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## Chapter 1

# WHAT DO THE NOTIONS OF INSTRUMENTALITY AND OF MANNER HAVE IN COMMON?

*A Channel Theoretic model for causality as dependence*

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**Abstract** In this paper we present an analysis and a model for the notions of instrumentality and manner through the study of the preposition *avec* (*with*).

These two notions are very often assimilated. We try to find out the semantic foundations of this intuition, considering first the meanings-in-context and then the underspecified representation common to them.

For the construction  $NP_1 VP NP_2 avec NP_3$ , we propose an analysis in terms of sub-events involving the denotations  $NP_1$  and  $NP_3$  and individuate two features shared by these meanings:

1. the causal relation linking the individual entities among themselves and with respect to the main action;
2. the situation dependence of these relations.

We propose a model based on the abstract notions of type, constraints and channel, which allows us to capture the abstract notion of causation as non-accidental association or property dependence (Lewis, 1973).

**Keywords:** Instrumentality, manner, *avec* (*with*), causality, situation, types, counterfactuals, dependence, accidentality, underspecification.

## 1. Aim and methodology

It has long been recognized that instrument and manner are two primitive, conceptually related notions that are generally introduced by a prepositional phrase (Spang-Hanssen, 1963; Wierzbicka, 1996; Cadiot, 1997):

- (1)  $NP_1 VP NP_2 Prep NP_3$
- (1')  $NP_1 VP NP_2 avec NP_3$
- (2) Jean coupe le pain avec un couteau  
*John cuts the bread with a knife*
- (3) Jean joue aux échecs avec plaisir  
*John plays chess with pleasure*

$Prep NP_3$  is supposed to specify what way in particular the action denoted by the  $VP$  is carried out, introducing a qualification in the scenario enhanced by the verb. In (2), *avec un couteau (with a knife)* makes explicit the way of cutting the bread; in (3), *avec plaisir (with pleasure)* qualifies the way of playing.

In this paper we argue that this intuition is well founded, and we try to discern its foundations. To this end we analyze and model the notions of instrumentality and manner through the study of the preposition *avec (with)* in French. More than *par (by)*, which instantiates a general meaning of cause or "way through", *avec* - as its literal translations in other Indo-European languages (*con* it., *mit* ger., *with* engl.) - has, among many others (see (Mari, 2003)), the meanings of instrument and of manner for which (2) and (3) are two typical examples.

Our study is based on the hypothesis that if primitive notions such as instrument and manner exist, they can only be studied through their possible lexicalizations. Moreover, because the meanings of an item can only be observed in context, the explanation of the similarity between these two notions follows from a bottom-up analysis, from the meanings to the abstract representation.

This paper is then structured as follows: we first describe the contextual behavior of *avec*-instrument and *avec*-manner in section 2. We take into account some features such as the distribution of determiners, the question of the  $NP_3$  types and the constraints on predicate interpolation. Then, we present a model based on the notion of type and property constraint inspired by (Barwise and Seligman, 1997) (section 3). In section 4 we develop a representation for the underspecified scheme that the notions of instrument and manner share, and we finally come back to a formal treatment of *avec* contextual meanings. We conclude (section

5) with an evaluation of our results and some theoretical speculations. But, to begin, let us present a brief note on *avec* and our methodology.

### 1.1 A note on *avec* and the scope of this study

The strategy that we adopt consists in observing the notions of instrument and manner in their maximal proximity, that is to say, in the configuration where they are instantiated by the same lexical item.

This strategy raises two questions:

1. are these two notions only lexically driven or,
2. can we extend the conclusions to other cases and show that their similarities are lexically independent?

It is well known that *avec* is a highly polysemous preposition. Among others, it has the meaning of comitativity “Jean is walking with Mary” (Mari, 2002) and of influence “John is watching the TV with his brother singing next to him”. Instrumentality and manner are two specific senses of *avec*. A complete study (Mari, 2003) of the meanings of *avec* shows that they belong to the same sub-family of *spatio-temporal location*. In this paper we concentrate on this subset and we show that the notions of instrumentality and manner are related: there is an underspecified representation that these meanings share. Specific parameters and constraints instantiate it in context ((Pinkal, 1985); (Poesio, 1996)).

To show that instrumentality and manner are two related, lexically independent notions, we would have to tackle some other items that present the meaning of manner and, separately, some other items or construals that present the meaning of instrument, and then show that these two meanings are related, an endeavor which is beyond the scope of this paper.

Nevertheless, the nature of the representation that we adopt, based on the notions of constraints and situation type ((Barwise and Perry, 1983); (Devlin, 1991); (Barwise and Seligman, 1997)) leads us to formulate the hypothesis that the similarities we have found extend beyond the lexical meaning of the preposition *avec*.

## 2. Analysis of *avec*-instrument and *avec*-manner

In this section we consider the meanings of instrument and manner, and we describe the lexical constraints that must be fulfilled for the use of *avec*. In the following discussion,  $NP_1$ ,  $NP_2$ ,  $NP_3$  and  $VP$  refer to construction (1’);  $X$ ,  $Y$ ,  $Z$  are, respectively, the denotations of  $NP_1$ ,  $NP_2$  and  $NP_3$ <sup>1</sup>.

<sup>1</sup> $X$ ,  $Y$ ,  $Z$  are variables for objects or entities, including abstract objects and events

## 2.1 *Avec-instrument*

Let us begin by considering the features that characterize the meaning of instrumentality. Recall that the typical example is:

- (2) Jean coupe le pain avec un couteau  
*John cuts the bread with a knife*

**2.1.1 Causality.** As shown in (Mari and Saint-Dizier, 2003), the notion of instrument is not self-standing. It cannot be found at the level of the  $NP_3$  type, it is not required as such by a particular class of verbs, nor does it have a unique lexical and conceptual representation. Instead, it minimally involves three sub-events and some relations among them: ( $e_1$ )  $X$  carrying out the action denoted by  $VP$ , ( $e_2$ )  $X$  controlling or undergoing  $Z$ , and ( $e_3$ )  $Z$  causing the action described by the  $VP$ .

