On the aspectual interactions between verbs and noun phrases

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1. Introduction

In this paper a formal analysis of the aspectual interactions between the verb and the noun phrases (Nps) of simple sentences will be introduced. It is not my purpose to go into detail. Rather, all the concepts will be introduced in an intuitive fashion, and the mathematical expressions will be used only for completeness purposes.

The approach here developed will be based on lattices, in a way which is very similar to Krifka's approach in Krifka (1989b). First of all, the problem will be specified in terms of the aspectual distinction between telic and atelic sentences. The influence of the Nps on the final aspectual properties will be shown by means of data examples. Some stress will be put on the fact the Nps may or may not determine the aspectual property of the sentence, depending on our interpretation of the sentence itself.

After describing the structure of the world in terms of lattices, tellicity/atelicity will be formally defined as general properties applying to predicates over events. It will be shown how the same or very similar properties may apply to predicates over objects, reinforcing the concept that objects and events are organised into two parallel structures.

The link beteween the objects and the events will be established by means of thematic relations. These thematic relations will be formalised here, and some properties applying to them will be also introduced. These properties will establish a three-way classification of the thematic relations, and this classification will be reported to correspond to our interpretation of the sentences in terms of the distributive/collective readings. It will be shown how these properties can explain the aspectual interactions occurring in our data.

1.1. Telicity/atelicity

Every sentence describes an event. Depending on how the event is described, the sentence may be telic or atelic. Thus, a **telic** sentence will specify an end point to its event. For example, in the sentence 'John ran a mile,' after the mile is covered the event is over. This does not mean that the general running event is over. John may still be running, but the event of running a mile will be over. A typical test for telicity can be established by attaching an *in*-adverbial to the sentence, as opposed to the use of a *for*-adverbial. Thus, sentence (1a) is fine, whereas (1b) is rather ackward:

(1) a. John ran a mile in five minutes.

b. *John ran a mile for hours.

It must be pointed out that sentence (1b) is also fine under an iterative reading, *ie,* a reading in which John runs over the length of a mile several times during an hour, as it may happen in an athlethic training session. However, no iterative interpretations are allowed in our test.

As opposed to a telic sentence, in an **atelic** sentence no end is expressed. For example, in 'John ran' we do not say when John finishes the run: the sentence is atelic. A typical test again is the inverse of the one used to check telicity: an atelic sentence is fine when a *for*-adverbial is used, but it is ackward when an *in*-adverbial is used instead, as it is shown in (2):

(2) a. John ran for hours.

b. *John ran in ten minutes.

Again, sentence (2b) can also have an interpretation. One could imagine an athletic event in which John must run three miles. After the event is over, one can say 'John ran in ten minutes.' However, such forced interpretations are to be excluded from our tests.

1.2. Data to be covered

In this section some data will be introduced which will show the several possible aspectual interactions between the verb and Nps. Consider the following sentences:

(3) a. John ran.

b. John ran a mile.

c. John drank beer.

d. John drank a pint of beer.

Whereas (3a) is atelic, sentence (3b) is telic. That is, an otherwise atelic sentence changes its aspectual properties when an NP is added. By examining examples (3c) and (3d) we can also see that different Nps may force a different final aspectual property to the sentence. Thus, (3c) is atelic, but (3d) is telic.

There are other cases, however, where the NP does not affect the final aspect. Consider the following sentences:

(4) a. John pushed a cart.

b. John drove a car.

None of the object Nps of the sentences in (4) affect the final aspect, as opposed to (3). That is, in some cases the NP plays a role in determining the final aspect, whereas in other cases the NP does not affect the aspectual properties at all. One may conclude that it is the verb which allows wheter the NP affects the aspectual properties. Thus, in (3a) the verb 'run' would allow this interaction, whereas in (4) the verbs 'push' and 'drive' would not allow such an interaction.

However, it is easy to find counter-examples. Consider the following sentences:

(5) a. John drove two cars.

b. John drove cars.

Sentence (5a) is telic (one cannot drive two cars for hours unless one drives one car, then the other, then again the first car and so on, giving an iterative reading), whereas sentence (5b) is atelic. Thus, sometimes the Nps are allowed to affect the aspectual properties of sentences whose verb in theory does not allow for this interaction.

