Aspectual Composition and Sentence Interpretation: A formal approach

Diego Mollá-Aliod

A thesis submitted in fulfilment of the requirements
for the degree of Doctor of Philosophy
to the
University of Edinburgh
1997

Abstract

This thesis is principally concerned with aspectual composition. Although there have been some recent studies on this topic, none has succeeded in explaining all the different aspectual interactions existing between a verb and its arguments. This thesis explores the interpretation of sentences containing transitive or intransitive verbs and their arguments. It is found that sentence interpretation (in terms of distributive and collective readings) together with a speaker's linguistic knowledge of the world plays a decisive role in determining the aspectual interaction between a verb and its arguments.

An important part in this thesis is the study of predicate properties. The parallelism between the domain of objects and that of events is stressed by defining a set of properties which may apply to predicates over both domains, namely quantisation and homogeneity. The analysis is formalised by means of lattices which represent our linguistic knowledge of the structure of the world. Objects and events are categorised by means of predicates, according to the standard (extensional) definition of a predicate in Predicate Logic. Quantisation and homogeneity are defined as properties of first-order predicates, allowing the use of classical deduction procedures to prove the different aspectual interactions.

These aspectual interactions are possible thanks to the link which exists between objects and events, which always appears in the semantics of a sentence. These links are interpreted as thematic roles, although in this thesis we take a look not at the thematic roles in themselves but at those properties which license one or another aspectual interaction. The properties of the thematic roles which are studied here and which are therefore relevant for the several types of aspectual interactions are very closely related to the readings of the sentence in the sense of distributivity and collectivity. There are three types of properties: those involved in a distributive reading; those involved in a collective reading; and those involved in a gradual reading (which here is treated as a special reading which shares properties from both the distributive and the collective

readings). Again, as is the case with predicate properties, the link properties are formally defined by means of expressions in first-order predicate logic, and the possible aspectual interactions are demonstrated by applying classical deduction procedures.

Declaration

This thesis has been composed by myself and it has not been submitted in any previous application for a degree. The work reported within was executed by myself, unless otherwise stated.

May 1997

Acknowledgements

There is an endless list of people without which this thesis would not have been accomplished. First of all, I would like to thank the Caja de Ahorros del Mediterráneo (CAM) and British Council, the former for providing the necessary funds for attending the MSc in Speech and Language Processing at the University of Edinburgh, the latter for providing the so necessary help in my first months in Edinburgh. I also wish to express my thanks to Stephen Isard, who first suggested me the possibility of studying the semantics of time, and the Faculty of Arts for providing the necessary funds (by means of a Vans-Dunlop scholarship) for the PhD.

A special thanks to all of the members of the Tense and Aspect Group (which for some not-yet-discovered-for-me reason has the acronym TASTELESS), which provided an ideal environment where I could acquire background and test some of my hypothesis. Some of the attendants which were specially helpful are Sheila Glasbey, Martin Mellor, Frank Schilder, Krasimir Kabaciev, and Martha Robinson.

I would like to thank most to my first supervisor, Ronnie Cann, who suggested to me something completely different to this but from which I gradually drifted away until I finally landed onto the land of aspectual composition. But still, he provided to me all the support necessary to make this thesis a reality.

Some of the issues discussed in this thesis are the direct or indirect result of dialogues by e-mail from Manfred Krifka, Henz Verkuyl and Ralf Naumann, to who I thank for their help and for which I devote a full chapter of the thesis.

As I have said already, this thesis has been possible thanks to an endless group of people apart from the ones that I have named here. Still, all the errors or misconceptions which may appear here are only mine; I don't need to thank to anybody for them.

Contents

List of Tables

List of Figures

Chapter 1

Aspectual Composition: Introduction

1.1 The world and language

There is a difference between what there is in the real world and what one sees of it. We humans, as any other living creature, have access to the world only through our senses. It is our senses which provide us with the information from the real world so that we can interact with the objects and events around us. The information we receive is far from complete: we cannot perceive every property an object has. For example, a very limited portion of the spectrum is perceived by us. We cannot sense radioactivity, and there are properties that other animals can sense but we cannot. In Bickerton's words:

> . . . what is presented to any species, not excluding our own, by its senses is not 'reality' but a species-specific view of reality — not 'what is out there', but what it is useful for the species to know about what is out there. (Bickerton 1990:82)

There is also a difference between what we see of the world and what we understand of the world. Even the limited information we receive through our senses is enough to overload any processing mechanism. Anyone who has tried to process a digital image is well aware of the huge amount of information which is superfluous, and from which we are to extract the relevant information (For a review of algorithms for processing visual information see, for example, Davies 1990; for a review of problems related to visual perception see, for example, Bruce & Green 1990). We human beings do not focus on all the information we receive. Rather, we select a tiny fraction of this information. As Chafe says,

> But selectivity is apparently present even with regard to the material constantly bombarding our senses from the outside world, which enters our consciousness in a partial, filtered way. One way to think of consciousness is as a narrow spotlight that can at one time be directed at only a small area of the available scene –but a spotlight that wanders constantly, sometimes with purpose and sometimes not.
>
> (Chafe 1974:111)

From this selected information we build an internal representation of the outside world (we "dream the world", according to Ornstein 1991), and act according to this representation.

Still, all the information available by means of our representation system must be arranged so that we can easily retrieve what is relevant. A powerful mechanism we use for classifying and sorting out this information is abstraction. Whenever possible we try to group properties and label them, giving as a result a complex hierarchy of the information we possess. Consider Wittgenstein's comments on the way we refer to a broom:

> Then does someone who says that the broom is in the corner really mean: the broomstick is there, and so is the brush, and the broomstick is fixed in the brush? — If we were to ask anyone if he meant this he would probably say that he had not thought specially of the broomstick or specially of the brush at all.
>
> (Wittgenstein 1958:I:60)

In other words, even when we know that a broom is composed of a broomstick and a brush, if we say that the broom is in the corner we do not think on the structure of the broom itself. If we were not able to organise our world knowledge in this hierarchical way we would have our mind flooded with unstructured information impossible to retrieve. The process of abstracting also applies to the abstracted forms themselves, so that at the end we wave a highly organised representation of the world. When analysing an object we first consider the most general properties of it, then we look at the general details, and we continue with this process until we are satisfied with the detail achieved. One looks at an object similarly to how one sees a person coming from a distance. First, we see that it is a person. As it approaches, we can decide as whether it is an adult or a child. Later we have enough information to decide the sex, and when the person is relatively near we can have a look at the face.

There is finally a difference between what we understand of the world and what we want to say about it. First of all, because of the nature of language (we can utter only one word at a time) we need to organise the way we want to convey the information so that the relevant bits of information are uttered with the correct timing. We do it by devising a strategy of focusing and providing the hearer some clues on what concept is in focus at every moment (Sidner 1979; Grosz 1981). Apart from that we must say one thing at a time, we do not always want to say *everything* of our interpretation of the world. Wittgenstein (1958:IIxi) already suggested that we can give different interpretations to the same object in the real world, and several scholars have also noticed the fact that we can use different expressions to denote the same action. To give an example from Moens (1987:59) (see also Smith 1991 for similar examples), the following sentences may describe the same event:

(1.1) a. 'I wrote two letters last night'
b. 'I wrote letters last night'
c. 'I was writing letters in my office'
d. 'I have written two letters'

All the sentences above describe different properties of the same event: only (c) says where the event took place, but it does not say when; only (a) and (d) specify how many letters were written, whereas (b) and (c) leave it unspecified. In (d) one assigns a certain importance to the fact that these two letters have been written, something that is missing in the other sentences, and so forth.

Another reason why we do not say everything we know of the situation is, simply, that it is not necessary. If the speaker assumes the listener shares certain common knowledge, the speaker may take some things for granted (Chafe 1974; Grosz 1981; Clark & Marshall 1981) and thus omit them. We only convey the information which is most relevant, where relevance can be defined as follows:[1]

> a. Other things being equal, the greater the cognitive effect achieved by the processing of a given piece of information, the greater its relevance for the individual who processes it.
> b. Other things being equal, the greater the effort involved in the processing of a given piece of information, the smaller its relevance for the individual who processes it. (Wilson & Sperber 1988:140)

And finally, another reason why we do not say everything is that we *cannot* do it. Language is a very powerful means of representation indeed, but it does not mean that

---

[1] Wilson & Sperber's definition of relevance is used in the context of the Relevance Theory (Sperber & Wilson 1995), which intends to provide an account of why humans communicate in the way we do by means of what they call 'ostensive communication.' This area falls outside the scope of this thesis. Still, Wilson & Sperber's (1988) definition of relevance is enough for my purposes; it is definitely more specific than Grice's (1975) principle 'be relevant'.

it can represent everything. Even if it did, the resulting sentences would be so long and complex that they would actually be unintelligible.

The purpose in this thesis is not to attempt to model the real world (only God knows what it is like), not even our interpretation of the world, but the linguistic interpretation of the world. Inside our linguistic interpretation, here we only focus on the representation of the event and object structure and how they interact, all this in the area of aspectual composition.

1.2 Aspect

What is aspect? The very definition of aspect has been a source of controversy, and different researchers have worked with different assumptions about what ‘aspect’ is (see a fine review in Comrie 1976 and Binnick 1991). One of the reasons for this controversy is the appearance in the literature of two words whose differences in meaning have been perceived by some researchers in different ways: ‘aspect’ and ‘Aktionsart.’ The main cause of this is that these words were used for describing aspectual phenomena in Slavonic languages, and when they were transferred into other languages these new languages did not show phenomena which could be clearly differentiated by means of these words. In Slavonic languages, several verbs can express different ways of performing the same action by adding some prefixes and suffixes to the same root. An example is Russian, where *čitat′* and *pročitat′* are the imperfective and perfective form, respectively, of ‘read’ (Comrie 1976:88). When two verbs have the same root and they differ only in their interpretation of the action because of their affixes, some scholars classified them as belonging to different Aktionsarten (Comrie 1976:6n). Aspect related to similar changes of meaning, the difference being that these changes were performed by grammaticalised syntactic means.

Some scholars extrapolated these words into languages other than Slavonic, leading to confusion. In many cases, the definitions were accommodated: Aktionsarten are *semantic classes of verbs*, inherent to the verbs themselves and thus attached to the lexical meaning of them; aspect is the grammaticalisation of rules for discerning among these semantic classes (see, for example, Alarcos Llorach 1970:77 and Rojo 1974:129 for the distinction applied to Spanish). Other scholars defined Aktionsarten in a broader sense: Aktionsarten are *different ways of mentally representing the action*. A verb will have an inherent Aktionsart which can be later consolidated or modified by different ways. Aspect would be the grammaticalisation of these changes of meanings (Real Academia Española 1973; Fenwick 1980). Comrie, aware that the terminology problem is a tricky one, explains in the introduction of one of his books:

> In the present book we shall speak of semantic aspectual distinctions, such as that between perfective and imperfective meaning, irrespective of whether they are grammaticalised or lexicalised in individual languages. However the noun 'aspect' will normally, and in the plural 'aspects' always, be restricted to referring to particular grammatical categories in individual languages that correspond in content to the semantic aspectual distinctions drawn. (Comrie 1976:6-7)

In the present thesis, I will use the term 'aspect of a verb / VP / sentence' to refer to what it has commonly been named the 'Aktionsart', which is also Smith's (1991) 'situation aspect' or Comrie's (1976) 'inherent or semantic aspect', among other terms. The aspect of a verb[2] or, more accurately, the verb's aspectual properties, is the set of properties which the verb (helped by other components of the sentence) assigns to the structure of the event described. How to characterise these properties is something that we will decide soon, but now an example will illustrate what I mean. If we look at Moens' sentences in (1.1), for example, and we focus only on their event structure, we can say, as Moens does, that 'I wrote two letters last night' refers to a process which took some time to happen but which has a clear point or culmination, a *culminated process;* that 'I wrote letters last night' refers to a process where we do not clearly specify its end (though we may conclude, by world knowledge, that it is over): a *process;* and that both 'I was writing letters in my office' and 'I have written two letters' describe *states* (though the former is a progressive state and the latter a consequential state, in Moens' words).

1.2.1 Aspectual classifications

One could try to define a sentence classification attending to its aspectual properties, and indeed there have been many attempts to do it, of which some will be briefly introduced here. This is only a very short introduction in which several types of classifications are presented, and I recommend the interested reader to consult the sources. Alternatively, Verkuyl (1989, 1993) offers a fine review. But before trying to define this classification one must decide what it is that we want to classify. It is not sensible to try to establish a classification of the events themselves. As I have shown above, an example of letter-writing event can be described in different ways. If we were to classify events according to their aspectual properties, we would arrive at

---

[2] Here we are referring only to verbs but, as we will see shortly, we can also assign aspect to a verb phrase or a sentence.

	Static verbs	Performance verbs	Activity verbs
Tests	“A is θing” not used	A is θing if A has been θing	A is θing only if A has been θing
	“A θs” not frequentative	“A θs” frequentative	“A θs frequentative
	A θs if A has θd	A θs only if A has θd; A has θd not only if A θs	A θs only if A has θd; A has θd not only if A θs
		A is θing only if A has not θd	A is θing only if A has θd
		A was θing not only if A θd; A θd only if A was θing	A was θing if and only if A θd
Examples	*understand, know how, love, mean, fear, exist, be able, be blue, perceive, be taller than*	*discover, learn, find, kill, convince, grow up, think out, build a house, wash, cut, lift, decide whether*	*listen to, keep a secret, weep, laugh, talk, enjoy, live at Rome, stroke, ponder on*

Table 1.1. Summary of Kenny’s aspectual classification, including tests and examples as they appear on page 175.

the odd conclusion that the same event could be a process or a culminated process, depending on how we describe it.

Instead of classifying events, therefore, an aspectual classification of *verbs* is more appropriate. Early aspectual classifications were already of verbs, or more exactly, of verb predicates. Kenny, for example, defined a three-way classification between static, performance, and activity verbs (Kenny 1963b). A summary containing some examples and linguistic tests is included in Table 1.1. Kenny’s classification was based on a distinction which was already noticed by Aristotle which, according to Kenny, distinguished between *energeiai* (states) and *kinesei* (activities and performances). Apart from this general classification, Aristotle also mentioned other properties in the verbs which oblige us to distinguish between *ekhein* and *energein*, which would correspond with Kenny’s distinction between states and activities. There is even a further distinction between *poesis* and *praxis*, which would correspond with Kenny’s distinction between performances and activities.

