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On the influences of noun phrases in the determination of the sentence aspectual class

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1 Introduction

The noun phrases in a sentence play an important role in the determination of the sentence aspectual class. This can be clearly seen in the telicity/atelicity distinction. A telic sentence is one in which the event expressed is considered as having a specific end beyond which the event is over (Comrie 1976:p44), as in the sentence "John ran a mile." As opposed to this, an atelic sentence does not specify an end to the event, as in "John ran." In these two examples we already see that the use of an NP may determine one or the other meaning. If we change the type of NP the aspectual properties of the whole sentence may be affected, as can be seen from the difference between "John drank beer" and "John drank a pint of beer," where the first sentence is atelic whereas the second one is telic. However, the NP does not always influence the sentence aspect: in the sentence "the donkey pushed the cart for hours," the NP in object position "the cart" plays no role in the determination of the final aspect, which in this case is an atelic process.[1]

It has been argued that NPs modify the sentence aspect by means of the thematic relations which link the NPs with the verb. Following Krifka (Krifka 1989), I will structure events and objects into lattices and define the thematic relations as homomorphisms from the domain of events to that of objects. These thematic relations may have several properties, but only three of them are needed to account for aspect compositionality, and thus only three main classes of thematic relations will be characterised. The mechanisms of their influence in sentence aspect will be analised. It will be shown how these thematic relations are very closely related to the distributive and collective readings of sentences involving plural NPs and mass terms, and these readings are no more than a way of expressing our interpretation of the structure or the grouping of the objects referred to by the NPs.

2 Lattices

Lattice theory has been used in several attempts to explain the parallelism existing between object and event structure. I will not go into detail about the mathematical properties here, but see (Link 1983; Landman 1991).

Link was concerned on how to explain plurals and mass terms by means of lattice structures. He used several lattices. One of them models matter fusion, so as we can give rules like "the gold of one ring plus the gold of another ring gives the gold of two rings." But there is another lattice which is more interesting for my purpose in this paper, the one which models sets of individuals. For example, a group of two rings, if we see it as the set which contains

[1] Brinton does a summary of possible aspectual interactions in (Brinton 1988), though this analysis is not exhaustive.

two rings, is an element which is made from the join of two other elements. Link's claim is that the same object can have different structures, depending on how we interpret it. In the case of the set of two rings, if we see it as the set itself, it will be a different entity which has no other components, ie it will be an atomic element (See also (Landman 1989; Landman 1991) for Landman's discussion of Link's theories). This possibility of structuring the same object in different ways explains the differences between the expressions "the cards" and "the deck of cards." In the first case, the entity referred to is compound; in the second case, it is atomic (Link 1983:p304). This approach will be exploited in this essay, since evidence seems to indicate that, depending on the sentence used, the same object can be seen differently, as I will discuss later in this paper.

Apart from their lattice structure, these objects can also have other properties. These properties make further structures in the set of objects, categorising them into an indefinite number of subsets (this subsets will be henceforth called **categories** or **predicates**). Thus, if we say that, for example, $P(a)$, we are saying that a is an element of a predicate called P. These categories are a good help in trying to express how we human beings classify objects: if we see an object c, we will also perceive some properties in it, for example that it is rather small and with a rectangular shape. This object may be classified as being a playing card:

$$card(c)$$

That is to say that what we see is not the card, but an object that we classify as being an object (c), and furthermore, a special kind of object: a card. As another example of how object lattice structure interplays with predication, take two different apples, a_1 and a_2. Each one can be categorised as being an apple: $an.apple(p_1) \wedge an.apple(p_2)$. Their join, however, will not be an apple, but two: $two.apples(p_1 \sqcup p_2)$. In this case, the join of two elements of a category gives an element of a different category. In some predicates, the join of two of their elements always gives an element of the same predicate. For example, if we have money in one hand and money in the other hand, what we have in both hands is still money: $\forall m_1, m_2[money(m_1) \wedge money(m_2) \rightarrow money(m_1 \sqcup m_2)]$.

