. We note that deductions which point to facts, or *factual deductions*, entail the introduction of some fact in the premises: one may not deduce a fact only from a set of rules; the information must grow at some place, that is, the set of worlds compatible with the information states must decrease in size, down to the point where we keep only the worlds where the fact to be proven is true.

[26]In French, there is a strong difference between the sentential *donc*, which is in the initial position and the VP–internal one. In the discussion to come, we consider only the sentential *donc*, which is more problematic.

Consider (47a). The first premise is a rule. According to definition (46,iv), the following configuration must obtain: from the minimal information state containing the rule 'every rectangle is four–sided' ($= r$) updated by the conditional 'if A is a rectangle' ($= Might\ p$), we can deduce 'A is four–sided' ($= r$). Let $\mathbf{0}$ be the minimal information state, the minimal information state containing r is $\mathbf{0} + r$. So, the update corresponding to (47a) has the form:
(47a) : $(\mathbf{0} + r) + Might\ p \vdash q$.
The update corresponding to the better examples is:
(47b), (47c) : $(\mathbf{0} + f) + Might\ p \vdash q$
In general, due to the difference we postulated between facts and rules, we have: $\mathbf{0} + f \subset \mathbf{0} + r$. So, the information on premises introduced in (47b) and (47c) is more precise than that introduced in (47a). We ascribe the observed difference to this fact. More generally, we submit that cases like (47b) or (47c) are more likely to be perceived as deductions than (47a) because their information growth resembles that of a factual deduction.

This hypothesis predicts that, in the case of *rule deductions*, that is, deductions which prove rules, it will be sufficient to have one asserted rule to improve the examples. The following data show that it is indeed the case.

(47) d. ??If every equilateral triangle is equi–angled, and if every equi–angled triangle has three 60 degrees angles, DONC every equilateral triangle has three 60 degrees angles

e. Every equilateral triangle is equi–angled, if every equi–angled triangle has three 60 degrees angles, ? DONC every equilateral triangle has three 60 degrees angles

Summarizing, these data suggest that introducing *if*–sentences in a *donc*–reasoning is acceptable insofar as the growth of information in the premises mimics that of the same reasoning in its 'normal', i.e. non–conditional, form.

5.2. REEVALUATION PCs

Reevaluation PCs have the following characteristic: in a form $X\ C_{reev}\ Y$, the informational effect of X is reevaluated when Y is introduced. We will describe here only the two PCs *de toute façon* and *quoi qu'il en soit*, and simplify their GQ relations for shortness. The associated relations will be denoted by DTF and QQS respectively.

Let us first describe intuitively the behavior of these two PCs. In a form $p\ C_{reev}\ q$,

1. if C_{reev} = *de toute façon*, then,[27]
   (a) q entails p, as in *John hates Paul,* DE TOUTE FAÇON *he hates everybody*, or
   (b) there is some r such that q entails r regardless of p (whether p is true or false), and p, in some context(s), entails r, as in *John completely forgot the meeting,* DE TOUTE FAÇON *it was postponed.* Suppose that r is something like 'John could not make the declaration he had prepared for the meeting'. Then, the cancellation of the meeting entails r irrespective of John's presence or absence. Or, more marginally,[28]
   (c) there is some r such that p entails r in some context(s) and q blocks the derivation of r from p in the speaker's world, as in *John flunked his exam,* DE TOUTE FAÇON *he can take this exam once again.* If r is 'John will not get his diploma', q blocks the derivation of r since John has got another chance. This is done by constructing a situation of the speaker's world, $w_{speaker}$, which allows one to derive the negation of a premise which is used in the derivation of r in some other[29] world.
2. If C_{reev} = *quoi qu'il en soit*, there is some r such that either the above situation 1c obtains, or p entails r in some contexts and q entails $\neg r$ in the speaker's world, as in *Mary is smart,* QUOI QU'IL EN SOIT *she is too young for this position*, where we understand that a possible conclusion from 'Mary is smart', e.g. 'The company should hire her', is anyway contradicted by q: Mary is too young to be hired.