A very well known classification was established by Vendler (1967). Here, verbs are classified into four main types, splitting Kenny’s performances into two classes,

States	*Activities*	*Accomplishments*	*Achievements*
know	run	paint a picture	recognize
believe	walk	make a chair	spot
have	swim	deliver a sermon	find
desire	push a cart	draw a circle	lose
love	drive a car	push a cart	reach
		recover from illness	die

Table 1.2. Examples of Vendler's aspectual classification.

	Criterion	STA	ACT	ACC	ACH
1.	Meets non-stative tests (i.e., (a) θing is grammatical, and (b) Chris persuaded Bill to θ is grammatical)	no	yes	yes	?
2.	Has habitual interpretation in simple present tense	no	yes	yes	yes
3.	θ for an hour, spend an hour θing	OK	OK	OK	bad
4.	θ in an hour, take an hour to θ	bad	bad	OK	OK
5.	θ for an hour entails θ at all times in the hour	yes	yes	no	d.n.a.
6.	x is θing entails x has θed	d.n.a.	yes	no	d.n.a.
7.	complement of *stop*	OK	OK	OK	bad
8.	complement of *finish*	bad	bad	OK	bad
9.	ambiguity with *almost*	no	no	yes	no
10.	x θed in an hour entails x was θing during that hour	d.n.a.	d.n.a.	yes	no
11.	occurs with *studiously, attentively, carefully,* etc	bad	OK	OK	bad

Table 1.3. Dowty's tests for the Vendlerian classification. The key to the table is: OK=the sentence is grammatical, semantically normal. Bad=the sentence is ungrammatical, semantically anomalous. D.n.a.=the test does not apply to verbs of this class.

accomplishments and *achievements,* depending on whether the event is durative or not, respectively. Dowty (1979) adopted the same classification and established a full set of linguistic tests to decide where the verb phrase falls in this classification. The tests and some examples are summarised in Tables 1.2 and 1.3.

In the examples shown in the previous tables we can see that it is whole predicates and not only verbs what are classified. This is so because it is not only the verb which determines the final aspectual class, since other components of the sentence also play a decisive role. How the interaction between the verb and noun phrases of the sentence works is the main subject pursued in this thesis.

In this section we do not need to go deeper into this matter. However, as I will show in Chapter 4, it is better to classify not predicates nor even sentences, but *event descriptions*. Some researchers have already resorted to classifying our interpretation of the real event. Smith (1983) (also Smith 1991) uses the term *idealised situation types* to describe our idealisations of the structure of the event happening in the real world. Smith uses an event ontology very similar to that of Moens & Steedman (1988), in which an event is seen as comprising three sections: a preparatory state, a culmination and a result state. Different event types may have all or only a few of these components, and they will correspond to what we want to say of the world, as I have explained above with our example in (1.1).

Following another formalism, Krifka (1989b) used an aspectual classification of certain Predicate Logic predicates. As we will see in Chapter 3, it may be useful to define the aspectual properties as formal properties over first-order predicates, and work with these formal definitions. The obvious advantage of this approach is that we can resort to all the facilities that Predicate Logic has when it comes to inferring new properties. This approach is the one we will adopt, and it will be further developed in Chapter 4. However, sometimes in this chapter I will define sentences (instead of predicates) as being of one or other aspectual type when this does not lead to confusion.

1.2.2 Three parameters

A possible way of establishing an aspectual classification can be made by defining a set of parameters or features and classifying the data according to whether they have or not the specified parameters. Several different parameters can be defined for aspect. Three of the most widely used ones will be introduced here: stativity, telicity and duration (Comrie 1976, Smith 1991, and Bennett *et al.* 1990, among others).

Stativity The most clearcut distinction is that of stativity. Verbs like ‘love’, ‘admire’, ‘have’, ‘be’ will be associated to states, as opposed to verbs like ‘run’, ‘swim’, ‘sing’, ‘think’, which will be associated to dynamic situations. In order to set the distinction between states and dynamic situations, Comrie (1976) provides an intuitive test. As he says,

> To remain in a state requires no effort, whereas to remain in a dynamic situation does require effort. (Comrie 1976:49)

Thus, any activity like ‘run a mile’, ‘build a house’, ‘think about a problem’ where some effort is needed will describe a dynamic situation. Note that it may be the case that this effort is not performed by the agent in the sentence. The sentence 'John hit the lamp and it fell down', for example, describes two dynamic situations, where the second one (the lamp falling down) is the result of the effort made by the force of gravity.

Comrie's definition of the distinction between states and dynamic situations is rather vague. One needs to resort to our understanding of the world in order to be able to decide whether a specific sentence describes stativity or not. Yet this is the only reliable test. If we take a look at the tests provided by Kenny or Vendler, we can discover that quite often these tests are not as clear-cut as desired. To cite an example, Comrie (1976) comments on the possibility for some stative verbs to have a progressive form. Consider the following examples:

(1.2) a. 'I live at 6 Railway Cuttings'
b. 'the Sphinx stands by the Nile'

(1.3) a. 'I'm living at 6 Railway Cuttings'
b. 'Mr. Smith is standing by the Nile'

Since the verbs of the sentences in (1.2) are stative, it is predicted that they cannot occur in the progressive form. However, in the sentences in (1.3) we see the same stative verbs occurring in a progressive form. One can see, however, that although the same verb is used, the progressive form forces a slightly different meaning in them. As Comrie points out on the previous examples:

> In such pairs, the non-Progressive refers to a more or less permanent state of affairs, whereas the Progressive refers to a more temporary state. Thus if I say 'I live at 6 Railway Cuttings', I imply that this is my normal residence, whereas if I say 'I'm living at 6 Railway Cuttings', I imply that this is only a temporary residence (for instance, while my Mayfair flat is being redecorated). Similarly in the examples with 'stand': the Sphinx is a reasonably permanent fixture on the banks of the Nile, while we might expect Mr. Smith to be a temporary feature, standing there for a very limited period of time. (Comrie 1976:37)

Several other linguistic tests have been designed to check the static / dynamic distinction. The most typical test consists of checking the possible alteration of meaning when the present form is used. Only states do not alter their meaning when used in the present tense; the difference of meaning between 'John loves Mary' and 'John loved Mary' is essentially one of tense. However, if we want to establish the same distinction in a dynamic predicate we must resort to the progressive form, as we can see for example in 'John wrote a letter', whose present form is 'John is writing a letter' and not *'John writes a letter'. Again, as it happens with the previous test, one can also use non-stative verbs in their present tense. For example, if one uses a reportive speech (as when commenting a live football match) it is possible to use the present tense to indicate an action which is happening at exactly that moment (Quirk *et al.* 1985:180).

Another concept which distinguishes a dynamic description from a state is that of progression in time. A dynamic description must force some change in some sense, as opposed to a state. This intuition is rather difficult to formalise, since one may find counter-examples like (a modification of) Comrie's example 'the oscylloscope emitted a pure tone at 300 cycles per second', where a situation is described by means of a dynamic description but no apparent change is implied.

Comrie is rather vague in his definition of a situation. As he says,

> In the present work the term 'situation' is used as a general cover-term, i.e. a situation may be either a state, or an event, or a process. (Comrie 1976:13)

The ways in which Comrie uses this term ('situation') however suggest that a situation is an extralinguistical entity which can be described by verbs or sentences. However, an aspectual classification of situations (or events) may lead to problems, as we have seen already: the same situation may be referred to by one or another different expression, and these different expressions may have different aspectual properties. To prevent any confusion, it would be more advisable to use the terms *state* and *dynamic description*, since an aspectual classification should be of descriptions, not of situations or events.

Telicity Another important parameter is that of telicity. This parameter will be thoroughly examined in this thesis, but here it will be introduced only. In a telic description there is a specific point in time beyond which the situation described changes its status. Generally this point or *culmination*, borrowing Moens' terminology, will mark the end of the situation, as we can see in the examples 'John read a book', 'Mary ran a mile', 'Peter entered the house'. In a situation described by an atelic predicate, however, there is no such a relevant point in time. Thus, in 'John swam', John may be performing the action for as long as he wishes.

It must be said that many situations do have a terminal point, but depending on how we describe it, this point is expressed or not. Thus, an event of running over a mile will have a terminal point implied if a telic description such as 'John ran a mile' is used, whereas it will not have any terminal point described if 'John ran' is used instead.

Typical tests to check telicity include the following: 'if X is ϕing implies that X

has ϕed, then ϕ is atelic, otherwise it is telic'. Another test is the 'in / for' distinction (Dowty 1979:56): 'if we can add a *for* adverbial to the sentence then it is atelic. If, on the other hand, we can add a *in* adverbial, then it is telic'. Typical examples are:

(1.4) a. 'John ran for hours'
b. *'John ran in twenty minutes'
c. 'John ran a mile in five minutes'
d. *'John ran a mile for an hour'

Something must be said about these examples. Sentences (1.4b) and (1.4d) are not really ungrammatical. In fact, they are correct if their interpretation is slightly modified: sentence (1.4d) is correct if John ran the mile several times during that hour, for example as a part of an athletic training session where the runner runs a mile several times. That is, the event is iterated. In general, any telic sentence iterates if it is modified with a 'for-'adverbial (when such a modification is possible), as Verkuyl (1989:50) comments. Sentence (1.4b) is also correct if some specific goal is obtained by merely running — for example, if we are talking of a particular race and we want to say that it took twenty minutes for John to run the whole race. Still, in the two examples examined here, some inference or change of meaning is needed.

Durativity The last parameter is that of durativity. Again, this parameter is intuitively very easy to define: it applies to the description of an event which is interpreted as having duration. Again, as is the case with telicity or stativity, the parameter of duration does not apply to events but to descriptions of the events, since the same event can be described as having or not having duration.

Typical tests for durativity consist of using expressions such as 'stop' or 'suddenly'. Some examples are:

(1.5) a. 'Ariadne stopped writing her CV'
b. *'Ariadne stopped winning the scholarship'
c. *'suddenly, Heinrich was asleep'
d. 'suddenly, Heinrich vanished'

Although very easy to define, the feature of durativity is the most difficult to test. In the previous example, sentences (b) and especially (c) are not really ungrammatical. These sentences can be successfully interpreted if the meaning of the verb shifts so that

(b) acquires an iterative meaning which converts winning in an activity which can be stopped, and (c) acquires a boundary, creating an inceptive reading. And we can see that we cannot use ‘stop’ for states, although they are durative: a sentence like ‘John stopped knowing the truth’ is very funny indeed. Also, we can see that the use of ‘suddenly’ is not very consistent either. A sentence like ‘suddenly, Ariadne won the scholarship’ is also very funny.

As we have seen with the tests for the parameters introduced above, there is a difficulty in using clearcut linguistic tests in general, and we need to resort to more vague definitions where the semantics of the sentence is tested. In the present work a strong emphasis on the *semantic interpretation* of sentences (more specifically of their event structure) is given, but we will resort to tests like the ones introduced above when they do not lead to confusion.

Classifications

It is possible to define a five-way classification with the help of the features above introduced. The result would be a table like the following one, which can be deduced from Smith (1991) and Bennett *et al.* (1990):

	State	Activity	Accomplishment	Achievement	Semelfactive
Static	+	⇔	⇔	⇔	⇔
Telic		⇔	+	+	⇔
Durative		+	+	⇔	⇔

In this table, note that the features *telic* and *durative* do not apply to states. The reason for this is that, although all the states are durative (Smith 1991), since a state is clearly differentiated by its +*static* feature, there is no need for more features to describe it.

Egg (1995) stated that the feature of durativity is irrelevant in an aspectual classification, and Verkuyl (1989) arrives at a similar conclusion when he states that the distinction between an accomplishment and an achievement is difficult to maintain. Verkuyl’s argument is based on sentences like ‘John typed a letter’, which is not durative at all if John actually uses a word processing system in which the letter is automatically typed by hitting one single key which triggers a special command. On the other hand, in the same word-processing system the typing of a single character p may take some time due to some “Please Wait” command. As Verkuyl says:

> If things are going that quickly it would mean that both *type a letter p* and *type a (business) letter* are members of one and the same category and that they manifest themselves as either Achievement terms or Accomplishment terms dependent on something which has nothing to do with language itself. (Verkuyl 1989:57)

Under such an approach only three aspectual classes would appear, which will correspond to the Kenny / Verkuyl distinction, summarised in the following table:

Kenny	State	Activity	Performance
Verkuyl	State	Process	Event
Static	+	⇔	⇔
Telic		⇔	+

It is not my purpose in the present thesis to decide for one or another aspectual classification. The tables above have been included here as a reference, and the reader interested in aspectual classes, their definitions and tests, may prefer to consult Dowty (1979); Verkuyl (1989); Smith (1991). In Chapter 4 I intend to provide a model-theoretic definition of telicity and durativity, and it will be shown how these properties are modified as a result of the interaction between verbs and noun phrases.

1.3 Aspectual composition: data

In this section we will consider some data one would like to account for in a serious analysis of aspectual composition. Several researchers have already analysed the aspectual interaction between the verb and the internal argument (for example, two of the earliest works are Verkuyl 1972; Dowty 1979). These analyses, however, are not as exhaustive as desired. Here, a more exhaustive case analysis of the interactions between verb and NPs will be presented, setting the problem which will be fully addressed in this thesis, concretely in Chapter 4.