These two kinds of predicates will have what Krifka called QUA and CUM properties, respectively (Krifka 1989). CUMulativity is a property of predicates such that for every predicate P it is cumulative if and only if the sum of any two elements of P still is P:

$$\forall P[\mathrm{CUM}(P) \longleftrightarrow \forall x, y[P(x) \wedge P(y) \rightarrow P(x \sqcup y)]]$$

QUAntisation is defined, not in terms of the join operation, but of the restricted *part-of* relation ($\sqsubset$).[2] A predicate P is quantised if and only if no two elements of P are related by means of $\sqsubset$:[3]

$$\forall P[\mathrm{QUA}(P) \longleftrightarrow \forall x, y[P(x) \wedge P(y) \rightarrow \neg(y \sqsubset x)]]$$

It is not only objects what can be structured into lattices: events can also be structured in the same way. The join of two events is the event consisting of both events, in the same

[2] An object is part of the join of the object and anything else $\forall x, y[x \sqsubseteq (x \sqcup y)]$. An object x which is a part of y is also a restricted part of y if and only if x and y are different $\forall x, y[x \sqsubset y \leftrightarrow x \sqsubseteq y \wedge \neg(x = y)]$.

[3] An equivalent way of expressing QUA is by saying that it applies to a predicate P if and only if no restricted part of any element of P is P:

$$\forall P[\mathrm{QUA}(P) \longleftrightarrow \forall x, y[P(x) \wedge y \sqsubset x \rightarrow \neg P(y)]]$$

In our example of apples, if we have an apple no strict part of it can be a whole apple.

sense as the join of two objects is an entity which consists of both objects. Events are also categorised, and thus, in some cases, the join of two events which belong to a category may belong to the same category or to a different one, depending on how we categorise them. Take for example, a donkey which pushes a cart from 2 to 3 o'clock and also, without stopping, from 3 to 4 o'clock. We will normally categorise both pushings as being a pushing itself, namely from 2 to 4 o'clock. That is:

$$push.a.cart(r_1) \wedge push.a.cart(r_2) \rightarrow push.a.cart(r_1 \sqcup r_2)$$

Does it happen for every member of the set *push.a.cart*? I will argue that, contrarily to Krifka, this does not always hold: if a donkey pushes a cart in Yorkshire and a horse pushes a cart in Sidney, then the event as a result of joining them is not a pushing of a cart, but of two carts. However, *push.a.cart* denotes an atelic process and processes have traditionally been associated with mass nouns, as in Mourelatos' paper (Mourelatos 1981).[4]

As a conclusion, CUM cannot be used to distinguish between atelic and telic events, since telic events do not have CUM either: Take *run a mile,* which is claimed to have the QUA property (Krifka 1989): if Peter runs a mile, no proper part of it will be a running over a mile, that is:

$$\forall x, y[run.a.mile(x) \wedge run.a.mile(y) \rightarrow \neg(y \sqsubset x)]$$

It is provable that, if a predicate P is QUA and is not singular ($\neg$SNG(P)), then the predicate is not CUM.[5] A predicate P is singular when it meets:

$$\forall P[\mathrm{SNG}(P) \longleftrightarrow \exists x[P(x) \wedge \forall y(P(y) \rightarrow x = y)]]$$

Since the predicate *run.a.mile* has more than one element (we can imagine in fact infinite instances of events y to which $run.a.mile(y)$ can apply), it is not singular. Hence, *run.a.mile* is not CUM.

If we want to maintain the distinction between atelic and telic events by using their lattice structure we will need to reformulate Krifka's CUM property so as to avoid using the join operator, since the operation can also be applied to two completely unrelated entities. The restricted part of $\sqsubset$ operation will be used in this paper:

$$\forall P[\mathrm{HOM}(P) \longleftrightarrow \forall x, y[P(x) \wedge y \sqsubset x \rightarrow P(y)]]$$

This formulation is no more than the specification of what has been called *subinterval property* or *homogeneity* (See (Dowty 1986) for a definition of processes in terms of their subinterval property).[6]

[4]One may argue that the join of the donkey's cart pushing and the horse's cart pushing is also a cart pushing, if we treat the cart as a generic one. While this explanation would assign the CUM property to atelic processes like *push.a.cart*, it would also assign the CUM property to telic ones like *run.a.mile*, and thus the 'generic explanation' still is useless in the task of differentiating between atelic and telic events, which is the initial goal of the CUM property in Krifka's paper (Krifka 1989).