(4) **Sub-events: analysis of *avec-instrument* (2)**

- $e_1$  : Jean cuts the bread ( $X$  / *Action*);
- $e_2$  : John uses the knife ( $X$  "controls"  $Z$ );
- $e_3$  : The knife cuts the bread ( $Z$  / *Action*).

Talmy (Talmy, 1976) calls the reconstructed event ( $e_3$ ) denoted by  $NP_3$   $VP$  the "semantic cause". It is *because* the knife has a certain property that enables it to cut the bread (e.g. its sharpness), that John can cut the bread. Of course, there must exist a relation between John and the knife. This is provided by sub-event,  $e_2$ . Different prepositions denoting instrumentality signal different degrees of involvement of  $X$  and  $Z$  in the action denoted by the  $VP$ , as well as different control degrees of  $X$  on  $Z$  (cf. Mari and Saint-Dizier, *ibid.*). On its side, *avec-instrument* shows a particular configuration of control relations.

**Relation  $X$  /  $Z$ .**  $X$  must control  $Z$ . This control can be physical (5), psychological (6), or even intellectual (7):

- (5) Jean a cassé la fenêtre avec une balle  
*John broke the window with a ball*  
 (6) Jean a évité la réunion avec une excuse peu vraisemblable  
*John avoided the meeting with an unbelievable excuse*  
 (7) Le gouvernement a évité la manifestation avec une longue déclaration bien sentie

*The government avoided the demonstration with a long heartfelt declaration*

Note that the following sentences are impossible:

(8) \*Jean a mis tout le monde mal à l'aise avec une gaffe

*John embarrassed everyone with a gaffe*

(9) \*Jean s'est fait mal avec une chute

*John hurt himself with a fall*

*Gaffe* and *chute* are non-controllable entities. Note also that the control need not be physical (5) vs. (6).

**Relation X / Z / Action.** It does not follow that the subject performs the action denoted by the *VP* voluntarily. In (5) the fact of breaking the window can be the unwanted result of a bad control of the ball. In other cases, the subject is volitional. According to Talmy's distinction (Talmy, *ibid.*) between *actor* (non volitional agent) and *agent* (a volitional actor), we can state that *X* can be either actor or agent. From these two observations, we can conclude that in (1'):

- *X* has to *control* some of the properties of *Z* thus causing the action denoted by the *VP* even though involuntarily<sup>2</sup>

- there is a causal relation between the properties of *Z* and the main action.

### 2.1.2 Situation-dependence of the properties of the instrument.

Another characteristic of *avec*-instrument is that the properties of *Z* are situation-dependent.

(10) Jean épate Marie avec sa voiture

*John is impressing Mary with his car*

If uttered in the 19th century, the existence of the car itself would have been sufficient to impress anyone. If uttered nowadays, the interpretation of the sentence would depend on the reconstruction of some relevant properties of the car that impress Mary. Moreover, the fact that

<sup>2</sup>It is important to note that *avec* does not solve the ambiguity agentive/non agentive interpretation of the main predicate (e.g. *John s'est brûlé avec de l'huile bouillante / John burned himself with boiling oil*). It only requires that *X* controls *Z* such that this control has consequences on the action. Whether the action is brought about voluntarily or not, it is not a question that is related with the semantics of *avec*.

the properties relevant for the interpretation are situation-dependent explains two other observations.

**Lexical and contextual constraints for the reconstruction of the interpolated predicate.** The relation between  $NP_3$  and the  $VP$  takes the form of an interpolated predicate. In (4) the knife "cuts" the bread, in (10) the declaration "convinces" the public opinion and so on. With respect to the meaning of instrument, one could expect to pick the material to interpolate from the telic role of the  $NP_3$  (Pustejovsky, 1995). Nevertheless, even if this option is the one by default, in most of the cases, the predicate to interpolate is provided by the lexical information and the context (Godard and Jayez, 1993). In (11), for instance,

(11) Il a écrasé les moustiques avec un livre / *He swatted the mosquitoes with a book*

the predicate to reconstruct is not "to read," as expected by default. Other properties of the book are called into play, namely the physical property of being heavy enough to swat the mosquitoes.

**Determiners and conditions on situation-dependence of properties.** Some kinds of determiners are not compatible with *avec*-instrument. Consider the following examples.

(12) \*Le gouvernement a calmé les manifestants avec la déclaration  
??*The government has calmed down the demonstrators with the declaration*<sup>3</sup>

(13) Le gouvernement a évité les manifestations avec la déclaration et calmé les parlementaires avec la promulgation de la nouvelle loi  
*The government avoided the demonstrations with the declaration and calmed down the Chamber with the promulgation of the new law*

(14) Le gouvernement a calmé les manifestants avec la déclaration que le Président a prononcée hier  
*The government calmed down the demonstrators with the declaration that the President gave yesterday*

(15) \*Le gouvernement a calmé la manifestation avec la longue déclaration

\**The government calmed the demonstrations with the long declaration*

(16) Hier, le gouvernement a préparé une longue déclaration. \*Aujourd'hui il a calmé les manifestations avec la déclaration

<sup>3</sup>Note that the acceptabilities can vary from one language to another.

*Yesterday the government prepared a long declaration. \*Today it calmed the demonstrations with the declaration*

(17) Le gouvernement a calmé les gens avec sa / cette déclaration

*The government has calmed down the people with its / this declaration*

(18) Le gouvernement a calmé les manifestations avec une déclaration

*The government has calmed the demonstrations with a declaration*

First of all, the definite is not acceptable when the properties of the instrument are not salient in the context (12). Following (Corblin, 1995), for the salient properties to emerge, a contrast has to be established (13). Eventually, the definite *NP* has to be spatio-temporally anchored (14). The overt specification of the relevant properties by an adjective is not sufficient (15), nor to know, on the basis of the context, the properties of the denotation that make it worth mentioning (16). Because the possessive and the demonstrative are context-anchored determiners, they are always possible (17). The indefinite, introducing a new entity into the context, is more easily accepted, especially when this is anaphorically bound by another salient entity as in (18).

We conclude that the properties of the instrument that allow *X* to achieve the action described by the *VP* are situation dependent and have to be relevant in the situation.