A semelfactive is a rather problematic aspectual class. It describes a non-durative atelic event, such as ‘blink’ or ‘cough’. This class is a very unstable one, and it tends to iterate and become an activity. For example, when one says ‘John coughed’, usually more than one cough is implied. It is thus difficult to analyse the interaction between a semelfactive and its arguments. The usual tests for achievements or activities (such as the use of ‘for’ and ‘in’ adverbials) may be misleading, since these adverbs themselves may coerce the semelfactive (or any other aspectual class) into a class compatible with the adverbs, as commented by Moens & Steedman (1988). Concretely, although a semelfactive is non-durative and atelic, usually it is compatible with a 'for' adverbial by coercing into an activity, as the following sentences show:

(1.6) a. 'John coughed for a while'
b. 'Peter blinked for one minute'
c. 'Mary knocked on the door for fifteen minutes'

The assumption in this section will be that a semelfactive, when combined with the sentence arguments, will remain a semelfactive. If the final combination actually falls into a different class, it will be because the semelfactive would have shifted into an activity or an accomplishment *before* the interaction itself. Some examples are:

sentence	original verb meaning	coerced verb meaning	sentence aspect
'he beat *six donkeys*'	sem	sem	acc
	sem	acc	acc
'he knocked on *six doors*'	sem	acc	acc

In the first interpretation of the first sentence 'he beat six donkeys', the semelfactive does not coerce, but since the agent beats several donkeys the final event is composed of six events and therefore it is a bounded durative event, that is, an accomplishment. In the second sentence 'he knocked on six doors' and in the second interpretation of the first sentence, for every door the knocking event iterates, generating a bounded durative event, that is, an accomplishment. We need a bounded event because the agent must stop knocking on one door before starting knocking on the next one (this is a similar argumentation as to why 'drive two cars' is bounded, of which we will comment later more extensively). The final event is a bounded set of accomplishments, that is, an accomplishment again.

1.3.1 The data

An NP may affect the aspectual properties of the sentence. Take, for example, the following sentences:

(1.7) a. ‘John read a book’
b. ‘John read books’
c. ‘Mary ate two apples’
d. ‘Peter ran 25 miles’
e. ‘Sue wrote letters’
f. ‘John drank two pints of beer’
g. ‘John drank beer’

Sentence (a) is telic and (b) is atelic, but both of them use the same verb ‘read’. And the same can be said of (f), which is telic, and (g), which is atelic but they both use the same verb ‘drank’. As we see here, there is a resemblance between the behaviour of plurals and masses. Generally, a bare plural and a bare mass noun will induce atelicity to the sentence, as we can see from (b,e,g). When the NP is delimited (by specifying the number of individuals referred to by a plural or the amount of stuff referred to by a mass), the result is telicity, as we can see from (a,c,d,f).

However, in some cases the NP does not affect the sentence aspect. The following sentences are all atelic:

(1.8) a. ‘John watched a car’
b. ‘John watched cars’
c. ‘Mary drove a car’
d. ‘Peter pushed a cart’

In all of these sentences it is reasonable to think that the NP does not affect the sentence aspect: regardless of the type of NP, the sentence is atelic. Note that it is generally possible to intransitivise a transitive verb, and therefore to use the verbs of the sentences in (1.8) or (1.7) without specifying the patient. If we do this to the sentences in (1.8), the result is atelic:

(1.9) a. ‘John watched’
b. ‘Mary drove’
c. ‘Peter pushed’

From this we can conclude that the verb ‘watch’ introduces atelicity, and the same can be said of ‘drive’ and ‘push’ and in general of any verb describing a durative event, like ‘read’ or ‘eat’ or the other verbs of example (1.7), as the following sentences show:

(1.10) a. ‘John read’

b. ‘Mary ate’

c. ‘Peter ran’

d. ‘Sue wrote’

e. ‘John drank’

However, whereas in (1.7) the NPs modify this aspectual property, in (1.8) no such a modification occurs.

It may seem plausible to think that it is the verb which decides whether the NP modifies the aspectual properties or not. However, the picture is not as simple as this. Consider the sentence:

(1.11) ‘John drove two cars’

It is reasonable to think that John did not drive both cars at the same time (unless we consider some special context such as that the cars are simultaneously driven by John by means of a remote control, but here we will stick to the normal interpretation). If now we say that John drove two cars for two hours, the only interpretation one can expect to this sentence is that John drove first one car, then the second car, then again the first car, and so on. Note that we will not get the reading that John drove first one car and then the other car and no more. That is, the reading is one of iteration. As a consequence, sentence (1.11) is telic.

The telicity of (1.11) is supported from evidence from other languages. In Bulgarian,[3] for example, the verb *kara* ‘drive’ can be used either in the aorist past form *kara* or in the imperfective form *karashe,* giving the following sentences:

(1.12) a. *John kara kala*
John drive.AOR car
‘John drove a car’

b. *John karashe kala*
John drive.IMP car
‘John drove a car’

The difference between (1.12a) and (1.12b) is that in the former the event is bounded, whereas in the latter it is unbounded. In both cases, however, only one event is referred to.

---

[3] These examples are a result of a dialogue with Krasimir Kabakciev.

If we specify only one car, the readings are essentially the same:

(1.13) a. *John kara edna kala*
John drive.AOR one car
'John drove one car'

b. *John karashe edna kala*
John drive.IMP one car
'John drove one car'

Sentence (1.13a) refers to a bounded event, whereas (1.13b) refers to an unbounded event. Again, only one event is introduced.

When we introduce a plural, however, the readings are essentially different:

(1.14) a. *John kara due koli*
John drive.AOR two cars
'John drove two cars'

b. *John karashe due koli*
John drive.IMP two cars
'John drove two cars'

In (1.14a) the interpretation is that John drove first one car and then the other, that is, the normal single event (although composed of two subevents) is available. However, the interpretation of (1.14b) is that of habituality, and therefore the single event interpretation is not available.

Similar results can be obtained from Spanish, where the simple past form has a distinction similar to that of Bulgarian, the *pretérito indefinido* versus the *pretérito imperfecto*:

(1.15) a. *John condujo dos coches*
John drive.IND two cars
'John drove two cars'

b. *John conducía dos coches*
John drive.IMP two cars
'John drove two cars'

Again, whereas the single-event reading is easily available in (1.15a), in (1.15b) only a habitual reading is possible (unless we can obtain the reading of simultaneously driving both cars).

- A **definite plural** will introduce duration by means of a limited repetition,[a] providing a durative telic reading.

He noticed six errors	ach→acc

- An **indefinite plural** will imply an unlimited duration through iteration, giving as a result an activity:

He noticed errors	ach→act
He kicked donkeys (for hours)	ach→act

- A **mass noun** will create an ambiguous meaning when the verb is an achievement:

He lost money (at once)	ach→ach
He lost money (for hours)	ach→act

---

[a] Whenever I say that a plural forces repetition or iteration, what I mean is actually *plurality of action*, since the several actions can occur in parallel. Iteration is a particular case of this: iteration happens when two events cannot happen at the same moment (for example, when the agent is singular, if the patient is plural the result will usually be an iteration).

Table 1.4. The aspectual interactions between a non-durative verb and a patient NP.

When ‘John drove two cars’ is forced into an imperfective reading, therefore, the meaning shifts to that of habituality, and this is so because the sentence is telic. We can conclude, therefore, that (1.11) is telic but, as we have seen in (1.8), the verb itself is atelic. For some reason, sometimes the verb allows for the NP to influence the sentence aspect, and sometimes not.

A summary of the aspectual interactions can be seen at Tables 1.4, 1.5 and 1.6.

1.3.2 Comments on the data

In the light of the data shown above we can see that, in some sentences, the NP may determine the aspect of the sentence. Thus, in a sentence like ‘John ran a mile’ or ‘he ate an apple’, the object itself decides whether the event is completed. After running a mile, for example, the event described by ‘John ran a mile’ is over. There are other cases, however, where NPs do not contribute to determining the end-point. Thus, in ‘he pushed a cart’ the cart itself does not specify whether the event is completed.

- A **definite singular** will force telicity if it implies a goal, like in:

  He ate an apple   act→acc

  If the noun phrase does not involve a goal, the aspect remains unchanged:

  He pushed a cart   act→act

- A **definite plural** will force durativity (by iterating) and telicity. When combined with an activity without a goal, the goal itself is somehow implied in every single action, so that it can be iterated:

  He drove 5 cars   act→acc→acc   (limited iteration of accomplishments)

- An **indefinite plural or a mass noun** implies an unlimited durative reading, and thus leaves the aspect unchanged:

He pushed carts	act→act
He ate apples	act→act
He drank water	act→act
He ate apple	act→act

Table 1.5. The aspectual interactions between a durative verb and a patient NP.

With **non-durative** verbs we have the following interactions:

- A **definite plural** will force a durative reading:

  They took a look through the microscope ach→acc

- An **indefinite plural**, like the case of patient NPs, forces an unlimited durative reading by iterating the verb:

  People took a look through the microscope ach→act

With **durative** verbs, the same interactions apply as with non-durative verbs, but the final class will always remain durative:

He ate apples	act→act
Men ate apples	act→act
He ate an apple	acc→acc
People ate an apple (and left the room)	acc→act

Table 1.6. The aspectual interactions with an agentive NP.

Another feature to remark is that an activity can be the result of different kinds of interactions. It is not the same to say ‘he pushed a cart’, where an unbounded singular pushing event is involved, than to say ‘he ate apples’, where there is an unbounded iteration of bounded apple-eating events.

Finally I must remark that all these data only show the distributive readings. When we incorporate collective readings a remarkable simplification occurs. Consider the following sentences, under their collective reading:

(1.16) a. ‘*three men* lifted a piano’
b. ‘the lawyer hired *three secretaries*’
c. ‘the lawyer hired *secretaries*’
d. ‘he noticed *errors*’

In all of these sentences, the collectivised NP (in *italics*) does not affect the aspectual properties of the sentence: They behave like in the examples of (1.8). This is a very important fact which will be extensively developed in this thesis, in which we will explain the aspectual interactions in sentences like those of (1.8) by resorting to collectivity.

The introduction of collectivity, however, creates one more problem. It is possible now for one and the same sentence to be either telic or atelic, depending on our interpretation of it. Consider the following examples:

(1.17) a. 'he pushed two carts'
b. 'he noticed two errors'
c. 'he noticed errors'

All these sentences can be interpreted distributively or collectively. Sentence (a), for example, will be telic if we assign to it a distributive interpretation by means of which the agent pushed first one cart and then the other. There is, however, a collective reading also, by means of which the agent pushed both carts at the same time with the same pushing. In such a case we can say that 'John pushed two carts for hours', without having an iterative reading. That is, a collective reading of (a) generates atelicity.

A similar argument can be said of (b,c). In this case, their respective verbs are non-durative, and as a result a collective reading of them renders a non-durative description. For example, a collective reading of (c) would mean that the agent noticed that there were some errors, and this noticing event happens in no time. However, in a distributive reading the agent keeps noticing one error after another. As a result, (c) is durative and atelic under a distributive reading. Sentence (b) would also be durative under a distributive reading, but now it is telic: after the agent notices the two errors, the event is over.

After examining the data above one may arrive at the conclusion that it is not the verb but our collective / distributive interpretation of the sentence what matters when it comes to analyse the aspectual interactions between the verb and patient NP. This is indeed one concept that I want to develop in this thesis, and it will be formalised in Chapter 4.

Chapter 2

Introductory theories

In this chapter some formal theories will be introduced which form the basis of several approaches to aspectual composition, including the one presented in this thesis. It will also be shown how the formalisms commented here are related to the intuitive concepts introduced in Chapter 1. This is only an introductory chapter, however. The link with Chapter 1 will be further developed in Chapter 4.

2.1 The Neo-Davidsonian approach

> Strange things going on! Jones did it slowly, deliberately, in the bathroom, with a knife, at midnight. What he did was butter a piece of toast. We are too familiar with the language of action to notice at first an anomaly: the 'it' of 'Jones did it slowly, deliberately,. . . ' seems to refer to some entity, presumably an action, that is then characterized in a number of ways. (Davidson 1980:105)

The quotation which opens this section is the opening of Davidson's famous paper on events as individual entities, first published in 1967. His argument is rather straightforward: in the same way as an object can be referred to by a variable in standard Predicate Logic, an event can also be referred to. The evidence for this is taken from the paragraph quoted above, and more specifically from sentences like the following, also taken from Davidson's paper:

(2.1) 'Jones buttered the toast in the bathroom with a knife at midnight'

The problem in (2.1) is that the sentence contains several complements which modify the action itself. If one were to use standard Predicate Logic, one would have to use a 5-place predicate to express its semantics, giving an expression like the following:

(2.2) $buttered(jones, the.toast, in.the.bathroom, with.a.knife, at.midnight)$

This approach would assign different predicates to the following sentences:

(2.3) a. 'Jones buttered the toast'

b. 'Jones buttered the toast in the bathroom'

c. 'Jones buttered the toast in the bathroom with a knife'

The relevant predicate in (2.3a) would be two-place, the one in (2.3b) would be three-place, and the one in (2.3c) would be four-place. All these sentences are related, however, and it is easy to see that (2.3b) implies (2.3a), that (2.3c) implies (2.3b), and that (2.1) implies all of the sentences in (2.3).

A possible solution to the problem is to assign existentially bounded variables to all of the sentences in (2.3). For example, a possible semantics of them would be, respectively:

(2.4) a. $\exists p, i, t\,[buttered(Jones, the.toast, p, i, t)]$

b. $\exists i, t\,[buttered(Jones, the.toast, in.the.bathroom, i, t)]$

c. $\exists t\,[buttered(Jones, the.toast, in.the.bathroom, with.a.knife, t)]$

Now all the implications are ensured, but this solution creates more problems. Since it is always possible to add more modifiers to the sentence which in turn will need more places in the predicate expression, and the number of possible modifiers has no limit, the predicate will need more and more places to accommodate all the possible modifiers it may need in the longest possible sentence. In order to account for the semantics of a single sentence we would need far more information than we initially thought! Kenny (1963a:VII) explicitly says that, in order to specify the semantics of a simple sentence like 'Brutus killed Caesar', one may need to use a predicate which 'describes, with a certain lack of specification, the whole story of the world' (page 160).