[5]Krifka classified these predicates as being strictly cumulative: $\forall P[\mathrm{SCUM}(P) \leftrightarrow \mathrm{CUM}(P) \wedge \neg\mathrm{SNG}(P)]$. We can prove what is claimed in the text with the help of Krifka's theorem $\forall P[\mathrm{QUA}(P) \rightarrow \neg\mathrm{SCUM}(P)]$.

[6]I must say that the use of the homogeneity property is not free of trouble, but I feel that the problems generated are easier to solve (see (Taylor 1977) for an exposition of the subinterval property and of continuity in objects and events). No attempt for doing so will be addressed here, though a line to follow is to consider that, despite masses may not be really homogeneous, we consider them as being so in our language (see (Bunt 1979), for example), and the same may apply to homogeneous processes.

Note that this formulation does not necessarily apply to objects, since *apples* is cumulative and, however:

$$\exists x, y[apples(x) \wedge y \sqsubset x \wedge \neg apples(y)]$$

Namely, when x refers to two apples and y to only one of them.

Finally, note that while predicates like *push.a.cart* do not have CUM, other predicates which refer to events may have it, as for example the predicates represented by bare verbs denoting processes: *run*, *push*, *swim*, *drive*.

3 Thematic relations

So far we have seen that objects and events refer to entities arranged in two different lattices. These two lattices, however, can be related. Krifka explained the relation between objects and events by re-using the concept of thematic relations: an event and an object are related by means of a homomorphism which follows a set of specific properties inherent to it. In other "classical" accounts, these properties have been categorised, creating the roles of agent, patient, etc (see (Fillmore 1968) for a classical work on thematic roles). Krifka does not try to make his own different classification. Instead, he tried to define thematic properties that could be useful to explain the interaction between verb and complements (Krifka 1989). I will not use all of Krifka's properties, however. Instead, in the remain of this section I will define and comment on the properties I will need for my analysis of aspect interaction. In fact, I am going to define a three-way classification depending on these properties.

3.1 Graduality

The first property is that of **graduality.** This property is in some sense the same as Krifka's graduality property. An example where the graduality property (GRAD) is seen at work is in the example *drink.wine*. Here, the event denoted is such that every subevent of drinking has associated a portion of wine (Krifka 1989:p6). It will also be true that every portion of the wine has associated a subevent of drinking. These two properties will be called *restricted mapping of objects* and *restricted mapping of events,* respectively:[7]

$$\forall R[\text{MAP-O}_R(R) \longleftrightarrow \forall e, e', x[R(e, x) \wedge e' \sqsubset e \rightarrow \exists x'[x' \sqsubset x \wedge R(e', x')]]]$$

$$\forall R[\text{MAP-E}_R(R) \longleftrightarrow \forall x, x', e[R(e, x) \wedge x' \sqsubset x \rightarrow \exists e'[e' \sqsubset e \wedge R(e', x')]]]$$

Another property implied in GRAD is that of *uniqueness of objects* or UNI-O, which states that, in our example *drink.wine*, for every drinking event or subevent the portion of wine which is drunk is unique:

$$\forall R[\text{UNI-O}(R) \longleftrightarrow \forall e, x, x'[R(e, x) \wedge R(e, x') \rightarrow x = x']]$$

The structures of both the entity referred to by the verb phrase (which will be called **action**, keeping in mind that an action is an event) and the object will be **isomorphic**, and the thematic relation provides the morphism. This isomorphism between action and object will always have the properties described by graduality.

[7] Krifka used slightly different properties, *mapping of objects* (MAP-O) and *mapping of events* (MAP-E), but I prefer MAP-O_R and MAP-E_R because they lead to easier explanations when it comes to formally prove the aspectual interactions. These proofs will not be included in this essay, however.