## 2.2 *Avec-manner*

There are many resemblances between *avec-instrument* and *avec-manner*. The most straightforward ‘ is that the subject, in construction (1’) for *avec-manner*, also has to minimally be an actor (Talmy, 1976).

(3) Jean joue aux échecs avec plaisir

*John plays chess with pleasure*

(19) \*Jean plaît avec enthusiasm

*\*John is liked with enthusiasm*

The *NP*<sub>3</sub> has to qualify the action carried out by *X* in the way *avec-instrument* does. This explains why it has very often been said that the meanings of manner and instrument can only be distinguished on the basis of the type of the head noun of *NP*<sub>3</sub>. *Avec-instrument* would require a concrete object, where *avec-manner* would select an abstract one.

We argue that the *resemblances* (Wittgenstein, 1953) cannot be reduced to this simple rule. First of all, as we show below, the nouns that can appear in construction (1’) for *avec-manner* are not clearly defined

for their type. On the other hand, the similarities concern the structuring relations among the *NPs* and the *VP* rather than the content of the *NPs* alone.

Our analysis of *avec*-manner shows that its two major characteristics are, as for *avec*-instrument, the situation-dependence of the properties of *Z*, and the causal relation that links these properties to the action described by the *VP*.

But before we come to these two points, we discuss two of the major theories of *avec*-manner in French and show that they are not explanatory adequate.

**2.2.1 *Avec*-manner and *NP* types.** As for the instrumental, one would try to look for the notion of manner into the *NP*<sub>3</sub> type. Given the apparent coherence of the semantics of the head nouns, this hypothesis seems reasonable. They are generally abstract items, belonging to the classes of *intensive* (roughly mass terms) and *extensive* (roughly countable terms) nouns (Flaux and van de Velde, 1993). Nevertheless, it is very difficult to identify a proper set that can enter construction (1') on the basis of distributional properties. This enterprise has been undertaken by (Molinier, 1984). The only result is that all the nouns that can enter construction (1') can be the object of *éprouver* (*to feel*) or *manifester* (*to show*). Either syntactically or semantically this result does not clarify what semantic properties make these nouns acceptable as complements of *avec*-manner. We have in fact to note that a certain number of abstract nouns are not compatible with this preposition:

(20) Avec \**beauté* (*beauty*), \**solitude* (*loneliness*), \**célébrité* (*celebrity*), \**silence* (*silence*)

Both the semantic and the syntax-semantic accounts seem unable to provide a plausible explanation. Both of them try to identify specific and permanent properties in the denotations of the nouns without considering the constraints imposed by the preposition. Let us consider them in turn.

**Semantic account.** Anscombe (1990) has provided a classification of abstract nouns on the basis of the nature of the property that they express. He proposes a distinction between *intrinsic* (*gentillesse* (*kindness*), *blondeur* (*blondness*)) and *extrinsic* (*intérêt* (*interest*), *silence* (*silence*)) properties. The intrinsic properties (without necessarily being permanent) characterize an individual as such; the extrinsic ones describe transitory states. It is easy to observe that *avec* is compatible

and incompatible with items belonging to both of these classes:

(21) a. Intrinsic : *avec gentillesse* / \**avec blondeur* / b. Extrinsic :  
*avec intérêt* / \**avec silence*

The second distinction established by Anscombe (ibid.) is between *endogenous* (*courage* (*courage*)) vs. *exogenous* (*méfiance* (*skepticism*)) properties. The first are supposed to have an internal psychological source; the second are considered to be enhanced by an external element. The status of this characterization is quite vague and difficult to state on a semantic basis. Moreover *avec courage* and *avec méfiance* are both possible.

We conclude that none of these conceptual distinctions help us to identify the nouns that can combine with *avec-manner*.

**Syntax-semantic account.** Some of the nouns that cannot enter construction (1') in the  $NP_3$  position belong to the class of state-nouns (Flaux and Van de Velde, ibid.). This class is identified by the context: *être en* (literally *to be in*).

(22) a. *Etre en colère* (*anger*), *désordre* (*untidiness*) / b. *avec*  
*??colère*, *avec \*désordre*

This is a promising hint for the analysis of *avec-manner*. However, we have to acknowledge what follows:

- first of all, *avec* is also incompatible with some abstract nouns that are non-state nouns:

(23) a. \**Etre en volonté* (*to be in will*) / b. *avec \*volonté*

- secondly, the semantics of *être en* is uncertain. Leeman (Leeman, 1995) argues that only episodic resultative nouns can follow the preposition *en* (*in*), without making clear what exactly a resultative noun is; moreover, Leeman's conclusion contradicts the account of (Flaux and Van de Velde, ibid.) and the notion of permanent state.

We conclude that this account only represents a tiny hint toward the individuation of the properties that a generally abstract noun has to fulfill in order to enter construction (1').

**2.2.2 Situation dependence.** We suggest that a noun is a possible candidate for construction (1') in  $NP_3$  position if the properties it expresses are situation-dependent. In this respect, the distinc-

tion between individual-level predicates and stage-level predicates seems to better capture the data (Carlson, 1977): only stage-level predicates are acceptable. It is well known that intrinsic properties belong to the individual-level. These are detected by the classical test using perception verbs:

(24) a. J'ai vu Jean \*beau - *I have seen John \*handsome* / b. avec \*beauté - *with \*beauty*

Nevertheless, this distinction is not sufficient to determine the candidates for  $NP_3$ . Some of the nouns, even if they denote stage-level predicates, cannot follow *avec*-manner:

(25) \*Jean regardait la télévision avec solitude  
\**John was watching the TV with loneliness*

**2.2.3 Causal dependence of the property in the scene denoted by the  $VP$ .** The denotation of  $NP_3$  also has to be causally related to the  $VP$ . Let us briefly discuss the notion of causal relation.

(26) \*Jean regarde la télévision avec dépression  
\**John watches TV with depression*

Even if *dépression* can denote an episodic property of John, this property is thought of as independent of the action of watching the TV. This explains why (26) cannot be accepted.

In (3), instead, “pleasure” is linked to the act of playing chess.