Davidson's solution consists in introducing a new parameter in the predicate which describes the action (*buttered* above). This new parameter will refer to an entity which represents the action itself. With this new approach, the semantics of (2.3a) is as follows:

(2.5) a. $\exists b\,[buttered(b, Jones, the.toast)]$

Further modifications of the action can be expressed by means of predicates containing the same action-referring entity, and thus the semantics of (2.3b-c) are, respectively:

(2.5) b. $\exists b\,[buttered(b, Jones, the.toast) \wedge in.the.bathroom(b)]$

c. $\exists b\,[buttered(b, Jones, the.toast) \wedge in.the.bathroom(b) \wedge with.a.knife(b)]$

The semantics of the original sentence (2.1) is, therefore:

(2.6) $$\exists b\,[buttered(b, Jones, the.toast) \wedge in.the.bathroom(b) \wedge with.a.knife(b) \wedge at.midnight(b)]$$

This semantics can be further decomposed. Parsons (1985, 1990) breaks down the three-place predicate which describes the main action, by specifying the thematic relations which come into play. Parsons's (1990) semantics of (2.3b) would be as follows:[1]

(2.7) $$\exists b\,[buttering(b) \wedge \mathrm{agent}(b, Jones) \wedge \mathrm{theme}(b, the.toast) \wedge \mathrm{in}(b, the.bathroom)]$$

There are several reasons why the use of thematic relations is more convenient (Parsons 1985; Parsons 1990). One of them is that there is no safe criterion to decide which arguments are to be included in the multiple-place predicate. One possible criterion, for example, would be to include those arguments which are not introduced by prepositional phrases. Thus, for the buttering event, since we can say 'Jones buttered the toast', the arguments $Jones$ and $the.toast$ are to be included, and all the remaining arguments should be introduced by means of auxiliary predicates, giving as a result the semantics in (2.5) and (2.6). This criterion has the problem, however, that the decision of which argument to include depends on the language used. In Latin, for example, the instrumental position is marked with a case marking, and therefore it should be included together with the agent and the patient, if we take this language as a reference.

Another reason for the use of a Neo-Davidsonian approach, apart from the ones introduced by Parsons, is that there is more flexibility when one attempts to compositionally deduce the semantics of the sentence. With one approach such as the Neo-Davidsonian, it is possible to introduce the predicate which characterises the action ($buttered$ in our example) even when it is not clear yet what the arguments are. This characteristic will be used in Chapter 5, where we will use expressions denoting the semantics of sentences with a distributive interpretation, similar to the following:

---

[1] Parsons uses sentences like 'Brutus stabbed Caesar in the back,' but I prefer Davidson's original sentence, which is less dramatic.

(2.8) ‘three people ate an apple’

$$\exists P, E\ [three.people(P) \wedge eating^{*}(E) \wedge$$
$$\forall p\ (p \in P \rightarrow \exists a, e\ [an.apple(a) \wedge e \in E \wedge \text{agent}(e,p) \wedge \text{theme}(e,a)])]$$

Here, since E is a multiple eating event (symbolised by the asterisk ‘*’), we do not need to specify that e is an eating event, since this is obvious for being e a subevent of E.

The use of thematic relations, however, has its drawbacks. The two most important of them are that it is not clear how to classify the possible thematic relations, and that the semantics of a thematic relation is very dependent on the verb itself (Parsons 1990; Dowty 1991). However, an approach like Parsons’ is possible without having to commit oneself to the identification of the thematic relations themselves. Under such an approach, the thematic relations are seen only as place-holders, that is, we use them only to determine which position an argument would take if we were using the standard Davidsonian approach. Under such an approach, (2.8) becomes (2.9):

(2.9) ‘three people ate an apple’

$$\exists P, E\ [three.people(P) \wedge eating^{*}(E) \wedge$$
$$\forall e\ (p \in P \rightarrow \exists a, e\ [an.apple(a) \wedge e \in E \wedge r_1(e,p) \wedge r_2(e,a)])]$$

This is the approach taken in several of the theories commented on this thesis, and it is the approach I will also take in my theory.

2.2 Lattices

In Chapter 1 we have stressed the human’s ability to abstract over the information available and create a hierarchical structure of our knowledge of the world. In this section I will introduce a mathematic structure which will prove very useful for modelling the structure of objects and events: the **lattice.** As we will see in Chapter 4, the use of lattices as the inherent mathematical structure will allow us to define the aspectual properties of sentences and how they can be compositionally established. I am not going to extend on these mathematic definitions, however. If the reader is interested in lattices themselves and some of their applications to semantic theories, (s)he could consult Partee *et al.* (1990) and Landman (1991).

Let us imagine a structure made of a set P and a relation between the elements of the set $\sqsubseteq$. The pair $< P, \sqsubseteq >$ will be a *partially ordered set (poset)* if the relation $\sqsubseteq$ is of the form $P \times P \rightarrow P$ and has the properties:

reflexive $\forall a \in P, a \sqsubseteq a$

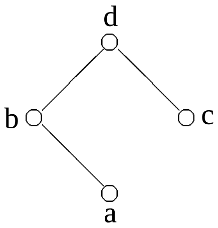

Figure 2.1. An example of a poset. The lines represent the $\sqsubseteq$ relation.

antisymmetric $\forall a, b \in P, (a \sqsubseteq b \wedge b \sqsubseteq a \rightarrow a = b)$

transitive $\forall a, b, c \in P, (a \sqsubseteq b \wedge b \sqsubseteq c \rightarrow a \sqsubseteq c)$

An example of a poset would be the one defined as follows:

$$\begin{array}{lcl} P & = & a, b, c, d \\ \sqsubseteq & : & a \sqsubseteq a \wedge b \sqsubseteq b \wedge c \sqsubseteq c \wedge d \sqsubseteq d \wedge a \sqsubseteq b \wedge a \sqsubseteq d \wedge b \sqsubseteq d \wedge c \sqsubseteq d \end{array} \tag{2.10}$$

Example (2.10) can be simplified. Since the reflexive and transitive properties always hold for a poset, we only need to specify the following relations to completely characterise (2.10):

$$a \sqsubseteq b \wedge b \sqsubseteq d \wedge c \sqsubseteq d$$

This is so because all the reflexive relations will be taken for granted, and the relation $a \sqsubseteq d$ follows from $a \sqsubseteq b \wedge c \sqsubseteq d$ and the property of transitivity. As a result, one can use a graph to represent a poset, if the arcs represent the additional $\sqsubseteq$. For example, the graph representing (2.10) is shown in Figure 2.1.

Now, let P be a poset and $P' \subseteq P$. We will have then the following definitions:

Def. 2.2.0.1 (upper bound) *$u \in P$ is an upper bound of P' if $p' \sqsubseteq u$ for all $p' \in P'$.*

Def. 2.2.0.2 (lower bound) *$u \in P$ is a lower bound of P' if $u \sqsubseteq p'$ for all $p' \in P'$.*

Def. 2.2.0.3 (supremum) *An upper bound u is a least upper bound or supremum of P' if for any upper bound u' of P', $u \sqsubseteq u'$.*

Def. 2.2.0.4 (infimum) *A lower bound u is a greatest lower bound or infimum of P' if for any lower bound u' of P', $u' \sqsubseteq u$.*

Given all these definitions we can now define a **lattice:**

Def. 2.2.0.5 (lattice) *A lattice is a poset* $< P, \sqsubseteq >$ *where every non-empty finite subset of* P *has a supremum and an infimum in* P.

The supremum of a and b will be called their *join*, and the infimum will be their *meet*. Notationally, $a \sqcup b$ is the join of a and b, and $a \sqcap b$ is the meet of a and b.

Let us now stop here and consider how we can use this structure. An intuitive mathematical device to model plurality is set theory. Thus, a singular NP will denote an object, whereas a plural NP will denote a set of objects. However, under such a model, an object falling under a singular NP will be of a type which is different from that of another object falling under a plural NP. An obvious shortcoming of this approach is that we need to double the rules applying to NPs, since we need to specify the type of the object as being either an element or a set of elements. This will create multiplicity in the formulation, and it will not reflect the intuition that we process singular and plural referents in a very similar way.

If one uses a lattice instead, an object and the join of several objects belong to the same domain. One can therefore model singular NPs by stating that their extension only contains atomic elements, and plural NPs by stating that their extension contains non-atomic elements. One can even model mixed predicates whose extension may have atomic elements but also non-atomic elements, something that cannot be easily formalised in set theory.

Since we are going to use lattices to model plurality, we actually need only the join relation. The result of not considering the meet relation from a lattice is a *join-semilattice:*

Def. 2.2.0.6 (join-semilattice) *A poset* $< P, \sqsubseteq >$ *is a join semilattice if every non-empty finite subset* P' *has a supremum in* P.

We still need to be more precise about the structure we want to form. Consider, for example, the contents of a glass of water. This contents is water, and every possible subpart of water is also water, and regardless of how small this portion of water is, we can always find an even smaller portion of water. As a consequence of this, the glass of water will contain the join of an infinite number of subparts of water.[2] We need therefore to be able to find the join of a set containing infinite elements. The resulting structure is a *complete join-semilattice:*

---

[2] Actually, it is not true that a portion of water is a compound of infinite elements, since it will be made of a finite (though presumably huge) set of atoms, mainly oxygen and hydrogen; I will address this pseudo-contradiction in Chapter 4.

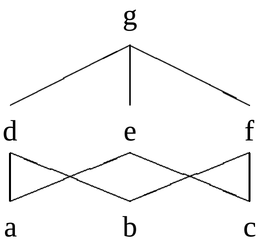

Figure 2.2. An example of a complete join-semilattice with the bottom element removed.

Def. 2.2.0.7 (complete join-semilattice) *A poset P is a complete join-semilattice if every subset of P (not just finite) has a supremum in P.*

Finally, we need to add one more restriction. It is convenient to define the objects referred to by a singular noun phrase as atomic. However, nothing prevents a complete join-semilattice having a bottom element which is part of all of the other elements. This element, which is the equivalent of the empty set in Set Theory, must be removed, giving as a result a *complete join-semilattice with the bottom element removed.* A graphical representation of an example of such a structure appears in Figure 2.2.

A consequence of removing the bottom element of a lattice is that, since there may be subsets which have no meet, the resulting structure is not a lattice at all. However, this structure is still a complete join-semilattice. For a mathematic definition and properties of a complete-join semilattice with the bottom element removed, see Landman (1991).

We could define a lattice in an alternative way, by means of an algebra $< P, \sqcap, \sqcup >$ whose operators satisfy the following properties:

Idempotency $a \sqcap a = a, a \sqcup a = a$

Commutativity $a \sqcap b = b \sqcap a, a \sqcup b = b \sqcup a$

Associativity $(a \sqcap b) \sqcap c = a \sqcap (b \sqcap c), (a \sqcup b) \sqcup c = a \sqcup (b \sqcup c)$

Absorption $a \sqcap (a \sqcup b) = a, a \sqcup (a \sqcap b) = a$

The definition of a lattice as an algebra can be very useful, since it would be possible to apply to a lattice all the properties one can define of its alternative algebraic definition. For example, a very common algebra is the so-called **boolean algebra**. The sextuple $< P, \sqcap, \sqcup, \sim, 0, 1 >$ is a boolean algebra if it obeys the following laws:

Associative (as above)

Commutative (as above)

Distributive $a \sqcap (b \sqcup c) = (a \sqcap b) \sqcup (a \sqcap c)$, $a \sqcup (b \sqcap c) = (a \sqcup b) \sqcap (a \sqcup c)$

Top and bottom $a \sqcap 1 = a$ and $a \sqcap 0 = 0$, $a \sqcup 0 = a$ and $a \sqcup 1 = 1$

Complementation $a \sqcap \sim a = 0$, $a \sqcup \sim a = 1$

Such an algebra can also describe a certain type of lattice, the so-called complemented distributive lattice. A complemented distributive lattice is a lattice $< P, \sqcap, \sqcup >$ which has the following properties:

complemented. For each $x \in P$ there is a $y \in P$ such that $x \sqcup y = 1$ and $x \sqcap y = 0$.

distributive. It satisfies the distributive laws $a \sqcap (b \sqcup c) = (a \sqcap b) \sqcup (a \sqcap c)$, $a \sqcup (b \sqcap c) = (a \sqcup b) \sqcap (a \sqcup c)$

A boolean algebra can be used to model set theory. In fact, sets are simple models of boolean algebras (Partee *et al.* 1990). However, a lattice structure is more powerful than a set. For example, it is very easy to model masses by means of lattices, but it is not so straightforward to do it by means of sets, since a mass (like our example of water above) is not made of a finite set of elements. In fact, it is not made of atomic elements at all, since for every portion of water we can always find subportions of it which are water too.

2.3 Relating objects and events

As it has been said already and confirmed with the data in Section 1.3, sentence aspect does not depend entirely on the verb, but also on other parts of the sentence (Dowty 1979; Verkuyl 1972). Even intersentential context may decide the final aspect (Moens 1987; Caenepeel 1989).

There is also evidence that event structure has many similarities with object structure. Mourelatos (1981), for example, compares accomplishments with quantified nouns. Consider the following sentences:

(2.11) a. ‘Vesuvius erupted three times’

b. ‘there were three eruptions of Vesuvius’

(2.12) a. ‘Mary capsized the boat’

b. ‘there was a capsizing of the boat by Mary’

The event described by (2.11a) and (2.12a) can be nominalised by means of a quantified noun phrase. Thus, (2.11a) can also be expressed by counting the three independent eruptions, giving (2.11b). In a similar way, (2.12a) can be also expressed by referring to the event itself by means of a singular noun phrase, giving (2.12b).

There is a similar parallelism between activities and mass nouns. Mourelatos uses the following example:

(2.13) a. ‘John pushed the cart for hours’

b. ‘for hours there was pushing of the cart by John’

Here, the activity described by means of sentence (a) can be nominalised by means of a mass expression ‘pushing’, giving the sentence (b).

It seems therefore sensible to try to model objects and events as belonging to two parallel domains with similar structures. Here I will focus on Hinrichs’ model, since he uses lattices as the main structure. But before going into Hinrichs’ approach it is convenient to consider Link’s theory of plurals and mass terms.

2.3.1 Link’s objects

Link (1983) uses a complete join-semilattice structure as a mean to treat the objects referred to by plurals and mass nouns, as an extension to Montague’s semantic theory.

Link’s notation and terminology for lattices differs from the one used above. For example, the join of two elements is called their *sum*. Also, $^*P$ forms all the individual sums of members of the extensions of a predicate P. Let $\|\cdot\|$ be the denotation function in a model ($\|P\|$, for example, is the extension of P). The extension of $^*P$ is $\|^*P\|$ (also called E in Link’s paper), and it forms a boolean algebra with the sum operation. E also forms a complete join-semilattice.