The same gradual relation holds between the components of the predicate *eat.an.apple*. Like our example with wine, the apple is considered as being an structured object made of infinite portions of apple which are eaten by means of infinite subevents of eating. In this case, since *an.apple* is quantised, the whole complex predicate *eat.an.apple* will be QUA too. Now, there seems to be a contradiction: *eat* is homogeneous but *eat.an.apple* is quantised. How can this be, when both predicates do actually refer to the same real event? The answer is that the properties here described apply to *predicates* and not to events or objects. $eat(e)$ means that an event e can be categorised as *eat*, but this does not prevent us from categorising it as *eat.an.apple* as well. In this example of apple eating, It is actually the predicate which refers to the object eaten which decides the temporal structure: an event referred to by *eat* may be either bounded (telic) or unbounded (atelic), but *an.apple* always refers to a bounded object. Hence, *eat.an.apple* is temporally bounded, ie, quantised.[8]

The analysis of *masses* is not very different from the above. A mass noun has both CUM and HOM. For example, take *beer*:

$$\mathrm{CUM}(beer) \longleftrightarrow \forall b, b'[beer(b) \wedge beer(b') \rightarrow beer(b \sqcup b')]$$

$$\mathrm{HOM}(beer) \longleftrightarrow \forall b, b'[beer(b) \wedge b' \sqsubset b \rightarrow beer(b')]$$

I have said that, in a GRAD reading, the structure of the NP passes to the complex action. The same occurs with a distributive reading of a mass noun. This means that *drink.beer* should have both CUM and HOM. However, CUM cannot be actually transferred because GRAD lacks one key property. This missing property is actually what diferentiates a GRADual reading from a DISTRibutive one as I will show in subsection 3.3. But HOM still is passed to the verb phrase.

In general, when dealing with GRAD, the action remains a continuous one over time. In that sense, "drink beer", "eat an apple" and "drink a pint of beer" are analysed in exactly the same way, and their aspectual differences correspond to the structure of the object: in the first example the s-object is HOM, hence the final verb phrase is HOM. In the second and third examples the s-object are QUA, hence their verb phrase is QUA.

3.2 Collectivity

Collectivity (COLL) is the second property a thematic relation may have. This property is characteristic of collective readings and is also the property which holds in the thematic relation which links the event and object in *push.a.cart*; for every subevent of pushing, its object pushed over may always be the whole cart:

$$\forall R[\mathrm{COLL}(R) \longleftrightarrow \forall e, e', x[R(e, x) \wedge e' \sqsubset e \rightarrow R(e', x)]]$$

That is, the possible object structure is not considered whatsoever, and one may as well consider it as being an unstructured entity. For example, in the collective reading of "John hired five secretaries," the five secretaries form an unstructured entity, COLL being its relevant thematic property. For the same reason, gradually affected patients have no collective reading: as soon as they acquire a collective reading, they are not gradually affected patients anymore.

[8] We can imagine this interaction as that the verb categorises the event as being one of eating, but leaves open the question about possible telicity. The verb phrase, however, decides this question with the help of the NP *an.apple*. This explanation has some resemblances with Sanfilippo's ontology for events (Sanfilippo 1991), though I do not follow his ontology.

As opposed to DISTR readings, when COLL holds, it is the HOM structure introduced by the verb the one which survives. However, not all the structural properties associated to the verb are transferred: if the verb is CUM, since the NP by necessity is not CUM, the final sentence will not be CUM.

Up to now, all the examples have had durative verbs, but this is not always the case: in predicates like *notice.an.error* or *beat.a.donkey* (semelfactive reading), the action itself occurs in no conceptual time. The verbs of such sentences are *atomic*, where the definition of atomicity is:

$$\forall P[\text{atomic}(P) \longleftrightarrow \forall x, x'(P(x) \rightarrow \neg x' \sqsubset x)]$$

That is, an atomic predicate is one that only holds for atomic elements.

Whenever a non-durative verb combines with a singular definite noun phrase, both graduality and collectivity trivially hold, but since the structure of both the event and the object are actually the same (they both are atomic elements), the resulting structure inherits the same properties from both elements, giving a non-durative structure. Note that any atomic predicate is both trivially homogeneous and quantised: $\forall P[\text{atomic}(P) \leftrightarrow \text{QUA}(P) \wedge \text{HOM}(P)]$. It is easily provable that, whenever $\text{atomic}(P)$, then $\text{atomic}(\lambda e\ P(e) \wedge \exists x(Q(x) \wedge R(e,x)))$, regardless of the aspectual properties of the thematic relation R.[9] Thus, if $\text{atomic}(notice)$ then $\text{atomic}(notice.an.error)$.