There are data which suggest that even the same sentence has different aspectual properties, depending on our interpretation of the sentence, as the following examples show:

(6) a. John noticed errors (Coll. reading)

b. John noticed errors (Distr. reading)

In a collective reading, the noticing event happens in a sudden, implying telicity. However, in a distributive reading, every time an error is noticed a new event is introduced. The whole set of events will define an atelic reading, since how many errors are noticed remains unspecified.

After examining all this data one may argue that it is actually our interpretation of the sentence what allows for the NP to modify the sentence aspect. This will be what I want to formalise in this paper, by means of a lattice theory and the use of thematic relations.

2. Structuring the world into lattices

Lattice structures will be used in our formal definition of our interpretation of the world. I do not want to go into detail here.[1] Instead, I will introduce a very intuitive and somewhat simplistic definition. A lattice is a mathematical structure in which one can model individual and plural objects in the same domain. Thus, if *a* and *b* are individual objects, the plural object which is the result of

[1]The reader interested may look at Partee *et al.* (1990), Landman (1991) or Link (1983).

considering *a* and *b* together will be *a*∪*b*, that is, the *join* of *a* and *b*. Apart from the join operation it is convenient to define also a *part-of* relation ⊆, so that it is always true that an element is a part of the join of the element with anything else, that is, *a*⊆*a*∪b. By means of this *part of* relation one can establish a partial order in the set of entities and their joins. This partial order is usually graphically represented as in *Figure 1*, where the lines show the ⊆ relation.

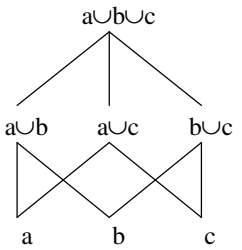

Figure 1: A representation of a lattice structure. The lines represent the ⊆ relation.

The objects and the events will be structured into two parallel lattices. These lattices will not model the real world, but our linguistic interpretation of the world. The same object in the real world can have several different referents in the lattice structures. For example, a collective interpretation of a deck of cards will be an atomic entity, whereas a distributive interpretation of the same deck of cards will be represented as the join of all the cards, as it can be seen in *Figure 2*.

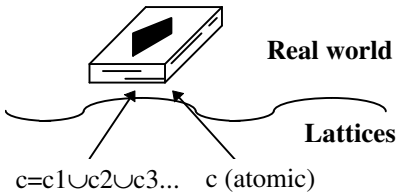

Figure 2: Different elements in the lattice structure may refer to the same object in the real world.

3. Predicates

The elements of the lattices described above can be categorised by means of **predicates.** Following the classical extensional definition of a predicate (Gamut 1991), a predicate P will define the set made of the elements *x* which make *P*(*x*) true. A predicate will represent our interpretation of what we want to describe of the real-world object. *Figure 3* shows a more ellaborated picture of our interpretation of the world where pedicates are introduced. In that figure we can see that we may describe the same object as either being a deck of cards or as being merely cards. In each case, even when the same real-world object is involved, we may use different objects in our lattices. Thus, we

may say *cards*(*c*) or *a.deck.of.cards*(*d*). In the second case we will generally interpret *d* as being an atomic object, althought we know that it contains cards. However, when we say *cards*(*c*) the object over which we predicate can be interpreted in either a distributive or a collective way. Again, in a distributive interpretation *c* would be the join of other objects, the cards, whereas in a collective interpretation *c* would be an atomic object, very much in the same case as with *d* in *a.deck.of.cards*(*d*).

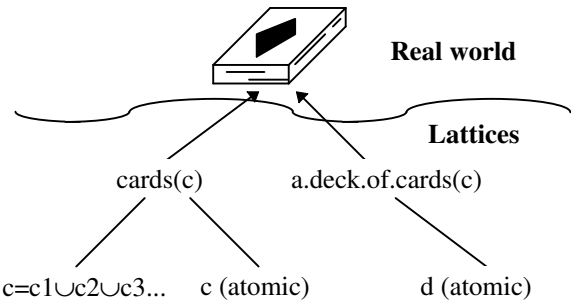

Figure 3: Depending on our interpretation of the predicate, the object predicated over may be atomic or structured.

The idea that the same predicate may be interpreted in one or other fashion will be very important in this paper. In the next sections it will be shown how these different interpretations -either a distributive or a collective interpretation- will play a vital role in determining the aspectual interactions between the verb and the Nps.