This observations points to the fact that the association between the eventuality denoted by the predicate and the property denoted by  $NP_3$  need *not be accidental*. These properties have to be related to each other, or dependent. Note that it is not the case that the “pleasure” causes the fact that John plays chess. Again, the notion we are pointing at, is more that of “property dependence.” The fact of feeling “pleasure” is dependent on the action of playing chess. We call this dependence “causal dependence” (see (Lewis, 1973) and the notion of counterfactualty).

Even though it may seem that the notion of cause has to be captured more abstractly for *avec*-manner than for *avec*-instrument, as we develop it in detail at section 3., the very same notion of regularity and non-accidental link (Lewis, 1973) is involved in both of the cases.

**2.2.4 Avec-manner and its determiners.** The existence of a causal dependence between the property expressed by  $NP_3$  and the eventuality/situation described by the  $VP$  is confirmed by the analysis of the determiners.

- *Determiner “zero” ( $\emptyset$ ).* Following (Anscombe, 1990) for the analysis of construction (27):

(27)  $VP \emptyset N_i$  or  $P \emptyset N_i$  or  $N \emptyset N_i$

we assume that determiner  $\emptyset$  in French is meaningful and indicates that there is a temporal and causal coincidence between the action denoted by the  $VP / P / N$  and the property denoted by  $N_i$ . In this configuration,  $N_i$  denotes a property that *structurally* describes the predicate. For instance in *confiture pur sucre* (*marmalade pure sugar*), *pure sugar* qualifies a kind of marmalade resulting from a particular treatment. In this case, a causal link exists between the substance and its property: given a certain process of production, it is not accidental that the resulting substance is “marmalade pure sugar”<sup>4</sup>. What Anscombe (ibid.) seems to mean by “causal link”, then, is an ontological dependence between the property being marmalade and being pure sugar.

This analysis of determiner “zero” confirms our hypothesis that in construction (1’),  $Z$  preceded by the determiner  $\emptyset$  has to be causally involved in the scenario enhanced by the  $VP$ . To put it otherwise, there has to be a non-accidental association between the property describing the eventuality denoted by the  $VP$  and  $Z$ . The *non-accidental association* is nothing but an *ontological dependence*, or a *causal relation* between two properties.

A property that is dependent on the substance is called *trope* (Simons, 1994). That the  $NP_3$  denotes a trope seems to be a general requirement.

- *Tropes.* A trope is syntactically obtained by the introduction of a modifier at the syntactic level.

(28) \*Jean a accueilli Marie avec la joie

\**John has welcomed Mary with the joy*

(28’) Jean a accueilli Marie avec la joie au coeur / la joie d’un vrai ami

<sup>4</sup>It is obviously the case that “being marmalade pure sugar” entails “being marmalade”. This is however not an issue, here. In accordance with Anscombe (ibid.) what is at stake here, is the ontological link existing between the substance and its property, in a topology where we are focusing the properties of “marmalades pure sugar”

(literally: *John has welcomed Mary with (?the) joy in his heart / the joy of a true friend*)

The fact that the presence of modifiers is mandatory whenever the property has to be made situation dependent leads us to conclude that *avec*-manner requires that this move be made for the sentence to be felicitous.

We can then claim that:

- the simultaneity between the realization of the property denoted by the  $NP_3$  and the action denoted by the  $VP$  is a necessary but not a sufficient condition;
- *avec*-manner requires a causal link between  $Z$  and the action described by the  $VP$ .

These observations lead us to the conclusion that *avec*-manner enters a structure of three sub-events:

**(29) Sub-events: analysis of *avec*-manner**

- $e_1$ :  $X$  performs the action denoted by the  $VP$ ;
- $e_2$ :  $Z$  is causally linked to (i.e. non-accidentally related to, or dependent on) the action denoted by the  $VP$ ;
- $e_3$ :  $X$  is the source of (generally “feels”)  $Z$ .

This tri-partition can be easily and straightforwardly compared to the one given for *avec*-instrument above (4).

### 2.3 Conclusion of the analysis

We can conclude our analysis of *avec*-instrument and manner by stating that they can both be analyzed in terms of sub-events. Abstracting from the representations in (4) and (29) the common features of these sub-events are the following:

**(30) Sub-events: analysis of *avec*-instrument/ manner and situation dependence**

- $e_1$ :  $X$  performs the action denoted by the  $VP$ ;
- $e_2$ :  $Z$  is causally linked (i.e. non-accidentally related to, or dependent on, (Lewis, 1973) to the action denoted by the  $VP$ ;
- $e_3$ :  $X$  and  $Z$  are in a certain relation (control, or psychological source relation) with respect to the action denoted by the  $VP$  (*situation dependence of the relation*).

The content of  $e_3$  follows from  $e_1$  and  $e_2$ . It can be paraphrased in the following way: Construction (1') denotes a scene in which  $X$  and  $Z$  are two entities whose properties are related. What clearly differentiates *avec*-instrument from *avec*-manner is the nature of the relation between  $X$  and  $Z$  ( $e_3$ ): in the first case this takes the form of a control, in the second case  $X$  is the psychological source of  $Z$ . This relation exists by virtue of the existence of a unique involving situation. On the other hand, this involving situation exists because  $X$  and  $Z$  are related: the bread can be cut with the knife because John uses the knife which has a certain property that enables it to cut (e.g. its sharpness). Chess is “played with pleasure” because “John feels pleasure while playing chess.”

Let us emphasize again, as we have mentioned above, it is not the case that the pleasure is the “cause” of the fact that John plays checks. The notion of “causal relation” stays at a more abstract level and amounts to that of “ontological dependence” of properties, or “non-accidental association.” It is the case that feeling pleasure is dependent on the eventuality of playing chess and reciprocally, the eventuality of playing chess intrinsically involves that of feeling pleasure. This coordination of properties (Lewis, 1973) is the abstract causal link that constitutes the common core of the meanings of instrumentality and manner, as they are instantiated by *avec*.