3.3 Distributivity

In a fully **distributive** reading, the normal individual structure of a plural NP is considered. For example, in the sentence "John hired five secretaries," when considered in its distributive reading, the five secretaries form a structured entity and each atomic part of this entity will have associated an event of hiring. As a consequence, the NP structure will force the structure of the final verb phrase. Another consequence of this is that "hired secretaries" (note that in this case the object is a bare plural) will have associated a predicate which has CUM but not HOM.

A distributive reading is very similar to one of graduality. The only difference is that here the objects and events are regarded as being joins of independent entities, whereas in GRAD they were seen as an entity which is internally structured. As a consequence, objects and events affected by DISTR do not have HOM but they may have CUM. The formulation of distributivity can be made from GRAD by adding the property of *summativity*:

$$\forall R[\text{DISTR}(R) \longleftrightarrow \text{GRAD}(R) \wedge \text{SUM}(R)]$$

$$\forall R[\text{SUM}(R) \longleftrightarrow \forall e, e', x, x'[R(e,x) \wedge R(e',x') \rightarrow R(e \sqcup e', x \sqcup x')]]$$

Note that, since it is the NP which decides the final structure, there will be cases where the verb is regarded as a classical atelic one but the combination gives a telic reading. For example, consider driving events. In the instance *drive.a.car*, since the reading is trivially collective (only one car is involved), the final structure is defined by the verb. However, in *drive.two.cars*, if we reject an habitual reading, the only possible reading is one of distributivity (one cannot drive two cars at the same time), and hence *drive.two.cars* gets its structure from

[9] As an example, take *notice.an.error*. This predicate applies to any event n such that there is an error e which is noticed by means of the noticing event n: $\forall n[notice.an.error(n) \leftrightarrow \exists e[error(e) \wedge notice(n) \wedge noticed(n,e)]]$. Since *notice* is atomic, if follows that it denotes only atomic events: $\forall n, x[notice(n) \rightarrow \neg(x \sqsubset n)]$. It can be easily proved that $\forall n, x, [notice(n) \wedge (\exists e[error(e) \wedge noticed(n,e)]) \rightarrow \neg(x \sqsubset n)]$.

the NP, giving a telic process (the reading "for hours I drove two cars" is only acceptable if repetition is involved, as in "for hours I ran a mile").

Note also that a verb which is usually regarded as atomic may involve an action which is not atomic. For example, in the distributive reading of "noticed errors," atomic(*notice*) but ¬atomic(*notice.errors*). However, in subsection 3.2 we have seen that this is impossible: *notice.errors* should be atomic. What is wrong here? The way out of this contradiction is to assume that the noticing event is *not* atomic in this example, but a plural event whose components are noticing events. This event plurality is determined by the plural object "errors."

3.3.1 Mixed distributive readings

There is one class of distributive readings which do not quite follow the standard logical structure imposed by the NP: the **mixed distributive readings.** In this class of readings, the object is structured into groups, and these groups are treated distributively. For example, a reading of "I hired secretaries and janitors independently" involves two hiring events, one for secretaries and another for janitors. In this reading, there are two groups, one of secretaries and another of janitors, but these groups are treated as individual elements. This difference between the structure of plurals and the real interpretation can be explained by providing a new operator to our lattice structure which creates atoms out of structures[10]. I will not go into detail with this; I just want to stress that there is a difference between the structure of plurals and the structure which is interpreted in distributive (and collective) readings. This last structure will be passed to the final verb phrase, as in any distributive reading.

An example where we can see the similarity between distributive, gradual and mixed readings is "ate five apples." In its gradual reading, *five.apples* is structured as a set of infinite portions of matter which interact with the inner structure of an eating event: at every moment of the eating event there is an amount of apple matter which is eaten. However, if we take a normal distributive reading, *five.apples* is a set of five elements, each one having an independent eating event. This second reading looks like a mixed distributive reading, since it is a reading over groups of matter who form atomic individuals (the apples).