3.1. Predicate properties

In order to provide a formal explanation of the aspectual interactions it is necessary to establish first a formal definition of the aspectual properties we want to examine. I will proceed to do so in this section, where the aspectual properties will be described as formal properties assigned to the predicates, following Krifka (1989b).

Krifka used the property of **quantisation** or QUA to describe telicity. In order to understand QUA, consider the predicate *a.card*. It is easy ot see that for any card no proper part of it can be a card in itself (it would be a portion of a card, but not a card). The same can be said of *a.pint.of.beer:* For every pint of beer we could imagine, no proper part of it is again a pint of beer but it is less than a pint. This can be formulated as follows:

(7) $\forall P [QUA(P) \leftrightarrow \forall x,y [P(x) \wedge P(y) \rightarrow \neg(y \subset x)]]$

Note that the same property can also apply to predicates over events. Thus, if someone runs a mile, no proper part of the event will be a run over a mile but over less than a mile. Thus, QUA(*run.a.mile*).

A quantised predicate over events will also be telic. This has already been noted by Krifka, and the intuitive explanation for this is that, since a quantised predicate has very well defined boundaries, its end itself is well defined. Thus, after reaching the endpoint the event is over.

Krifka also attempted to describe atelicity by means of another predicate property, **cumulativity** or CUM. A predicate such as *cards* is cumulativity because given two objects *x* and *y* which are described as being cards, their join will also be cards. This can be formulated as:

(8) $\forall P [CUM(P) \leftrightarrow \forall x,y [P(x) \wedge P(y) \rightarrow P(x \cup y)]]$

Krifka argued that any cumulative predicate over events which is not singular (*ie* whose set of objects falling under the predicate contains more that one element) is atelic. However, this is not the case. Consider the predicate *run.* If John is running in Edinburgh and Mary is running in Manchester, the join of the runs will not be a run but a *plural* run. As I will show later, a predicate over individual events is different from a predicate over plural events.[2] Another argument against the use of CUM to describe atelicity is that there are atelic predicates like *push.a.cart* which cannot be cumulative because of the possibly narrow scope of the cart involved. For example, if a donkey pushes a cart in Edinburgh and a horse pushes a cart in Manchester, two carts may be involved and therefore *push.a.cart* cannot generally apply to the join of both pushing events. I qualify 'generally' because sometimes the pushing can be of only one cart. After all, the same cart may be pushed in both events. We could also consider the join of pushings as being a pushing event if we can establish a non-linguistic connection between the events in such a way that both pushing events can be considered as being only one. A typical example of such a non-linguistic link is the one which we can establish between the event described in 'John pushed a cart from 3 to 4' and 'John pushed a cart between 4 to 5'. If John actually does not stop between the two pushings we would interpret them as being part of a bigger pushing event. However, although these interpretations may apply in some cases, they will *not always* do. Therefore, CUM cannot be used to describe atelicity.

In order to describe atelicity we must resort to another property over event predicates in which the join operator $\cup$ does not appear. In this paper, the strict *part-of* relation $\subset$ will be used in our definition of **homogeneity** or HOM.[3] A predicate such as *beer* is homogeneous because for every object over which we can say that it is beer we can say the same thing for every possible part of it: every single part of beer is beer. This can be formulated as follows:

(9) $\forall P [HOM(P) \leftrightarrow \forall x,y [P(x) \wedge y \subset x \rightarrow P(y)]]$

The same can be said of atelic predicates: if someone is running, then every part of the running event will be running as well... will it? There have been some arguments against homogeneity, the most important being the *minimal parts problem* (Taylor 1977; Bunt 1979). It can be argued that it is

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[2] This has been noted, among others, by Link (1983) (see also Landman (1989, 1991)), where a plural operator * is defined, in such a way that if *P* predicates over objects, then **P* predicates over the join closure of the objects predicated by *P*. As an example, if $\|P\|=\{x,y,z\}$ then $\|*P\|=\{x,y,z,x\cup y,x\cup z,y\cup z,x\cup y\cup z\}$.