As an example, let P denote three objects: $\|P\| = \{table, chair, lamp\}$. If we represent their sum as $\sqcup_i$, then $\|^*P\| = \{table, chair, lamp, table \sqcup_i chair, table \sqcup_i lamp, chair \sqcup_i lamp, table \sqcup_i lamp \sqcup_i chair\}$, which is a complete join-semilattice under the *part-of* relation defined as follows:

$$a \leq_i b \leftrightarrow a \sqcup_i b = b$$

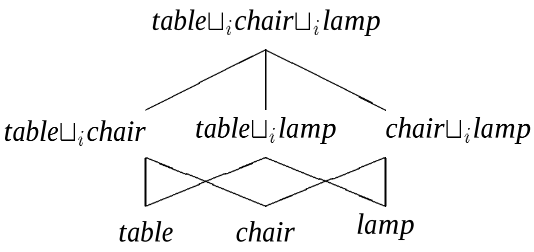

Figure 2.3. An example of Link's complete join-semilattice.

This structure can be represented in Figure 2.3, which is no more than a rewriting of Figure 2.2.

The structure defined in this form, as we see, models plurality by means of the *individual* part-of relation $\leq_i$ and the *individual* sum $\sqcup_i$ operation, which can be seen at work in expressions such as "one ring plus another ring makes two rings." This semilattice, as it has been explained above, is generated from the set containing the extension of all the individuals $A = \|P\|$.

Apart from this structure, Link uses another structure to model stuff and masses. This structure is again a complete join-semilattice under the $\leq$ relation and the $\sqcup$ operation, which works on matter instead of individuals, as in the expression "the stuff of one ring plus the stuff of another ring makes the stuff of two rings." This semilattice is also generated by a set $D \subseteq A$.

I must say here that Link says specifically that this lattice is a complete, but not necessarily atomic, join-semilattice. However, $D \subseteq A$ and A is a set of atoms, since Link also says that $< E, \leq_i >$ is an *atomic* boolean algebra. Link's restriction on using an atomic boolean algebra is not necessary, however, and the whole theory will still work if we use non-atomic lattices. It would be therefore more convenient to use non-atomic lattices so that masses are included as well without generating any contradiction in the formalisation.

Link also defines another lattice structure over the set A, but now the order relation is the *material* part of $\leq_m$ "an arm is part of the body which has it" and its respective sum operation $\sqcup_m$. This lattice is linked with the lattice defined in the previous paragraph by means of a homomorphism h from $E \Leftrightarrow \{0\}$ (E without the bottom element) to D such that $h(x) = x$ for all $x \in D$ and:

$$a \leq_m b \leftrightarrow h(a) \leq h(b)$$

Following our example of rings, if a is a ring, $h(a)$ is the stuff of that ring.

Link uses all this structure to determine the semantics of plurals and mass terms. In order to do so, he defines the following operations:

- $a \prod b \leftrightarrow \|a\| \leq_i \|b\|$
- $a\mathrm{T}b \leftrightarrow \|a\| \leq_m \|b\|$
- $\|a \oplus b\| = \|a\| \sqcup_i \|b\|$
- P is a 1-place predicate on A.
- ${}^{*}P$ is a 1-place predicate on E, which is P's closure under the individual sum operation.
- ${}^{\oplus}P$ is a 1-place predicate on $E \Leftrightarrow A$, which is *the proper plural predicate* of P:

$$\|{}^{\oplus}P\| = \|{}^{*}P\| \Leftrightarrow A$$

- ${}^{m}P$ is a 1-place predicate on D, defined as *the mass-term correspondent* of the predicate P:

$$\|{}^{m}P\| = \{x \in D | x \leq \mathrm{sup} h(\|P\|)\}$$

- $\|\sigma x P x\|$ is the supremum of $\|{}^{*}Px\|$. This expression will correspond to the join of all the elements under the extension of P.
- $\|\sigma^{*} x P x\|$ is the supremum of $\|{}^{\oplus}Px\|$. The only difference between this and $\|\sigma x P x\|$ is that now one presupposes that P predicates over more that one element.

For example, consider a world where there are only three tables. Some of the operators above defined apply to the predicate *table* as follows:

$$\begin{aligned}
\|table\| &= \{t_1, t_2, t_3\} \\
\|{}^{*}table\| &= \{t_1, t_2, t_3, t_1 \sqcup_i t_2, t_1 \sqcup_i t_3, t_2 \sqcup_i t_3, t_1 \sqcup_i t_2 \sqcup_i t_3\} \\
\|{}^{\oplus}table\| &= \{t_1 \sqcup_i t_2, t_1 \sqcup_i t_3, t_2 \sqcup_i t_3, t_1 \sqcup_i t_2 \sqcup_i t_3\} \\
\|\sigma x.table(x)\| &= t_1 \sqcup_i t_2 \sqcup_i t_3 \\
\|\sigma^{*} x.table(x)\| &= t_1 \sqcup_i t_2 \sqcup_i t_3
\end{aligned}$$

With these operators and a few more, Link is able to write the semantics of sentences like:

(2.14) a. There is apple in the salad $\exists x, ({}^{m}apple(x) \wedge in.the.salad(x))$

b. There are apple parts in the salad $\exists x, y, ({}^{*}apple(x) \wedge y\mathrm{T}x \wedge in.the.salad(y))$

c. A child built the raft $\exists x, (Child(x) \wedge built.the.raft(x))$

d. Children built the raft $\exists x, ({}^{\oplus}child(x) \wedge built.the.raft(x))$

e. John and Paul are pop stars ${}^{*}pop.star(j \oplus p)$

f. John and Paul sing a song $sing.a.song(j \oplus p)$

With the help of lattice approaches, Link provides an account of the semantics of plurals and mass terms in a way that is more intuitive than the use of sets. As we have seen above (page 27), since an element of a set does not belong to the domain of sets, there were some problems in determining the extension of singular NPs: does the NP ‘an apple’ refer to an entity or to the set formed by an only entity? With a lattice approach ‘an apple’ will refer to an entity, and a plural NP like ‘two apples’ will refer also to an entity which is itself the join (Link’s sum) of two other entities.

Link also attempts to structure events in lattices in his 1987 paper. In his extension, there is also a lattice for events, and the events themselves are categorised by means of **event types,** as we will see below. Following a Neo-Davidsonian approach, events are independent entities which can be predicated over, very much like in the case of objects. There will be a relation between an event and the set of objects which participate in the event, effected by means of thematic relations.

Very briefly, an event type can be any of the following, among others:

- An atomic event type $e_1, e_2, \ldots$
- A structure of the form:

$$\theta = [e; Cond_1 \wedge \ldots Cond_n]$$

This structure can be read as “θ is the event type which contains the events e which satisfy the conditions from $Cond_1$ to $Cond_n$.” These conditions include the following:

Role conditions of the form $\rho_i(e) = a$; these role conditions are like Parson’s thematic roles, but Link does not commit to the typical division between agent, theme and so on. Instead, Link uses generic names: ρ_1, ρ_2, etc. Also, in Link’s notation a role is a function of events which gives as a result an object, whereas in Parson’s notation a role is a two-place predicate. Both notations, however, are equivalent.

Restrictions such as book(b).

Here is an example:

(2.15) 'John reads a book'
$[e;\rho_1(e) = a^0 \wedge \text{john}(a) \wedge \rho_2(e) = b^0 \wedge \text{book}(b) \wedge$
$\tau(e) = t^0 \wedge t \geq t_0 \wedge \text{reading}(e)]$

- A complex event type of the form:

$$\theta = \sum(\theta_1|\theta_2)$$

Such a complex event type is used to model quantification in a way which resembles DRT's account — DRT stands for "Discourse Representation Theory" (Kamp & Reyle 1993). An example follows:

(2.16) 'every student reads a book'
$\sum(\text{student}(a^1)|\ \|^1[a \text{ reads a book}]\|) =$
$\sum(\text{student}(a^1)|[e;\rho_1(e) = a^1 \wedge \rho_2(e) = b^1 \wedge \text{book}(b)$
$\wedge\, \tau(e) = t^1 \wedge t \geq t_0 \wedge \text{reading}(e)])$

In this example, a complex event type is created which refers to all the events such that, if there is a student involved in them, then this student reads a book.

- A complex event type of the form:

$$\theta = \theta_1^*$$

The asterisk (*) models negation. (Link 1987:8)

Link uses such a model to explain the semantics of event structure. In order to do so, Link mentions the existence of several levels to which an object or event belongs, and these levels are referred in the semantics by means of superscripts (a^1, t^0, and so on). The most basic level is level 0, in which all the objects referred to by proper names and definite descriptions stay. Other structures in the sentence or in context may create new levels. Thus, in Example 2.16 the book b^1 and the student a^1 are at level 1. Links uses these levels to establish a hierarchy of entities according to their accessibility for reference. Any entity at level 0, for example, is always accessible, and whenever there is a need for restricting the scope of an entity, such as when quantifiers are introduced as is the case in (2.16), a new level is created. It is not clear why Link uses this structuration in levels when it is possible to restrict the scope of an entity by other means. For example, DRT (Kamp 1981; Kamp & Reyle 1993) provides a more structured account where the scope of an entity is clearly determined according to its position in the semantic expression and is better designed.

I would like to remark on Link's (1987) use of **granularity.** Link resorted to granularity to solve the minimal parts problem, applied to events. Take Link's sentence 'Mozart died on the 5th of December, 1791'. The dying event, as Link says, would be reported as being non-durative, since 'die' is an achievement. However, we may wish to describe it at a different level, in which Mozart's death is composed of a more or less complex series of events (the physical processes involved in his dying). In such a case, the event would not be non-durative. Link's proposal to solve this consists in generating a whole system of lattices, where each lattice represents one level of the granularity intended to describe. These lattices would be indexed so that the events in the lattice E_i are more fine-grained than those in E_j for $i \leq j$. A family of mappings is also needed so that every one of the elements in one lattice has its corresponding elements in all of the other lattices. By means of these mappings, it is assured that all the lattices are no more than different conceptualisations of the same situation.

Link's use of such an array of lattices is arguable. According to that approach, one would think that there are several well-defined discrete steps in our granular interpretation of the world so that we can unmistakably refer to one of the lattices. This is not so, however. According to what we want to describe and how, an object may be described in much detail whereas its neighbour may be just roughly described. Even some parts of the same object may be described with different levels of detail; for example, when one describes a person one will probably give more details of the face than of any other part of the person's body. Also, depending on the purpose of the description, one part of the object will be described more exhaustively than others; for example, a dentist may pay more attention to somebody's dental features and eating habits than to the person's face itself. This variation of the level of description would entail that we would always be shifting from one lattice to another, in such a way that different parts of the same object are described from different lattices. This is very difficult to formalise, if not impossible.

Another argument against Link's use of granularity is that the levels of granularity sometimes are not well defined. For example, between the level of days and that of hours we may think of other intermediate levels like work shifts, etc. In some domains there may be no discrete distinction at all, since there may always be an intermediate level set by world knowledge. There may even be cases where we cannot talk of different levels because there is much overlapping between the real-world elements referred to by two lattice entities. For example, if one considers a deck of cards, one may say that there is one entity (the deck of cards) or 54 entities (one entity for each card), or 4 entities (for clubs, diamonds, spades and hearts), or 2 entities (for red and black), or 3 entities (for Aces, Figures and the rest), and so on.

The real problem in Link's approach to the minimal parts problem is the way he addresses the problem. He is trying to classify events as being or not being durative. This problem disappears completely if our classification is not of events but of descriptions of events, that is, of predicates. Despite these problems, however, Link's concept of granularity is important, since as we have seen in Chapter 1 we do interpret the world in a granular way, grouping properties so that they can be easily handled.

2.3.2 Hinrichs' semantics for Aktionsarten and NP reference

Hinrichs also uses lattices to describe object and event structure. As we will see below, both domains have a parallel structure which allows them to interact. In this section I will introduce some of Hinrichs' concepts, but for an exhaustive explanation see his PhD thesis (Hinrichs 1985).

Hinrichs distinguishes between three types of NPs: those which refer to *kinds of objects*, those which refer to *individual objects* and those which refer to specific spatio-temporal realisations of objects or kinds, what he calls *stages*. These three types are related by means of the two-place predicates R and R': R relates stages with objects and kinds, and R' relates objects with kinds.

The set L of possible spatio-temporal realisations, stages or locations is structured in a complete join-semilattice defined by the sum operation $+$ (what Link defined as $\sqcup_m$ in his domain of extensions). The set O of objects is a complete, atomic boolean algebra very much in the sense of Link's $< E, \sqcup_i >$, which has a partial order relation $\leq_i$ (the same as Link's one).

The relation R defines the set of all the possible stages of any kind or object. A very important property of R is that it defines subsemilattices in L. That is to say that, for example, the set of all the possible realisations of the person *John* forms a complete join-semilattice in itself.

But the main contribution of Hinrichs is in the domain of events and the interaction between the object and the event. Hinrichs follows a Davidsonian approach to the analysis of events by saying that a verb introduces an event referent. These event referents will have a structure which is very similar to that of NP objects: there will be a set of *event types*, a set of *individual events* and a set of *event stages*.

The set of event stages is no more than the set of spatiotemporal stages L, since Hinrichs claims that the spatiotemporal realisations of events and those of objects belong to the same domain. He even says that there are some events whose stage is the same as that of the agent. For example, the realisation of an event of walking is the same as the one of the person who is walking: when we see somebody walking, we see the person and the event together; it would be impossible to separate the person who is walking at that moment from the very act of walking.

The sets of event types and of individual events are very much like the sets of kinds and objects, respectively. Types and individuals are related with their stages by means of the predicate R, and types are related with individuals by means of the predicate R'.

The verb will determine how the relations R between the event and the referents of the NPs work. Thus, for example, the semantic representation of the sentence 'John slept' is:[3]

(2.17) 'John slept'
$$\exists e^i e^s x^s [R(x^s, j) \& R(e^s, e^i) \& PAST(e^s) \& sleep^+(x^s, e^s)]$$

This representation states that there is an individual event e^i and an event stage e^s which occurs in the past[4] such that e^s is a realisation of e^i and there is a stage x^s of the individual 'John' such that x^s and e^s are related by the predicate $sleep^+$. This predicate is over stages.