4 A characterisation of telicity and atelicity

In the previous section I have proceeded to an analysis of the possible interactions between verb and arguments, based on how we structure the entities referred to. Now, how does all this relate to the 'classical' classification between atelic and telic predicates? Here I will analyse telicity and atelicity for predicates containing the verb and one argument and show that this classification is not so straightforward.

4.1 Telic predicates

Telic verb phrases, as predicted by Krifka, have the QUA property, which can be compositionally assigned by two main means as described below.

In the first mean, we have those predicates whose verb and relevant argument are linked by a distributive reading and the argument has the QUA property. In this class, by virtue of

[10](Landman 1991) uses the concept of packaging and grinding of masses. Link's concept of grouping is analysed in (Landman 1989)

the properties of GRADuality, the whole predicate will have the QUA property as well. Some examples are *drive.two.cars* and *eat.an.apple*.

In the second mean, the verb and argument are interpreted as relating to atomic entities. The final predicate will be atomic, and since any atomic predicate also has the QUA property, the final predicate will be QUA. Some examples: *notice.an.error*, *notice.errors* (collective reading).

4.2 Atelic predicates

Atelicity seems to be more difficult to define. Several kinds of atelic predicates appear:

Those predicates which have HOM as a result of a collective reading involving a non-durative verb, such as *drive.a.car* or a gradual reading involving a mass noun, like in *drink.beer*.

Those predicates which have CUM as a result of a distributive reading over a CUM argument: *drive.cars*.

Those predicates which have neither CUM nor HOM, although they share the core of both properties. These predicates are the result of combining a CUM verb or verb phrase with a non CUM argument, as in *John.run.miles*. In this last example, the verb phrase *run.miles* does not have HOM because "miles" is a bare plural. However, the subject (which is linked to the VP by a collective reading) does not have CUM, and therefore the sentence does not have any of CUM or HOM, though we can see that it has something 'in between.'

As a result of this diversity in atelic predicates, one may feel tempted to define atelicity 'not telicity,' that is, as not having QUA. However, this definition will lead us to a definition of atelicity containing an existential predicate

$$\forall P[\neg \mathrm{QUA}(P) \longleftrightarrow \exists x, y(P(x) \wedge P(y) \wedge y \sqsubset x)]$$

and I am not fond of introducing existential definitions, since they are sometimes too general.

5 Conclusions and problems

Argument structure influences sentence aspect in different ways. In a collective reading, the argument is considered as having no structure, and the final aspect is mainly provided by the verb. In a distributive or in a gradual reading the argument structure will determine the overall event structure, imposing a specific aspect to the sentence.

This structure not always is determined by plurality. We have seen that some arguments which normally are considered as atomic are actually structured, and interact with the inner verb structure as in "John ate an apple," whereas other plural arguments are considered as not having any structure at all as in the collective reading of "Mary noticed errors."

The concept that different kinds of interactions decide the final sentence temporal (and aspectual) property is important. For example, the aspectual properties of "John pushed a cart" are different from those of "John pushed carts" (the first one is HOM whereas the second one has a structure 'between' HOM and CUM), though both are considered to be atelic events.

I cannot put enough stress in the issue that the thematic relations here described and even the event structure are only those which relate with *structures in time*. Many verbs may logically structure the event but temporally they regard it as an atomic entity, as is the case with *notice*: a noticing event may be logically compound. One may notice that somebody is coming, then that it is a tall person, then that he is a man, and finally that he actually is John. The final noticing event is logically compound, but it is temporally atomic.

This necessity of working with temporal but not logical structures simplifies our analysis a great deal, since only a limited set of thematic relation types is needed (those thematic relations involved in distributive readings, those involved in collective readings and those involved in gradual readings). But it also creates problems. For example, all the readings considered so far are based on the principle that argument structure creates plurality of events, and this event plurality is actually their temporal structure. This works well if we assume that two different events occur at different times. What happens, however, when events occur in parallel? In section 3.3 I have argued that "I drove two cars" is telic, since I cannot drive two cars at the same time. But, what about "For hours, fifty people drove a car"? In examples like the last, although a distributive reading may be implied, *temporally* the reading is collective, since all the driving events happen at the same time: they are logically distributed but temporally collectivised. Clearly, more research is still needed in this subject.

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