[3] The strict *part-of* relation $\subset$ differs from the *part-of* relation $\subseteq$ in that an object is never a strict part of itself. A common definition of $\subset$ is: $a \subset b \Leftrightarrow a \subseteq b \wedge \neg(a=b)$.

not true that a predicate such as *fruit.cake* is homogeneous, since there are small parts of a fruit cake which are not fruit cake. If we consider a very small part of a fruit cake it may contain only fruit, or it might even be a part of a bubble, which it is nothing but air! However, one must consider what we are trying to model. Whereas it is true that real-world objects are not homogeneous, linguistically some of them may be homogeneous (Bunt 1979). We are modelling *not the real world but our linguistic interpretation of the world*. When someone says 'fruit cake' (s)he will not be thinking on the minimal parts of the fruit cake indeed. Linguistically, 'fruit cake' is homogeneous. Therefore, the predicate *fruit.cake* will be homogeneous. And the same argument can apply to event predicates: *run* is also homogeneous.

We can therefore use QUA to describe telicity and HOM to describe atelicity. Actually, atelicity is the result of different kinds of interactions (Verkuyl (1993) described atelicity as a 'garbage can'), and sometimes an atelic predicate will be described in terms of CUM, as it will be shown later.

4. Thematic relations

So far, there is a lattice for describing events and another lattice for describing objects. Telicity/atelicity is considered as being a property of the predicates over events. However, as I have shown at the beginning of this paper, the Nps determine the aspectual properties of the predicate containing the NP. Thus, there must be a connection between these two lattices. This connection can be explained by means of **thematic relations,** as Krifka did in (Krifka 1989a, 1989b).

A thematic relation will be a *homomorphism* from the domain of events to that of objects, and it will be represented as a two-term predicate. Thus, a complex predicate such as *drive.a.car* will be represented as:

(10) $drive.a.car \leftrightarrow \lambda d\, \exists c\, [a.car(c) \wedge driving(d) \wedge role(d,c)]$

In such an expression an object *c* is described, an event *d* is also described, and finally a thematic relation *role* is introduced, linking *d* and *c*.

These thematic relations can be classified in the usual way as *agent, patient* and so on (Fillmore 1968). However, for our purpose in this paper such a classification is not necessary. Since we are interested in the aspectual properties of sentences, and more concretelly in telicity/atelicity, we only need to consider the formal properties of these thematic relations which are necessary to explain telicity/atelicity. In this paper such properties will be briefly analysed. As a result, a three-way classification of the thematic relations can be established: the gradual, the distributive and the collective ones.

4.1. Graduality

The property of graduality has already been studied by Krifka (1989a, 1989b), and in one or other fashion by other schollars when they studied the verbs of motion (White 1993) or expressions defining a path (Verkuyl 1989, 1993; Naumann 1995). According to Krifka, the object and the event are related in such a way that for every possible subevent there is a portion of the object which is involved in the event. As an example, for every subevent of a beer drinking event there is a portion of the beer which is drunk. Also, for every portion of the beer involved in the drinking event there is a subevent in which the beer is drunk. This can be shown in *Figure 4*.

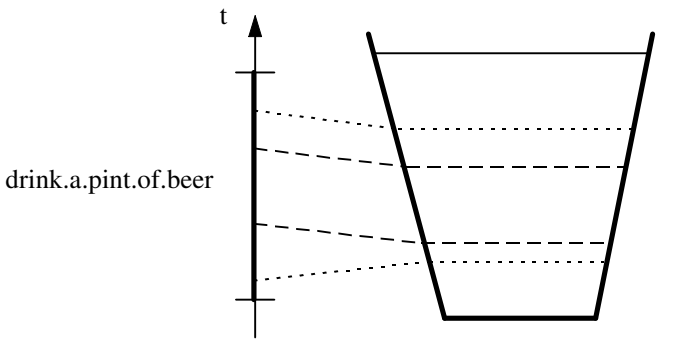

Figure 4: A gradual interpretation of *drink.a.pint.of.beer.*

These two properties are called *mapping to objects* and *mapping to events,* respectively, and they are formulated as follows.[4]

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

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

Apart from mapping to objects and mapping to events a further property is necessary to specify that an event stands in relation with only one object in the same thematic relation. Following our example, a beer drinking event can only apply to the beer which is drunk. This is true even when the object is not created nor destroyed. For example, a book can be read several times, but it is not the case that one reading event applies simultaneously to two different books if we want to maintain the gradual reading. This property is called *uniqueness of objects,* and it can be formulated as:

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

With the help of all these properties we can define the property of graduality as follows:

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[4] These properties differ from Krifka's MAP-O and MAP-E only in that in the definitions presented in this paper the strict *part-of* relation $\subset$ is used. Krifka used instead the general *part-of* relation $\subseteq$. The reason why I use $\subset$ is that the formal proofs are easier to carry. These formal proofs will not be included in this paper, however.