The interactions between the NPs modifying the verb and the verb itself determine the Aktionsarten of the sentence, as Hinrichs (1985) explains in depth. Here I will only write some examples of sentences where we can see the difference. The sentence 'a pill dissolved', for example, has this semantic representation (ignoring tense):

(2.18) 'a pill dissolved'
$$\exists e^i e^s x^s x^o [pill'(x^o) \& R(x^s, x^o) \& R(e^s, e^i) \& dissolve^+(x^s, e^s)]$$

Since 'dissolve' is an accomplishment, there will be a meaning postulate of the form:

---

[3] In Hinrichs' notation, the entities referring to objects and events have a superscript which denotes the type of object or event referred. Thus, x^o is an individual object, x^s is a stage, e^i is an individual event and x^k is a kind of object.

[4] Hinrichs's (1985) treatment of tense relies on the Reichenbachian reference points, but he did not stress much in this matter in his dissertation.

Postulate 1
$$\begin{aligned}\forall e^i e^s x^s y^o\ &[R(e^s,e^i)\&R(x^s,y^o)\&\delta^+(x^s,e^s)\\ &\rightarrow\\ &\neg\exists e_2^s y^s[e_2^s < e^s\&R(y^s,y^o)\&\delta^+(y^s,e_2^s)]]\end{aligned}$$

Where δ translates as $dissolve$, etc.

This meaning postulate ensures that there cannot be any subevent[5] $e^{s\prime}$ and stage y^s with the properties $e^{s\prime} < e^s\&R(y^s,x^o)\&dissolve^+(y^s,e^{s\prime})$, that is, there cannot be any subevent of e^s which is in a $dissolve^+$ relation with a stage of x^o; this is no more than Taylor's (1977) property of non-homogeneous reference, which applies to accomplishments (K-predicates under Taylor's terminology).

On the other hand, the sentence 'pills dissolved' translates as:

(2.19) 'pills dissolved'
$$\exists e^i e^s x^s[R(e^s,e^i)\&R(x^s,\iota x^k[\forall z^o[R'(x^k,z^o)\leftrightarrow^{\oplus} pill'(z^o)]])\&dissolve^+(x^s,e^s)]$$

This interpretation has the same meaning postulate introduced by the verb (since we use the same verb), but in this case, since x^s is not a realisation of an object but of a kind of object x^k, the meaning postulate does not apply. It means that, as the set of stages is structured in a complete join-semilattice, there may be subevents of e^s, and some of them may be in a $dissolve^+$ relation with a stage of x^o, that is, an activity is described.

In order to explain the case where the subject of an intransitive verb does not affect the aspect, Hinrichs establishes a two-way classification such that the comments above would apply to accomplishment verbs, but activity verbs like 'sleep', 'run', 'walk', 'move', etc. will have associated a meaning postulate which expresses the cumulative property which, Hinrichs claims, is inherent to activities:

Postulate 2
$$\forall x^s,y^s,e_1^s,e_2^s[\delta^+(x^s,e_1^s)\&\delta^+(y^s,e_2^s)\rightarrow\delta^+(x^s+y^s,e_1^s+e_2^s)]$$

Where δ translates as $sleep$, run, etc.

Hinrichs' theory is also extended to cover the case of masses. A bare mass like 'beer' will introduce a kind, and therefore Postulate 1 would not apply to a sentence like 'John drank beer'. Hinrichs, however, does not comment on the use of measures such as 'a pint of beer'. Measured masses like 'a pint of beer' might be treated in an extension of Hinrichs' theory by assigning individuals to them. If we follow this procedure, in 'John drank a pint of beer' Postulate 1 would apply and therefore the sentence would be an accomplishment.

---

[5] We say that e_s is a subevent of e iff e_s is a *partof* e in the lattice structure.

Hinrichs also tries to provide an explanation of the behaviour of transitive verbs. Accomplishments, for example, are classified into two types: those dealing with object accomplishments and those dealing with event accomplishments. For all of the possible cases, a case study is performed so that the correct inferences regarding the aspectual properties are performed, by providing the necessary meaning postulates. For example, a (rather complex) meaning postulate used for describing events where an object is created follows:

Postulate 3 $$\begin{aligned}&\forall e_1^s, e^i, x_1^s, x^o, y_1^s, y^o[\\ &\quad R(e_1^s, e^i)\&R(X_1^s, x^o)\&R(y_1^s, y^o)\&\delta^+(x_1^s)(y_1^s)(e_1^s)\\ &\qquad \rightarrow \forall e_2^s, x_2^s, y_2^s[R(x_2^s, x^o)\&R(y_2^s, y^o)\&x_2^s \leq x_1^s\&y_2^s \leq y_1^s\&\\ &\qquad\qquad e_2^s \leq e_1^s\&\delta^+(x_2^s)(y_2^s)(e_2^s)\\ &\qquad\qquad \rightarrow x_2^s = x_1^s\&y_2^s = y_1^s \leq e_2^s = e_1^s]\\ &\quad \&\neg\exists x_3^s[R(x_3^s, x^o)\&x_3^s \propto x_1^s]]\end{aligned}$$

Where δ translates as *build*, etc. The symbol $\propto$ denotes temporal precedence.

The case of PUSH-verbs is also treated by means of a postulate which will ensure the cumulativity property of an activity:

Postulate 4 $$\begin{aligned}&\forall x_1^s, x_2^s, y_1^s, y_2^s, e_1^s, e_2^s[\delta^+(x_1^s, y_1^s, e_1^s)\&\delta^+(x_2^s, y_2^s, e_2^s)\\ &\qquad \rightarrow\\ &\qquad \delta^+(x_1^s + x_2^s, y_1^s + y_2^s, e_1^s + e_2^s)]\end{aligned}$$

Where δ translates as *push*, *drive*, etc.

Hinrichs' analysis is very extensive and very insightful. Still, there are some obscure points in it. The first one is its actual ontology for objects and events which, as he says, is borrowed from Carlson (1977) in the case of objects, and extended to events. An upgrade of lattices over set theory is that singular and plural NPs are predicates over elements of the same domain. However, in Hinrichs' ontology, bare plurals and quantified plurals are predicates over kinds and individuals, respectively, setting again a distinction in the domain which may be problematic later. Hinrichs establishes a parallel classification for the domain of events, adding more complexity to his semantic translations of sentences.

A second problem with Hinrichs' theory is that there is too much stress on trying to model every single case in the real world. The consequence of this is that a very extensive range of rather complex postulates are introduced to cover many different data (one such is, for example, Postulate 3). No attempt to unify these postulates is attempted. However, as we will see in Chapter 4, such an attempt of modelling the real world is unnecessary and also counter-intuitive.

2.4 Our interpretation of the world: groups and granularity

Lattices are a powerful tool to represent the structure of objects and elements, but we still need a further extension to model abstraction and granularity. Consider the following sentences:

(2.20) ‘the Photography Committee met yesterday’

(2.21) ‘the Golf Committee met yesterday’

Now, imagine that John and Bill form the Photography Committee, which is in charge of organising the weekly events in the local photography club. Imagine also that, apart from photography, they also very fond of golf, and they decided to form a committee to organise a golf championship in the local golf course, and that they met yesterday. Under this context, (2.21) is true, but we cannot say the same about (2.20). Still, the Photography Committee and the Golf Committee have the same members. If we were to use the standard lattice approach we would need the join operator to express the composition of both committees. We would have, then, the following, where C_a refers to the Photography Committee, and C_b refers to the Golf Committee:

(2.22) $C_a = j \sqcup b$

(2.23) $C_b = j \sqcup b$

But now, $C_a = C_b$, and therefore (2.20) and (2.21) are equivalent, which is the wrong conclusion.

The only solution under a plain lattice approach would be to keep C_a and C_b different, by not specifying what they are made of. Under such an approach, C_a and C_b would be treated as any other atomic entity in the lattice. But this approach lacks the power of expression needed to represent the fact that C_a and C_b are composed of the same elements. This can be made by means of Landman’s (1989) groups which is based on Link’s approach to groups, as Landman himself says.

In Landman’s approach, a new operator is introduced, the **group** operator. This operator creates an (impure) atom or group out of a structure. Thus, if j and b represent John and Bill, respectively, then $\uparrow (j \sqcup b)$ represents the group made by John and Bill.

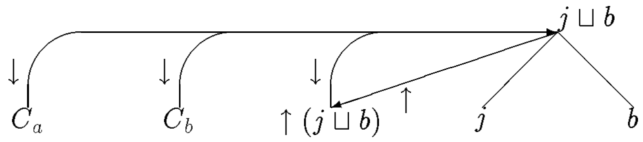

Figure 2.4. The expression of groups.

This group is again atomic, but now this atom is not a "pure" atom. This new atom would be easier to understand if we look at the fact that we see the world with different levels of detail depending on diverse factors. An example we have seen already is the domain of time, which may be measured in seconds, days, weeks, years,... depending on the accuracy we want to show. In terms of time, it is not the same to say 'it is going to snow pretty soon' than 'soon the polarity of the earth's magnetic field will be reversed'.

There is an inverse operator, $\downarrow$, which, when applied to a group, returns the join of the members of the group. In a sense, it undoes $\uparrow$'s operation so that, for every pure sum x, the following holds: $\downarrow (\uparrow (x)) = x$. There is a difference in the type of function between $\uparrow$ and $\downarrow$: whereas $\uparrow$ is an injection, $\downarrow$ is a surjection: there may be several atoms x_i such that $\downarrow x_i = x$. For example, John and Bill may be the members of two different committees, C_a and C_b. In that case we will have that:

(2.24) $\downarrow (C_a) = \downarrow (C_b) = \downarrow (\uparrow (j \sqcup b)) = j \sqcup b$

This can be graphically expressed in Figure 2.4, extracted from Landman 1989:577.

This forming of groups is recursive, so that if A and B are actually groups, then $\uparrow (A \sqcup B)$ is a group whose components are A and B, where A is a group whose components are x, y and z, and so on. It is this group-forming recursivity which allows us to express granularity in a lattice. As a consequence, the use of $\uparrow$ is better than Link's (1987) use of several levels of lattices, since now $\uparrow$ relates two elements in *the same lattice,* and therefore we do not need any mapping from one lattice to another nor the establishment of several levels of granularity in independent lattices. In this approach, all the possible objects at every possible level of granularity are in the same lattice, from the smallest portions of masses to the most abstract all-embracing concepts.

Given all the machinery above, a sentence like 'John and Bill carried the piano upstairs' may have the following possible readings, according to Landman (1989):

Distributive reading: Both John and Bill independently carried the piano, and as a consequence a plural event is created, one for John and another for Bill: $^{*}C(j \sqcup b)$.

Collective reading: John and Bill did the carrying as a team; in this case, it is the group of John and Bill which does the carrying, creating only one event: $C(\uparrow (j \sqcup b))$

These two types of readings will have associated different aspectual interactions, as we will see in Chapter 4.

Chapter 3

Several Approaches to Aspectual Composition

There have been several attempts to explain aspectual composition. In Chapter 2, for example, we have already seen Hinrichs' approach. Now, in this chapter I will focus on Verkuyl's, Krifka's and Naumann's models. The reason why I am focusing on these theories is that all three of them represent serious attempts to solve the problem of aspectual composition by using formalised semantic models: Generalised Quantifiers, Lattices, and Dynamic Semantics, respectively. By examining these approaches in depth one can see better what they share in common and in what they differ, and what types of problems one may expect to encounter in the field of aspectual composition.

3.1 Verkuyl

3.1.1 The basic framework

Verkuyl has been analysing the compositional nature of aspect since as early as 1972. Since then he has formalised his theory in a series of publications (1986, 1989, 1993, 1994, 1995a, 1995b).

With respect to the determination of the aspect of a sentence, Verkuyl establishes a clear difference between the behaviour of an NP and that of a verb. Both expressions contribute to the final aspectual properties of the sentence, but each of them do it differently:

- An NP is characterised by means of the feature **SQA**, which indicates the possible quantisation of the entity referred to by the NP. Thus, a determined plural or singular NP will be [+SQA], whereas a mass or bare plural NP will be [⇔SQA].
- A verb will be characterised by means of **ADDTO,** which indicates the verb's ability to divide time into several stages. A stative verb will be [⇔ADDTO], whereas a dynamic verb (activities, accomplishments and achievements in Vendler's terminology) will be [+ADDTO].

The several NPs a sentence may have do not interact with the verb at the same level. Rather, Verkuyl speaks of an **aspectual asymmetry** where first the verb's ADDTO feature interacts with the inner NP's SQA feature giving a new feature **T** which accounts for having or lacking terminativity. This feature T will then interact with the outer NP's SQA, giving the final value of T for the whole sentence. The following examples are extracted from Verkuyl (1993:22):

(3.1) a. 'ate three sandwiches' [+ADDTO]+[+SQA]=[+T]$_{VP}$
b. 'ate sandwiches' [+ADDTO]+[⇔SQA]=[⇔T]$_{VP}$
c. 'wanted a sandwich' [⇔ADDTO]+[+SQA]=[⇔T]$_{VP}$
d. 'wanted sandwiches' [⇔ADDTO]+[⇔SQA]=[⇔T]$_{VP}$

e. 'Judith ate three sandwiches' [+SQA]+[+T$_{VP}$]=[+T]
f. 'Judith ate sandwiches' [+SQA]+[⇔T$_{VP}$]=[⇔T]
g. 'nobody ate a sandwich' [⇔SQA]+[+T$_{VP}$]=[⇔T]
h. 'no one wanted sandwiches' [⇔SQA]+[⇔T$_{VP}$]=[⇔T]

From (3.1) we see that we need for all the components to have the + value if we want to have a terminative [+T] reading. If one (or more) of the elements has ⇔, the final sentence results in [⇔T] (non-terminativity): this is what Verkuyl calls the **plus-principle.**

The interactions between the verb and the inner NP are different from those between the resulting predicate phrase and the outer NP. Thus, an **internal θ-role** is specified by the interaction between the object referred to by the inner NP and a **path** defined by the verb, by means of a Path-function ℓ (see below, Section 3.1.6). The result of this interaction will be the aspectual interpretation of the VP. An **external θ-role** will be defined by the participancy function π, which takes as domain the external NP-denotation and has as its range the VP. The combination of both interactions gives the aspectual interpretation of the whole sentence, as can be seen in Figure 3.1, extracted from Verkuyl (1995b:35).