(48) $DTF_{p,q}(\Sigma_w, \Sigma'_{w_{speaker}}, \{r\})$ iff Σ' is non empty and:
(i) $\Sigma', q \vdash p$, or
(ii) $\Sigma, p \vdash r$ and $\Sigma', q \vdash r$, or
(iii) $\Sigma, p \vdash r$ and $\Sigma', q \vdash \neg p'$ for some p' in Σ.

(49) $QQS_{p,q}(\Sigma_w, \Sigma'_w, \{r\})$ iff:
(i) $\Sigma, p \vdash r$ and $\Sigma', q \vdash \neg p'$ for some p' in Σ, or,
(ii) $\Sigma, p \vdash r$ and $\Sigma', q \vdash \neg r$.

De toute façon and *quoi qu'il en soit* are inappropriate in some configurations of indirect opposition compatible with *but* or *mais.* E.g., in *Mary is smart* ($\Rightarrow$ 'she can be hired') *but she is rather young* ($\Rightarrow$ 'she should not be

[27] We ignore here extra factors connected with the difference between logical and generic entailment, and with restrictions on causal ordering.
[28] Speakers do not agree on this inferential structure.
[29] As remarked in note 22, worlds can be inconsistent. Should this be avoided, we ought to require that w be different from $w_{speaker}$, if we want $\vdash$ to be monotonic.

hired'), the two PCs are clumsy. This is explained by our hypothesis, since, in such cases, there is no pragmatically available interpretation in which the restriction *she is rather young* blocks the conclusion *she can be hired.* It is only in contexts where this interpretation emerges naturally that such sentences are felicitous.

6. Conclusion

While we have provided here only a very limited sample of problems, observations and techniques, we have made clear two points:

• PCs impose constraints on the construction and management of their arguments. They behave as complex relations on complex semantic entities. In some cases, their behavior can be seen as a generalized quantification on proof space.

• The observed constraints are essentially *hybrid.* In contrast with other domains in lexical semantics, one cannot rely only on feature and type systems to account for the phenomena. It is necessary to formulate the constraints at a level where inferential (global) and more local parameters, particular to each class of PCs, interact. However, this interaction is not just discourse–driven, which would take us back to some vague conception of contextual dependence. It is controlled by lexical informations associated with PCs, which determine how inference affects them. Moreover, taking into account detailed instructions allows us to distinguish between lexical items which belong to the same functional class, that is, to address the problem of *plesionymy* (Hirst 1995).

In this paper, we have not considered the relation of PCs to more general discourse phenomena. In most approaches to discourse, a distinction between content relations and discourse or rhetoric moves is used. Generally speaking, one can say that discourse coherence is achieved by connecting discourse units (e.g. sentences, speech acts, interactional moves) so that no unit remains unattached. Several attachment procedures have been proposed (see Polanyi 1985, Asher 1993, Traum & Heeman 1996, Roulet *et al.* 1985 for some discussions and examples). It should be clear that the relations we consider here are much more low–level and pertain to content rather than to global discourse organization. Although we use sometimes labels for rhetoric moves (e.g. explanation) to provide intuitive guidance, we are not concerned with discussing precise definitions of such labels. This 'minimalist' option is possible only because rhetoric relations are usually defined in terms of basic content relations, not the reverse.

However, this leaves two questions open.

(a) Can rhetoric relations always be eliminated in favor of content relations in the case of PCs ? Answering this question depends on further empirical

studies. Note that this problem is in principle distinct from that of the identification of a generating subset of discourse relations, allowing one to derive their whole spectrum (Sanders et al. 1993).
(b) Are there specific attachment properties of PCs? In his 1993 book, Asher has generalized the open constituent approach of (Polanyi & Scha 1984). This allows in particular more flexibility for linking a sentence to a non immediately preceding one. Is this sentence–hopping phenomenon controlled by the PCs in some way?

We intend to address these questions in further research.

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