(14) $\forall$ R [GRAD(R) $\leftrightarrow$ UNI-O(R) $\wedge$ MAP-O_R(R) $\wedge$ MAP-O_R(R)]

When graduality applies, the object structure and the event structure are actually the same. The thematic relation is therefore more than a homomorphism: it is an *isomorphism,* preserving the lattice structure.

4.2. Collectivity

The name of **collectivity** to design a thematic relation is inspired from the use of collective readings of plurals (Landman 1989). A collective reading of a plural object will consider this object as having no structure. For example, in the sentence 'three people lifted a piano' the three people form a group, and it is the group which lifts the piano. The fact that the group consists of three people is irrelevant.

We can use the same concept of collectivity even when only one object is involved. Thus, in contrast with a gradual reading where the object is structured in the same way as the event, in a collective reading the object structure is irrelevant, since for every possible subevent of the main event the whole object will be involved in the event. For example, in the predicate *drive.a.car,* every subevent of the driving event will be over the whole car, as it is expressed in *Figure 5*.

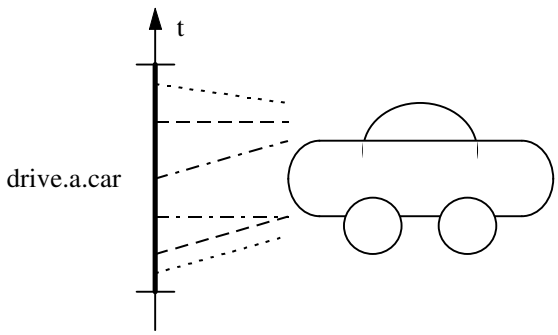

Figure 5: A collective interpretation of *drive.a.car.*

Collectivity can be formulated as:

(15) $\forall$ R [COLL(R) $\leftrightarrow$ $\forall$e,e',x [R(e,x) $\wedge$ e'$\subset$e $\rightarrow$ R(e',x)]]

4.3. Distributivity

Finally, a **distributive** thematic relation will be based in a normal distributive interpretation (Scha 1984): a distributive interpretation of 'three people lifted a piano' will involve three different lifting events, each one of the events having assigned a piano to it. The same can be seen of a predicate such as *drive.three.cars,* whose interpretation can be graphically expressed as shown in *Figure 6*.

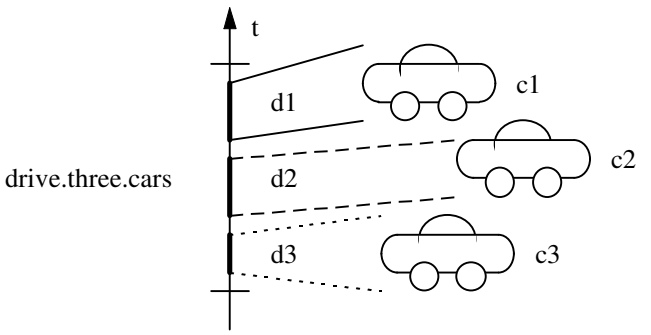

Figure 6: A distributive interpretation of *drive.three.cars.*

A distributive reading is very similar to a gradual reading. The only difference is that in this case a *plural* event is described. That is, in a gradual reading of *drink.a.pint.of.beer* there is only one event and one object, whereas in a distributive reading of *drive.three.cars* there are three independent driving events and three independent cars.

Since plural events are involved it makes sense to work with the concept of cumulativity, since the join of a plural driving event with another plural driving event gives again a plural driving event. Associated to cumulativity is the property of *summativity*, which will apply to a distributive relation:

(16) $\forall R [SUM(R) \leftrightarrow \forall e,e',x,x' [R(e,x) \wedge R(e',x') \rightarrow R(e \cup e', x \cup x')]]$

The property of summativity has already been described by Krifka (1989b), where he claimed that every (patient) thematic relation is summative. However, since the definition of summativity includes the join of events, it is not convenient to use it in the cases where no plural events are involved. Therefore, only a distributive thematic relation will be summative:

(17) $\forall R [DISTR(R) \leftrightarrow GRAD(R) \wedge SUM(R)]$

With respect to distributivity it is also worthly to mention that sometimes the independent objects which are related to the events are not individual objects but groups, giving the **mixed distributive readings.** An example of a mixed distributive reading is that of the sentence '2000 people gathered in Manchester,' where we may think of several different gatherings happening in Manchester, each one of them involving a group of people. Under such an interpretation there would not be 2000 gatherings but less.