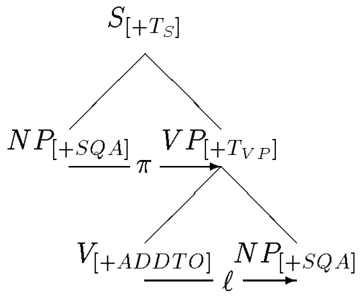

Figure 3.1. The external and internal aspectual interactions.

This is a simplified sketch of Verkuyl's theory, and this summary is far from complete. In the remainder of this section I will comment more exhaustively on Verkuyl's insights, together with some consequences and problems which derive from them.

3.1.2 NPs and SQA

Verkuyl uses **generalised quantification** to account for the determination of the value of [SQA] which is assigned to an NP. In the Theory of Generalised Quantifiers, the determiner of an NP specifies a set of sets (see Barwise & Cooper 1981 and the collection of papers which form van Benthem & ter Meulen 1985). This set has some restrictions, presuppositions and implications which are established by the determiner itself, as can be seen in the following example, taken from Verkuyl (1986):

(3.2) a. 'all children were photographed'
b. $\|all\ N\| = \{X \subseteq U \mid \|N\| \subseteq X\}$; Presupposition: $|\,\|N\|\,| > 0$
c. $U = \{a, b, c, d\}$
d. $A = \|child\| = \{b, c, d\}$
e. $B = \|be\ photographed\| = \{a, b, c, d\}$
f. $\|all\ children\| = \{\{b, c, d\}, \{a, b, c, d\}\}$

The determiner *all* is such that whenever it combines with a noun the result is a set of all the sets which include the denotation of the noun (3.2b), giving (3.2f) above.

Under such a framework it is possible to define SQA by referring to the sets A and B, which correspond to the extension of the N and the VP, respectively. A simple attempt at defining SQA appears in Verkuyl (1993:101), which I repeat here:

English	semantics	$\|A \cap B\|$	SQA
an N	$\{B \subseteq U\| \ \|A \cap B\| \geq 1\}$	> 0	$+$
the N(sg)	$\{B \subseteq U\| \ A \subseteq B\}$	$= 1$	$+$
the N(pl)	$\{B \subseteq U\| \ A \subseteq B\}$	> 0	$+$
all N	$\{B \subseteq U\| \ A \subseteq B\}$	> 0	$+$
no N	$\{B \subseteq U\| \ A \cap B = \emptyset\}$	$= 0$	$\Leftrightarrow$
$\emptyset$ N(pl)	$\{B \subseteq U^*\| \ A \subseteq B \wedge \|A \cap X\| = \%\}$	undetermined	$\Leftrightarrow$

Table 3.1. Generalised Quantifiers and SQA.

(3.3)
$$
\begin{array}{lll}
|A \cap B| = m \text{ (where } m \in N) & \Rightarrow & [+\text{SQA}] \\
|A \cap B| = 0 & \Rightarrow & [\Leftrightarrow\text{SQA}] \\
|A \cap B| = \text{undetermined} & \Rightarrow & [\Leftrightarrow\text{SQA}]
\end{array}
$$

That is, if the intersection gives the empty set or if the number of the elements of the set is not determined, then the NP will be [⇔SQA]. Otherwise it will be [+SQA]. Some examples of the SQA properties of determiners, extracted from (Verkuyl 1986), are included in Table 3.1 .

Verkuyl points out that these definitions are not free of trouble, especially when dealing with some special complex NPs. He provided later a better and far more complicated explanation of what SQA should stand for, by using lifting types (Verkuyl 1993). However, for our purposes the explanation above suffices.

Verkuyl's use of generalised quantifiers may represent a problem in trying to account for **mass nouns.** The reason for this is that the Theory of Generalised Quantifiers is based on sets, but masses do not refer to sets of entities since there are no minimal atomic elements referred to by masses, as we have seen in Chapter 2. Verkuyl overcomes this by using **measures**, which may be seen as functions from the mass domain to that of integers. Thus, $|A|_{\text{litre}} = 1$ in 'one litre of whisky'. With this new definition of the cardinality of A it is possible to use the rules expressed in (3.3) to decide ±SQA in NPs containing masses.

3.1.3 Partitions and quantification

As we have seen above, in the Theory of Generalised Quantifiers $A \cap B$ is actually the set of all the elements under the extension of the noun which are engaged in the action referred to by the VP. These elements, however, are not always jointly engaged in the same action. Rather, they may form smaller groups in such a way that every group is

Is a partition	Is not a partition	Why is not a partition
$\{\{a, b\}, \{c, d\}\}$	$\{\{a, b\}, \{c\}\}$	missing d
$\{\{a\}, \{b\}, \{c, d\}\}$	$\{\{a, b\}, \{b, c\}, \{d\}\}$	b repeated
$\{\{a, b, c, d\}\}$	$\{\{a\}, \{b, c\}, d\}$	d is not a set
$\{\{a\}, \{b\}, \{c\}, \{d\}\}$	$\{a, b, c, d\}$	this is not a set of sets

Table 3.2. Some legal and illegal partitions.

independent from the others in the action. Consider, for example, the sentence:

(3.4) ‘three people wrote a letter’

Let j, m and p be the three entities which are engaged in writing (they may refer, for example, to *John*, *Mary* and *Peter*). Sentence (3.4) may refer to two letter-writing events such that in the first event e_1 John and Mary together write one letter, and in the second event e_2 Peter writes another letter. Verkuyl expresses this possibility by defining a **partition** on the set $\{j, m, p\}$. A partition is any of the possible sets of disjoint subsets whose union make the whole set again. Table 3.2 exemplifies what (and what not) a partition is of a set $\{a, b, c, d\}$.

By means of partitions it is possible to determine all the possible situations in which the participants may be engaged in the action, including the collective and the distributive readings. In a collective reading, for example, all the participants are jointly involved in the same event. Under such a reading, one may consider all the participants as forming a group which is engaged in the action (Landman 1989). This interpretation can be expressed by means of a partition with only one set containing all the elements: $\{\{a, b, c, d\}\}$. At the other end, in a distributive interpretation every element is independently engaged in the action (or a bit of the action). That is, now there will be as many actions as participants involved. This can be expressed as a partition with singular sets: $\{\{a\}, \{b\}, \{c\}, \{d\}\}$. Between these two extremes there is a range of possibilities which can all be expressed in terms of different partitions. An example of such an intermediate reading is the one assigned to (3.4) in which one person writes one letter and the other two jointly write another letter. Such a partition would be expressed as:

$$\{\{j, m\}, \{p\}\}$$

When two quantifiers appear we will have two different partitions, one for the objects engaged in the action (related to the NP in subject position), and another for the objects affected by the action (related to the NP in object position). As an example, Verkuyl's (1993) initial version of the translation of the sentence 'two girls ate five sandwiches' is as follows (Verkuyl 1993:157-158):

(3.5) 'two girls ate five sandwiches'

$$\exists Z[Z \subseteq \|\textit{girl}\| \wedge |Z| = 2 \wedge \exists P \mathrm{ps} Z[P = \{V \cap \|\textit{girl}\| : \exists W[W \subseteq \|\textit{sandwich}\| \\ \wedge |W| = 5 \wedge \exists Q \mathrm{ps} W[Q = \{U \cap \|\textit{sandwich}\| : \|\textit{eat}\|(U)(V)\}]]\}]]$$

In Example (3.5) there are two partitions defined. First of all, the set of sandwiches eaten W is partitioned into Q. This is expressed by $Q\mathrm{ps}W$ 'Q partitions W.' But we need also another partition P of the set of the girls Z which ate the sandwiches W. The example is saying, therefore, that there is a partition P of the set Z of girls such that every member of P ate five sandwiches W and furthermore the sandwiches are eaten in the order determined by the partition Q of W.

Which partition is actually chosen as Q or P is left unspecified, giving room for the possibility of expressing different interpretations including the distributive and collective readings, all of them with the same representation. For example, let the set of five sandwiches be $W = \{s1, s2, s3, s4, s5\}$. One of the possible partitions is $Q = \{\{s1, s2, s3, s4, s5\}\}$, which would represent a collective reading. Another partition representing a distributive reading would be $Q = \{\{s1\}, \{s2\}, \{s3\}, \{s4\}, \{s5\}\}$. An example of an intermediate reading where the sandwiches are grouped would be the partition $Q = \{\{s1, s2\}, \{s3\}, \{s4, s5\}\}$. Any one of these partitions could be the one chosen by the variable Q, which is existentially quantified.

3.1.4 Verbs and [+ADDTO]

To model the structure of the actions, Verkuyl uses the concept of a **path.** In the example of movement verbs, the path is the spatio-temporal projection of the NP object during the movement. This path is continuous in the real world, but we actually interpret it as being discrete. In Verkuyl's words:

> What we are basically doing is extracting from a dense structure some part that is equivalent to the structure inherent to the set of natural numbers. (1993:219)

To show the discretisation of the path, Verkuyl uses an example of walking home, where on the way home a man goes first to a bookshop, then he suddenly realises he has forgotten something and goes back, then he stops at a bar, *etc.* Every one of these stages will set an **index** which will divide the path. As a result, the whole set of indices will create a discrete path.

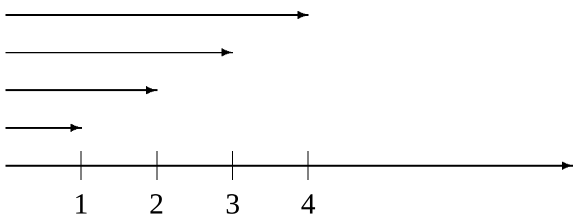

Figure 3.2. This figure expresses the concept of an odometer: each natural number k that appears on the odometer represents the stretch $(0, k)$. Verbs expressing change can be compared with an 'active' odometer: their semantics represent stretches (Paths) having an origin.

In this way, the verb is considered as an **odometer** which counts the 'mileage' from point zero. A [+ADDTO] verb will express this feature by means of a succession of well-ordered numbers (the indices) which represent the path so far from the start up to a certain point, as Figure 3.2 shows, extracted from (Verkuyl 1993:222).

Jackendoff's parts and boundaries

Verkuyl uses Jackendoff's (1991) theory to explain the composition of bounded and unbounded events and objects. The reason for this is that Verkuyl claims that the intuitions underlying Jackendoff's theory can be used in such a way that the plus-principle (see Section 3.1.1) can be explained. A translation *à la* Jackendoff of the sentence 'John walked to the store' follows:

(3.6) 'John walked to the store'

$$\begin{bmatrix} \text{EVENT} \\ +\text{bounded} \\ \text{GO}(\begin{bmatrix} \text{THING} \\ +\text{bounded} \\ \text{JOHN} \end{bmatrix}, \begin{bmatrix} \text{PATH} \\ +\text{bounded} \\ \text{TO}(\begin{bmatrix} \text{THING} \\ +\text{bounded} \\ \text{STORE} \end{bmatrix}) \end{bmatrix}) \end{bmatrix}$$

This semantics is compatible with Verkuyl's plus-principle, since according to the plus-principle the semantics of (3.7) below must give a bounded event, since both arguments are bounded:

(3.7) $\mathrm{GO}(+\mathrm{bounded}, \begin{bmatrix} +\mathrm{bounded} \\ \mathrm{TO}(+\mathrm{bounded}) \end{bmatrix})$

and this expression is the ‘core’ of (3.6).

When it comes to explain the aspectual effect of plurals, Verkuyl performs ‘a localistic construction of Path structure,’ as he says in his (1993) book. We can see what Verkuyl means with the following sentence:

(3.8) ‘John walked to stores’

Sentence (3.6) is bounded, as we have seen, but (3.8) is actually unbounded; the reason for this may be either ‘i)’ or ‘ii)’ below:

i) the sentence refers to an unbounded set of walkings, or

ii) the sentence refers to a walking over an unbounded set of stores.

Since ‘stores’ is [⇔bounded,+internal structure,1-dimensional][1] and TO applies to 0-dimensional entities, TO will automatically distribute over the elements of the set of stores, yielding not one path but an unbounded set of bounded paths (Verkuyl 1993:231). As a consequence, GO will have to distribute as well over the unbounded set, and therefore *John* will have to distribute as well.

The same would roughly apply to sentences like the following:

(3.9) ‘Judith ate three sandwiches’

The NP ‘three sandwiches’ will also be 1-dimensional, like ‘stores’ in (3.8), this time ordered according to which sandwich is going to be eaten first. The difference between ‘three sandwiches’ and ‘stores’ is, of course, that the first is [+bounded] whereas the second is [⇔bounded], thus giving a different result regarding terminativity.

Verkuyl is able to explain these sentences, but still some data remain unexplained. First of all, Verkuyl’s explanation does not cover the case ‘ii)’ of the interpretation of (3.8), that is, when we have a unique walking event over an unbounded set of stores. Secondly, there are counterexamples where the final sentence is bounded even when the subevents are unbounded, as we can see in the sentence:

(3.10) ‘John drove 5 cars’

---

[1] It is 1-dimensional because Verkuyl assigns this property to any plural; see Verkuyl (1993:231).

As we have seen already in Chapter 1, (3.10) is telic despite ‘John drove a car’ being atelic. Under Verkuyl’s approach the sentence would be analysed as a set of unbounded events, and therefore, atelic.

3.1.5 Context-dependent readings

As it has been pointed out in Chapter 1, a sentence may be interpreted as either durative or terminative, depending on context. Verkuyl provides two devices to explain this.

Durative leakage

There may be cases where an NP, despite being usually considered [+SQA], in some contexts it acquires a [⇔SQA] value. Consider the following examples:

(3.11) a. ‘for weeks she turned off Dallas’
b. ‘for years Mary sold three saucers’

Even when ‘she turned off Dallas’ is a terminative sentence, in (3.11a) the proper name ‘Dallas’ refers to a set of issues of Dallas, acquiring a [⇔SQA] value. This gives the sentence a durative reading. In (3.11b), ‘three saucers’ refers to three types of saucers, and as a consequence it is also [⇔SQA].