### 3. The model: properties and constraints

The model we have developed to explain the behavior of *avec*-instrument and *avec*-manner is inspired by Channel Theory of (Barwise and Seligman, 1997). This is a theory of distributed systems: wholes, whose parts have a coordinated behavior. Consequently, the theory is not used as a mere formalism, but as a model whose expressive power is entirely exploited.

Let us very briefly introduce the main definitions and emphasize their relation with the issues developed so far. No other acquaintance with the theory is required in order to read this section.

- **Objects.** Ordinary objects or entities (e.g. tables, individuals, animals etc.), properties (e.g. blondness, patience, etc.) or eventualities<sup>5</sup> are *Objects*. They can all be described by, at least, their spatio-temporal location.

<sup>5</sup>An eventuality (Parsons, 1990) is any kind of temporal entity, static or dynamic (see (Binnik, 1991) for an introduction).

- **Types.** Types are descriptions of *Objects*. Technically, it has to be possible to assign at least one type or description to each object in a given situation. From a semantic point of view, we can consider types as *tropes* denoting spatio-temporally anchored properties of entities.

(31) **Classification.** A classification is a triple  $(Objects, Types, \models)$ , where *Objects* is a set of objects, *Types* a set of categories or types, and  $\models$  a relation between *Objects* and *Types*. If  $o \in Objects$  and  $\sigma \in Types$ ,  $o \models \sigma$  means that  $o$  is of type  $\sigma$ .

We assume that an object can (at least) be described by its spatio-temporal properties, or, in other words, its spatio-temporal location. In that case, the classification "Jean  $\models \langle \lambda, t \rangle$ " expresses the fact the object "Jean" occupies position  $\lambda$  at time  $t$ .

A predicate (e.g. *to be tired*, *to walk*) is taken to denote an eventuality (Parsons, 1990), and this is an *Object* in the model. As any other (abstract) *Object*, an eventuality can be described by a type (spatio-temporal location). For instance, we can specify at where and when someone has been walking:  $walk_x \models \langle \lambda, t \rangle$

However, it is not possible to assign a spatio-temporal location to any kind of predicate. Individual-level predicates such as *to be blond*, *beautiful ...* (Carlson, 1977) cannot be described in this way. Nevertheless, note that when IL-predicates are transformed into tropes (e.g. *the blondness of Mary*) they can be described - in some particular cases - by a spatio-temporal location.

- **Constraint.** Constraints are strict entailments (Lewis, 1973). A strict entailment can be considered a standard entailment that has undergone the rule of necessitation.  $\Box \neg(p \rightarrow q)$  means that whenever  $p$  is true,  $q$  is also true. It is not possible that  $p$  is true but not  $q$  (as for standard entailment) nor that  $q$  is true but not  $p$  (differently from standard entailment).

The constraints are key to our interpretation of *avec*-instrument and manner. As we said, they are strict entailments, and, as such they express the notion of cause in counterfactual terms: it is not possible that  $p$  and  $\neg q$  or that  $\neg p$  and  $q$ .

Intuitively, for *avec*-instrument, they allow the expression that it is not possible that if John cuts the bread using a knife, then the knife does not have the necessary properties to cut the bread. Nor it is not possible that if the knife has the property to cut the bread, then John,

using this knife, can not cut the bread<sup>6</sup>. This intuition also underlies the interpretation of *avec*-manner. Let “it is the case that John is watching TV and he is feeling pleasure” be a partial paraphrase for (3). *Avec* adds a constraint and the complete paraphrase becomes: it is not possible that, if John watches TV, then he does not feel pleasure nor that, if he feels pleasure, then he is not watching TV. It follows that it is not necessary that John feel pleasure otherwise. Recall that whenever the property is not dependent on the eventuality denoted by the *VP*, the sentence is out. The model correctly predicts this fact.

A constraint between types is represented by a channel. A channel rests on infomorphisms, that we consider now.

(32) **Infomorphism.** An infomorphism is a pair of classifications -  $(Object_1, Type_1, \models_1)$  and  $(Object_2, Type_2, \models_2)$  associated with two total functions  $f : Object_1 \rightarrow Object_2$  and  $g : Type_2 \rightarrow Type_1$  such that for  $o \in Objects_1$  and  $\sigma \in Types_2$  :  $f(Object_1) \models Type_2$  iff  $Object_1 \models g(Type_2)$

$$\begin{array}{ccc}
 Type_2 & \xrightarrow{g} & Type_1 \\
 \vdots & & \vdots \\
 \models_2 & & \models_1 \\
 \vdots & & \vdots \\
 Object_2 & \xleftarrow{f} & Object_1
 \end{array}$$

Let us consider an example:

(33) La fille avec un chapeau  
*The girl with a hat*

(33')

$$\begin{array}{ccc}
 \langle\langle \lambda_i \rangle\rangle & \xrightarrow{g} & \langle\langle \lambda_i \rangle\rangle \\
 \vdots & & \vdots \\
 \models_2 & & \models_1 \\
 \vdots & & \vdots \\
 hat & \xleftarrow{f} & girl
 \end{array}$$

Let  $f(girl) = hat$ ;  $g(loc_i) = loc_i$ . Following definition (32) -  $f(Object_1) \models Type_2$  iff  $Object_1 \models g(Type_2)$ . By proper substitution we obtain:

<sup>6</sup>The hearer assumes that John has the ability to cut the bread if he uses a knife that allows him to do so and that there are no other obstacles.

$f(girl) \models loc_i$  iff  $girl \models g(loc_i)$  and then  $hat \models loc_i$  iff  $girl \models loc_i$ . This formula states that the hat is exactly the hat of the girl who wears it. Under this representation the localization of the hat depends on the localization of the girl who wears it. Infomorphism (33') links the entities in such a way that their spatio-temporal locations depend on each other.

Two infomorphisms sharing a common classification form a channel.