4.4. Comparing the properties

So far, three different thematic properties have been described, depending on our interpretation of the sentence itself. Since one sentence may have several different interpretations, the predicate representing the sentence may have different properties, depending upon the actual interpretation. In example (6) he have seen that 'John noticed errors' may have either a distributive or a collective reading. In fact, a sentence may even have all the three possible readings, depending on context. Consider the example:

(18) John ate 5 apples.

In a distributive reading there will be five different eating events and five independent apples, and for every event an apple will be assigned to it. In a collective reading, however, there will be only one eating event and one collective object (a group of apples), which is the object of the event. Finally, in a gradual reading there will be one object and one event, but in this case the object and the event will be structured in subevents of eating and subobjects of apple, respectively.

5. Aspectual interaction

All the formalisations introduced above suffice to explain the aspectual interactions between the verb and the Nps. First of all, the verbs will have assigned some aspectual properties in terms of QUA, CUM or HOM, and the Nps will have assigned some structural properties which actually may be the same as for verbs: QUA, CUM or HOM. The thematic relations will establish a link between the domain of events and that of objects. Depending on the possible aspectual properties these thematic relations may have (DISTR, COLL or GRAD), the final complex predicate will result as having one or other property. This aspectual property transference can be formally deduced by following the standard mechanisms of natural deduction. However, due to lack of space the formal proofs will not be included here. Here, the general results will be presented.

In a **gradual** reading almost all of the NP's aspectual properties will be transferred to the complex predicate.[5] The interactions occurring in the sentences of example (3) are analysed in *Table 1*.

verb	**property**	**NP**	**property**	**VP**	**property**
run	HOM	a mile	QUA	run a mile	QUA
drink	HOM	beer	HOM,CUM	drink beer	HOM
drink	HOM	a pint of beer	QUA	drink a pint of beer	QUA

Table 1: The aspectual interactions in a gradual reading.

In a **distributive** reading all the NP's aspectual properties will be transferred to the complex predicate. *Table 2* shows the interactions occurring in the sentences of example (5).

verb	**property**	**NP**	**property**	**VP**	**property**
drive	CUM[6]	two cars	QUA	drive two cars	QUA
drive	CUM	cars	CUM	drive cars	CUM

Table 2: The aspectual interactions in a distributive reading.

[5]The only property which is not transferred is that of CUMulativity, which cannot transferred because GRAD does not have SUM.

Finally, in a **collective** example it is the verb's aspectual properties which are transferred to the complex predicate,[7] as the interactions of *Table 3* show, taken from the sentences of example (4).

verb	**property**	**NP**	**property**	**VP**	**property**
push	HOM	a cart	QUA	push a cart	HOM
drive	HOM	a car	QUA	drive a car	HOM

Table 3: The aspectual interactions in a collective reading.

6. Final remarks

In this section some final comments will be briefly pointed out. First of all, the aspectual classification here introduced is one of *predicates* and not of situations nor sentences. Thus, two different predicates with different aspectual properties may refer to the same situation. For example, both the atelic predicate *eat* and the telic predicate *eat an apple* may refer to the same event *e*.

Another important remark is the distinction between a singular and a plural event which is clearly established here. This distinction can be noticed in the distinction between a gradual (singular structured object and event) and a distributive (plural object and event) reading.

Special stress has been made on that this analysis is not of the real world but of our linguistic interpretation of the world. Thus, a mass noun like *fruit cake* is homogeneous even when in the real world it is true that it contains parts which are not fruit cake.

Finally, note that all this analysis has been focused on the aspectual properties, concretelly on the telicity/atelicity distinction. According to that analysis only three different types of thematic relations are needed. But this does not mean that the classical distinction between agent, patient ... is obsolete. This classification might still be needed if we want to account for more general semantic properties.

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[6]Note that in a dirstributive reading, *drive* will be a predicate over plural events. Thus, *drive* will be CUM: the joining of a plural driving event with another plural driving event gives a plural driving event.

[7]Again, not all the properties are transferred: CUM cannot be transferred, since COLL does not have SUM. But since HOM can be transferred, if the verb is atelic the final verb phrase will be atelic, and thus, the telicity/atelicity feature is transferred indeed.

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