(34) **Channel.** A channel is a set of infomorphisms sharing a common classification called the *core* of the channel.

$$\begin{array}{ccccc}
 \alpha & \xrightarrow{f'} & f'(\alpha) \vdash g'(\beta) & \xleftarrow{g'} & \beta \\
 \vdots & & \vdots & & \vdots \\
 \models_1 & & \models_3 & & \models_2 \\
 \vdots & & \vdots & & \vdots \\
 Part_1 & \xleftarrow{f} & Whole & \xrightarrow{g} & Part_2
 \end{array}$$

The constraint  $f'(\alpha) \vdash g'(\beta)$  means that the association is not accidental (*validity of the inference*). It can be written, following (Lewis, 1973):  $\neg \diamond \neg (f'(\alpha) \rightarrow g'(\beta))$ .

Consider again example (33). We can state that the location of the girl determines the localization of the hat that she wears (33'). Another possible interpretation is that the girl and the hat form a **whole** “the girl with a hat” such that the girl on the one side and the hat on the other side are two parts of this whole (33''). This is obtained by instantiating scheme (34):

(33'')

$$\begin{array}{ccccc}
 \ll \lambda, t \gg & \xrightarrow{f'} & f'(\ll \lambda, t \gg) \vdash g'(\ll \lambda, t \gg) & \xleftarrow{g'} & \ll \lambda', t' \gg \\
 \vdots & & \vdots & & \vdots \\
 \models_{loc1} & & \models_{loc3} & & \models_{loc2} \\
 \vdots & & \vdots & & \vdots \\
 Part_1 : girl & \xleftarrow{f} & S : a girl with a hat & \xrightarrow{g} & Part_2 : hat
 \end{array}$$

Again, the constraint  $f'(\ll \lambda, t \gg) \vdash g'(\ll \lambda, t \gg)$  expresses a non-accidental linking between the position of the girl and the one of the hat she wears. Contrary to (33') they are represented as two parts of a unique whole. This representation is particularly suitable for cases where there is an exact symmetry between the entities as for *A mum with her baby*  $\rightarrow$  *A baby with his mum*.

It is important to note that in a very abstract sense, a **situation** can be interpreted as a whole: it “keeps together” the entities that it

involves. This implies, as in every part-whole relation, that the situation does not exist without its parts. More precisely, the *relations* among the entities create the situation.

The relation between two entities of the same situation (or whole) can be modeled by a channel. In this case, we can affirm that they are **coordinated** in the situation. By “coordination” we mean that:

- a. their properties depend on each other, and
- b. they co-participate in a unique action.

The arrows (representing functions) from the whole to the parts “extract” the participating entities; the arrows from the types of the parts to the type of the whole indicate that the descriptions of the parts are of a certain type **any time**<sup>7</sup> the description of the situation is of a certain type. The types of the parts and of the whole can be the same as in this case.

In this way, our model can also integrate the notion of **situation-as-a-whole-dependence** of the coordination.

The idea that a situation can constitute the core of a Channel is fundamental to the definitions of instrumentality and manner and very likely extends beyond the scope of this study. Let us then develop it in the next section before we come back to *avec*.

### 3.1 The notion of situation type

The notion of situation is at the heart of the literature on situation semantics (Barwise and Perry, 1983) to which Channel Theory is strictly related. It is generally assumed that a situation is a structured part of the reality that the cognitive agent manages to pick out. Individuals, relations and spatio-temporal locations are the ingredients of situations.

Moreover, the cognitive agent is able to recognize situation types, that is to say, she is able to foresee how the entities will behave, given the knowledge that she has about the situation.

Let us consider two examples. In a situation where the agent observes some people in a queue, she will be able to foresee how the individuals will move, without having to observe the specific queue. A more complex situation consists of two entities related by a causal relation, for instance, a computer linked to a printer. Any time the agent makes a certain action on her computer (for instance she makes the request of printing a document by specific commands), the printer (linked to the computer that the agent uses) will print the document. The behavior of the printer is coordinated to that of the computer. Because she knows

<sup>7</sup>Validity of the inference

that the computer and the printer are linked to one another and that their behavior is coordinated, she knows that when she makes a certain action on the computer she will obtain another action from the printer.

In this respect, the situation where the computer is linked to a printer, i.e. "*computer*  $\otimes$  *printer*" behaves as the abstract whole or the core of a channel. From now on, then, we will be considering situation types.

(35) *Situation type*. A situation type is a higher-order situation in which the behavior of the entities is predictable on the basis of their description.

Moreover, situation types are wholes that coordinate the behavior of the entities that they support.

(36) *Situation as whole*. A situation is the maximal entity supporting coordinated entities.

Of course, the very maximal entity is the universe. Following (Devlin, 1991) we will be considering only those situations that the cognitive agent can pick up in a limited spatio-temporal region.

Before we come back to *avec*, let us recall the main features of our model:

- it integrates tropes or spatio-temporal situated descriptions; namely the categorizations of the entities that depend on situation types;
- it integrates situations conceived as wholes keeping together the entities that they involve;
- it relies on constraints or causal relations linking the properties of the entities among each other and with respect to the situation.

## 4. A model for *avec*-instrument and manner

### 4.0.1 An interpretation of *avec* in terms of channel.

We can now return to *avec*. Recall that our aim is to find the unique conceptual scheme which arises from these two meanings.

We have already emphasized that their similarities lie in the structuring relations among  $X$  and  $Z$  and the sub-events involving these entities. In particular, we have stated condition (30) that we repeat here for clarity reasons. Sub-event  $e_3$  is particularly important: two entities  $X$  and  $Z$  are in a certain relation *with respect to the action denoted by the VP (situation dependence of the relation)*.

**(30) Sub-events: analysis of *avec*-instrument/ manner and situation dependence**

- $e_1$ :  $X$  performs the action denoted by the  $VP$ ;
- $e_2$ :  $Z$  is causally linked (or non-accidentally related, or dependent on) to the action denoted by the  $VP$  (see (Lewis, 1973) for the notion of counterfactuality);
- $e_3$ :  $X$  and  $Z$  are in a certain relation with respect to the action denoted by the  $VP$  (*situation dependence of the relation*).

We can now further abstract toward the common notion:  $X$  and  $Z$  are two *coordinated* entities with respect to two parameters given in (37):

**(37) *Avec*-instrument and manner and the abstract notion of coordination**

- a. they are coordinated with one another ( $X \otimes Z$ ):  $X$  controls - or is the source of -  $Z$ ;
- b. they are coordinated with respect to the main action:  $X$  and  $Z$  participate (in coordination) in the action denoted by the  $VP$  - causal or non-accidental link. -

It is possible to conclude that the properties of the entities are *regulated* or *coordinated* with respect to each other when the main action takes place. Conversely, the action can take place when the entities that it involves have such properties that they can enter in a relation of coordination. In other terms, there is a *causal constraint* between:

- a.  $X$  and  $Z$  and
- b. between the action on one side and ( $X \otimes Z$ ) on the other side.

As we have shown, these are features that Channel theory can easily express.

**4.0.2 Underspecified representation for *avec* in construction (1').**

We can now elaborate the unique, underspecified (Pinkal, 1985, Poesio, 1996), possibly conceptual based-scheme for the meanings of *avec*-instrumentality and manner. In both of the cases the coordination has scope over the spatio-temporal locations of the entities involved in the situation. This means not only that the two entities share the same spatio-temporal location but also that it is *necessary* that, if one of them is in a certain location, the other be there too. This is so by virtue of the existence of a unique situation in which they are involved. We do not need to specify, at this point, the nature of  $X$  and  $Z$ .

**(38) Underspecified representation for *avec*-instrument and manner**

$$\begin{array}{ccccc}
\ll \lambda, t \gg & \xrightarrow{f'} & f'(\ll \lambda, t \gg) \vdash g'(\ll \lambda, t \gg) & \xleftarrow{g'} & \ll \lambda', t' \gg \\
\vdots & & \vdots & & \vdots \\
\vdash_{loc1} & & \vdash_{loc3} & & \vdash_{loc2} \\
\vdots & & \vdots & & \vdots \\
X & \xleftarrow{f} & S & \xrightarrow{g} & Z
\end{array}$$

This representation can be paraphrased in the following way: entity  $X$  and entity  $Z$  are in a certain spatio-temporal location because the situation  $S$  takes place in this very same spatio-temporal location. Reciprocally, the situation  $S$  takes place in a certain spatio-temporal location because there is a link between the spatio-temporal locations of the entities it supports. This link, as it is expressed by the constraint  $f'(\ll \lambda, t \gg) \vdash g'(\ll \lambda, t \gg)$ , is not accidental.

As expected from (37),  $X$  and  $Z$  are coordinated with one another and with respect to the main action.

#### 4.1 Representation of *avec*-instrument and manner

Representation (38) is differently instantiated by *avec*-instrument and manner.

In the case of *avec*-instrument,  $X$  *uses* or generally *controls*  $Z$ , in the case of *avec*-manner,  $X$  is the psychological source of  $Z$ .

Only the coordination of the spatio-temporal locations of the parts has to be represented at the semantic level. In this case, the "parts" of the situation, are, on the one side, the action involving the actor/agent ( $NP_1 VP$ ), and, on the other, the property/action involving the entity denoted by  $NP_3$  ( $NP_1 VP_{interpolated}$ ). These two are, respectively, an overt and an interpolated predicate, and they are considered as *Objects* in the model. Recall, in fact, that *Objects* stands for any kind of abstract entity: properties or eventualities. *Types* describe them, assigning, minimally a spatio-temporal location.

It is important to note that control or psychological source relations are not introduced as types. Instead, they are treated as abstract relations between properties of singular entities. More precisely, they are treated as holding between the property that the agent has (i.e. the action she is involved in ( $NP_1 VP$ )) and the property/action involving the entity denoted by  $NP_3$  ( $NP_1 VP_{interpolated}$ ). As we have just noted, these correspond to two *Objects* in the model, or to two "parts" of the situation described by the sentence.

Let us illustrate this by considering, in turn, *avec*-instrument and manner.

## 4.2 Representation of *avec*-instrument

In the case of *avec*-instrument there exists a situation in which the property of the agent effectuating a certain action is coordinated with the property of a certain entity.

Let us consider the situation described by the sentence

(39) Jean a brûlé le tapis avec une cigarette  
*John burned the carpet with a cigarette*

In this case, the *Objects* will be  $burning_{John} / burning_{cigarette}$ . These are properties of John and the cigarette. They are treated as *Objects* (see section 3., (31)) and they are assigned a *Type*. In particular, they are described by their spatio-temporal location, specifying at what place and time John and the cigarette have the property of burning the carpet.

These spatio-temporal locations are coordinated. It follows that John burns the carpet with the same cigarette that that burns the carpet in the same spatio-temporal location.

Given the knowledge that the speaker has about the relation between an individual and a cigarette, she can conclude that John was smoking or manipulating the cigarette in some way, i.e. he was “controlling” or “using” it. However, this is lexical or contextual information that is not encoded in the semantics of *avec*-instrument.

Representation (38a) is then a possible instantiation of (38) for (39).

(38a) Representation of *avec*-instrument

$$\begin{array}{ccccc}
 \langle\langle \lambda, t \rangle\rangle & \xrightarrow{f'} & f'(\langle\langle \lambda, t \rangle\rangle) \vdash g'(\langle\langle \lambda, t \rangle\rangle) & \xleftarrow{g'} & \langle\langle \lambda', t' \rangle\rangle \\
 \vdots & & \vdots & & \vdots \\
 \models_{loc1} & & \models_{loc3} & & \models_{loc2} \\
 \vdots & & \vdots & & \vdots \\
 burning_{John} & \xleftarrow{f} & S & \xrightarrow{g} & burning_{cigarette}
 \end{array}$$

This representation can be paraphrased in the following way: in the situation where John is burning the carpet with a cigarette, the spatio-temporal locations of the property of John burning the carpet and of the property of the cigarette burning the carpet are related. It follows that John is burning the carpet with the cigarette that is burning the carpet. The agent can *infer* that John is smoking or using/playing with the cigarette in some way.

Note that lexical or contextual factors make explicit what property of the entities, and of *Object*<sub>2</sub> in particular, are called into play. In this case, the reconstruction is straightforward. In some other cases, it

can be more complex and totally context dependent. Almost anything can be used as an instrument and the relevant characteristics that are expected to cause the action are very high in a given context (see section 2.1.2).

### 4.3 Representation of *avec*-manner

*Avec*-manner is the other possible instantiation of (38). In this case what makes the situation exist is that the agent is the psychological source of the feeling. This “psychological-source” relation, again, is not a type. Consider the following sentence.

(40) Jean regarde la télévision avec intelligence  
*John is watching TV wisely*

As for *avec*-instrument, the spatio-temporal location of the property of watching TV of John is coordinated with the spatio-temporal location of being wise. The coordination of the spatio-temporal location of a certain property of John (*regarder/watching*) with the spatio-temporal location of the wisdom of John allows the expression that John is not necessarily wise otherwise. According to what the sentence tells us about John, only his watching of TV is wise.

(38b) Representation of *avec*-manner

$$\begin{array}{ccccc}
 \ll \lambda, t \gg & \xrightarrow{f'} & f'(\ll \lambda, t \gg) \vdash g'(\ll \lambda, t \gg) & \xleftarrow{g'} & \ll \lambda', t' \gg \\
 \vdots & & \vdots & & \vdots \\
 \vDash_{loc1} & & \vDash_{loc3} & & \vDash_{loc2} \\
 \vdots & & \vdots & & \vdots \\
 watching_{John} & \xleftarrow{f} & S & \xrightarrow{g} & sensibility
 \end{array}$$

This representation can be paraphrased in the following way: in the situation where John watches TV, John is watching TV and he is sensible. It follows that the observer can only know that John’s TV watching is wise, but not necessarily that John is wise otherwise.

## 5. Conclusion

In this paper we have tried to provide a formal account for the well-founded intuition that instrument and manner are two related notions. We have argued that it is possible to provide an explanation considering their lexicalizations.

*Avec* has, among others, the meanings of instrument and manner. We have proceeded by a bottom-up analysis individuating first the descriptive parameters and then their common conceptual ground.

We have shown that *avec*-manner and instrument share some essential characteristics:

- the properties of the denotation of the head noun of the  $NP_3$  have to be situation-dependent and causally related to the action described by the  $VP$ ,
- both of these meanings can be analyzed in terms of the sub-events involving  $X$  and  $Z$ . These entities are coordinated (depend on each other) and both, by virtue of their coordination, participate in the action described by the  $VP$ .
- The different natures of the relation between  $X$  and  $Z$  distinguish the two meanings. These are “control”, or “psychological source” relations. They depend on lexical or contextual information and are not encoded in the semantic representation of *avec*-instrument and *avec*-manner.

The notion of causality we have been referring to is strictly related to that of counterfactuality (Lewis, 1973) and amounts to a non-accidental relation among objects via their properties or, more generally, to a relation of dependence.

We have proposed a model inspired by the Channel Theory of (Barwise and Seligman, 1997) and we have emphasized two points in particular:

- the model uses types and thus takes into account the categorization that human beings make out of the entities in a given situation or state of affairs,
- it represents the coordination of the properties of two entities (dependence of the descriptions) within a unique situation that keeps them together.

We have then interpreted the characteristics common to *avec*-instrument and -manner along the lines of these formal features. A coordination of  $X$  and  $Z$  in the situation enhanced by the  $VP$  is minimally required. We have expressed the underspecified coordination of  $X$  and  $Z$  by the non-accidental linking of their spatio-temporal locations. This coordination is represented by the channel.

We can conclude that the intuition according to which there is a link between the notions of manner and instrument is well founded, but that their similarity requires a high degree of abstraction to be captured.

An explanation based on the observation that the types of the head noun of the  $NP_3$  are not the same is too simple. Moreover, no distributional criteria have been found for *avec*-manner, such that they can clearly delimit the set of acceptable nouns. In the same way, because almost anything can be used as an instrument, it is impossible to individuate specific classes of nouns denoting instruments.

The last open question is to know whether the similarities between the notions of instrumentality and manner are lexically driven or if they are more general, possibly universal.

### 5.1 How universal is the relation between the notions of instrumentality and of manner?

At this point we can conclude that instrumentality and manner are two related notions that share an underspecified mental representation.

The study we have presented here could lead to the conclusion that the similarities between these two notions are lexically driven: *avec* (*with*) is the only preposition that instantiates both of them. It would follow that the notion of dependence (in channel-theoretic terms) is lexically driven. This conclusion seems to be confirmed by a complete study of the meanings of *avec* (Mari, 2003). Here it is shown that this preposition is specialized in the instantiation of the notion of “association as dependence”. This is specified in two ways: association as influence and association as spatio-temporal link. Instrument and manner belong to this second class.

This might not be the final conclusion, though. In fact, it does not follow that instrumentality and manner are completely unrelated in other cases. There are certainly some *resemblances* (Wittgenstein, 1953) that go beyond the lexical meaning of *avec* and cognitively relate these two notions. To show this, one has to consider, separately, other lexicalizations of instrumentality and manner. This goes beyond the scope of this paper, but independent studies on instrumentality on one side (Mari and Saint-Dizier, 2003) and on manner adverbs on the other (Molinier, 1984), seem to confirm this hypothesis. The meaning of instrumentality and manner can be explained in many cases by a causal connection between the entities involved in the action denoted by the *VP*. This connection can take the form of a control or a psychological-source relation and can be represented as a coordination of descriptions.

Moreover, with respect to the model, the notions of situation type and constraint are general enough to lead us to believe that we have reached a fundamental point of similarity. Again, one could argue that that *avec* is specialized in instantiating these notions in language. It is known

nevertheless that other items and constructions behave, conceptually, in a similar way (Jayez and Mari, 2004). This is why we can risk affirming that the similarities between instrumentality and manner formulated in terms of causal relation are only lexically driven by *avec* but generate at a higher level of abstraction, involving a notion of causality as non-accidentality. The next step of our analysis will be to compare *avec* and the notions it expresses with other items whose senses can be formulated in terms of coordination and constraints on descriptions. Meanwhile, we can add *avec* to the list of items that express causality in language<sup>8</sup>, even if it captures a more abstract aspect of this notion than the other items already admitted to this list.

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<sup>8</sup>See, for a survey, (Nazarenko, 2000)

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