Verkuyl names this phenomenon ‘durative leakage,’ since a [+SQA] NP may have a [⇔SQA] interpretation but not the other way round, Verkuyl argues. Note that what is described here is the possibility for a complete NP to acquire its final [±SQA] interpretation. The fact that a mass noun is sometimes interpreted as a count noun and vice versa is an independent issue. Examples like the following, extracted from Pelletier (1979), show the point:

(3.12) a. ‘there is steak all over the floor’
b. ‘how many oatmeals are in your kitchen?’

The noun ‘steak’ will normally be countable, but in (3.12a) it is treated as a mass, and it is clear in that sentence because it is syntactically marked as a mass. As a result, ‘steak’ is straightforwardly [⇔SQA]. Similarly, the noun ‘oatmeal’ is usually a mass, but in (3.12b) it is syntactically treated as count, since it is pluralised.

The perspective shift

There is another case in which a sentence acquires a terminative/durative reading which is different from that of its natural interpretation. Verkuyl uses the example of some of the possible Tarski worlds, for which one can say ‘I moved the small cube to the left of the largest tetrahedron’ implying a terminative reading, but it may be durative if we actually refer to an indefinite set of Tarski worlds where the speaker moved the cube in all of them.

The following example is self-explanatory. Here a possible situation is described where two different guns are trying to sink Miles’ vessel.

> The guns were taken apart and put on different location, say one mile from each other . . . They have now different commanders shooting independently from one another, according to their own judgement. The two commanders are ordered by a general to sink Miles. Now, the guns happen to fire one after the other and Miles is hit by two projectiles at exactly the same time. Is it reasonable to speak of one event? It depends on the observer. For Miles (not being able to tell the sound of the two guns apart from that of other guns) it is reasonable to think of one event consisting of receiving two hits at the same time. For those who do not know about the span of control of the German general, there are two events: they do not take into account coordination of the gun. For the general it is one event.
> (Verkuyl 1993:278-279)

Verkuyl explains this behaviour by appealing to the possibility of taking one or another perspective of the situation. In the example quoted above, depending on who is viewing the situation there is one event involved or two.

Different perspectives are accounted by Verkuyl by grouping what is expressed by the indices. In Verkuyl’s words:

> In my view, aspect construction should indeed be analysed in terms of perspective, in the sense that indices are playing a crucial role in determining sentential aspect, where *index* is the neutral term for semantic entities on which other semantic entities are made dependent. To the set of indices belong numbers, worlds, models, intervals, situations, points, etc. Perspective comes in at the moment at which it depends on the choice of an index whether or not a sentence is used to express terminative aspect or durative aspect. (Verkuyl 1993:268)

That is, Verkuyl uses the indices to express the different interpretations of the event, by defining one or another level in granularity. This way of working with perspective therefore looks like the event ontology discussed in Chapter 2. That is, one object can be seen in different ways, and even the same expression may imply either atomicity or structuration. But Verkuyl relies not only on different perspectives: he also uses the concept of partition to explain the vagueness in the interpretation of the event structure (see Sections 3.1.2 and 3.1.3).

There is, however, another type of aspectual shift which is difficult to explain with Verkuyl's perspective shift. Consider Example (1.4), which I repeat here:

(1.4) a. 'John ran for hours'
b. *'John ran in twenty minutes'
c. 'John ran a mile in five minutes'
d. *'John ran a mile for an hour'

As I said in Page 11, (1.4b) and (1.4d) are not really ungrammatical under an appropriate context: if it is possible to assign a goal to the run of (1.4b), for example, if we are referring to a race, (1.4b) will not be ungrammatical. In the same way, (1.4d) is fine under an iterative reading. These two phenomena have been noticed by several scholars. For example, Moens & Steedman (1988) uses the concept of coercion: 'John ran' is originally an activity, but when it combines with an in-adverbial it coerces into an accomplishment (or culminated process under Moens & Steedman's terminology) so that the adverbial is compatible. Verkuyl's account can explain (1.4d) by shifting the perspective outside the scope of the running event over a mile, and thus allowing the occurrence of iterativity: there is an undetermined set of indices and each of them signals one independent run (this explanation is the same as the one given by Verkuyl to the durative interpretation of the sentence 'I moved the small cube to the left of the largest tetrahedron', which we have seen above). But the perspective shift approach cannot explain why (1.4b) can sometimes be acceptable.

3.1.6 Internal and external θ-roles

Verkuyl describes two different types of interactions according to whether they affect either the internal or the external argument. In the case of the internal argument, there is a mapping between the objects referred to by the argument and the path of the action. This mapping is explained by means of the path-function ℓ.

The external argument triggers a different interaction. Now there is no mapping with the path but with full actions. In this approach, therefore, the external argument can affect only the possible plurality of the action, very much in the line of Naumann's (1995a) plurals, Eberle (forthcoming), or Sanfilippo (1991).

Thus, the example

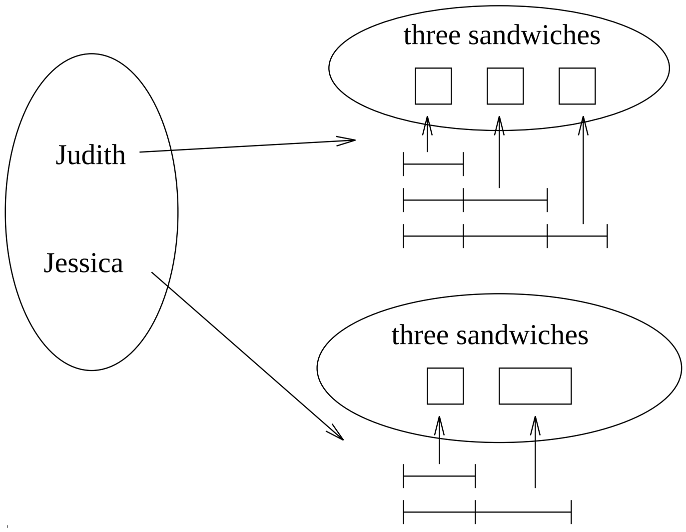

Figure 3.3. A possible interpretation of 'Judith and Jessica ate three sandwiches'.

(3.13) 'Judith and Jessica ate three sandwiches'

can be used to describe a situation where two independent events are happening. In the first event, Judith eats three sandwiches, one at a time. In the second event, Jessica eats also three different sandwiches, but now she eats first one and then the other two together. This interpretation is depicted in Figure 3.3.

Internal θ-role and the path-function ℓ

An internal θ-role is one which usually applies to the object of a transitive verb in sentences like 'John read a book' and 'Peter ate an apple'. But this θ-role also applies to the subject of an unaccusative verb ('die', 'depart', ...), since in these verbs the subject plays a semantic role which is very similar to that of an object of a transitive verb, as we will see in Chapter 5.

Verkuyl uses the Path-function ℓ to account for the interaction between the verb and the NP. As the action progresses in time a path is defined which follows the trace of the movement of the object in time. This path, as we have seen before, is not a continuous one, since there is a set of indices which divide the path, creating a discrete path. For example, if we examine again the example in Section 3.1.4 of somebody's walk home, the path-function establishes a set of pairs <index,location> such as the following:

$$\ell_{\text{walk home}} = \{< 0, \text{office} >, < 1, \text{book shop} >, < 2, \text{office} >, \cdots$$

$$\cdots, < t_m, \text{home} >\}$$

Verkuyl only works with relatively simple path-structures like the one shown above. However, the progression can occur along a path which does not necessarily need to be related to a distance or a place; it can also occur in another domain. Thus, in (3.14a) the domain is distance, but in (3.14b) the action progresses in the sequence of apples which are actually eaten. The movement can also happen in other more exotic domains, such as the scale of degrees of ripening in (3.14d). It may even be the case that the domain is not linear. Thus, in (3.14c) the domain is the volume of the beer which is drunk. In such a case the domain is linearised according to how the beer is drunk. Although Verkuyl does not say anything about this, it could be possible to accommodate Naumann's (1995a) account on the study of the progression of the action along a non-trivial path (see Section 3.3 for Naumann's account).

(3.14) a. 'John ran a mile'
b. 'Judith ate three apples'
c. 'Mary drank a pint of beer'
d. 'the fruit ripened'

When the internal interaction occurs, every index will have associated one element of the partition of the set of objects engaged in the action. At every index, Verkuyl (1993) considers all the elements from the beginning of the action up to the index — Verkuyl establishes a comparison with the odometer of a car, which counts the miles which have been run from the beginning of the journey. As the action progresses the set of objects considered from the beginning increases in size, and this set can be expressed by the function **W**. Every index i will have its corresponding **W**(i), which will represent the set of objects considered from the beginning. This is graphically expressed in Figure 3.4.

Verkuyl (1993) formalises this by saying that the partition Q of the set of objects W is as follows, if we are talking of sandwiches, for example:

$$Q = \bigcup_{I} \mathbf{W}|_{||sandwich||}$$

The subexpression $\bigcup_I \mathbf{W}$ is an abbreviation of $\bigcup_{i \in I} \mathbf{W}i$, which, as Verkuyl says, "is a collection of sets obtained by taking **W** as the function ℓ such that at any index i it gives us a collection of sets to which the predicate applies at i" (1993:299). Verkuyl adds that "a collection of sets P is constructed by **W** because **W** is defined as a function

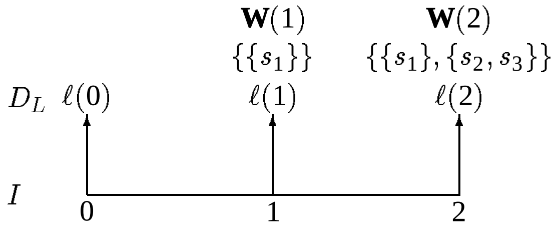

Figure 3.4. An example of the path structure for the sentence 'Mary ate three sandwiches'.

determining exactly which sets are in P at each construction step." The expression $Q = \bigcup_I \mathbf{W}|_{\|sandwich\|}$ is an abbreviation of $Q = \bigcup_{i \in I}\{U \cap \|sandwich\| : U \in Q\}$. Thus, the sentence 'Mary ate three sandwiches' could be seen as shown in Figure 3.4.

The result of the interaction between the verb and the NP is straightforward. If there is a finite number of entities involved in the action the partition is also finite, and as a result the division established to the path is finite too. As a consequence, the action is bounded i.e. telic. However, if the number of entities involved is left undetermined there is no guarantee that the division established to the path is finite, giving as a result an unbounded action i.e. atelic.

A feature of Verkuyl's account which is rather striking is its complexness. At every index i assigned to the path, the function $\mathbf{W}(i)$ returns the set of all the objects considered from the beginning, such that at the last index n, $\mathbf{W}(n)$ records all the objects considered in the action. But this is not our intuitive interpretation of the role of the index. Taking Verkuyl's example of someone walking home, he is specifically assigning one place in the real world to every stage of the walking action: first a bookshop, then the office, then a bar, and so on. In other words, if we look at our intuitions, it would be far simpler if $\mathbf{W}(i)$ returns only the object which is considered at index i, as shown in Figure 3.5. This new definition of $\mathbf{W}$ would also explain the aspectual interactions in the same way as Verkuyl's odometric theory: if the NP refers to an unbounded set, then the set of time chunks is also unbounded and therefore there is no terminativity [⇔T]. But if the NP refers to a bounded set, then the set of time chunks is also bounded and therefore there is terminativity [+T]. While the reason why Verkuyl uses the 'odometric' approach is not clear, a redefinition of **W** in the line suggested here would result in a simpler and more intuitive method.[2]

---

[2] Incidentally, note that in Verkuyl's subsequent papers (1995a, 1995b and 1995c) there is no reference at all to the use of **W**, although he still uses the concept of an odometer.

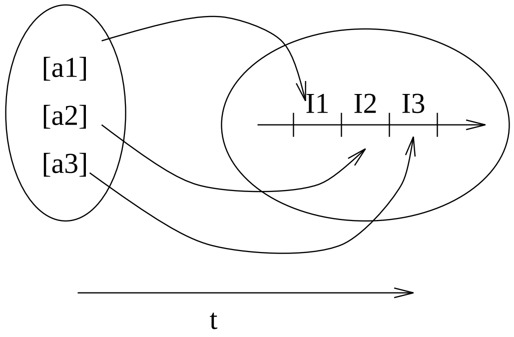

Figure 3.5. An intuitive explanation of the interaction with an [+ADDTO] verb, as an alternative to Verkuyl's proposal: in this case, an interval is assigned to every partition element referred to by the NP (no reference at all to what has happened before), and the intervals themselves are consecutive.

External θ-role and the participancy-function π

An external θ-role is one which applies to the subject of transitive and unergative verbs. The external θ-role is materialised in Verkuyl's theory by means of the **participancy function** π. This function takes as an argument an element of a partition of the objects which perform the action, and it returns the path-structure defined by ℓ. An example provided by Verkuyl (1993:305) follows.

(3.15) 'four boys lifted three tables'
$\text{Boy}_1 \mapsto \{< i_1, \text{table}_1 >, < i_2, \text{table}_{2,3} >\}$
$\text{boy}_2 \mapsto \{< j_1, \text{table}_{4,5} >, < j_2, \text{table}_6 >\}$
$\text{boy}_3 \mapsto \{< k_1, \text{table}_7 >, < k_2, \text{table}_8 >, < k_3, \text{table}_9 >\}$
$\text{boy}_4 \mapsto \{< m_1, \text{table}_{10,11,12} >\}$

The function π can be either an injection or a constant. When an **injection,** π will assign different objects to every individual. However, when a **constant,** π will assign the same objects to every individual. By means of this function Verkuyl can express the different readings regarding the participation of the elements in the action. Concretely, a distributive reading can be expressed by means of an injection, whereas a collective reading will be expressed by means of a constant function. Verkuyl (1994) puts a strong emphasis on blurring the distinction between a distributive and a collective reading. One reason for this is that, apart from these readings one can also find many intermediate readings which would be very difficult to classify as either distributive or

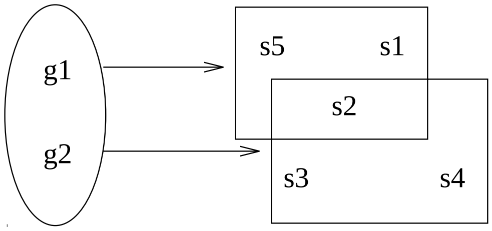

Figure 3.6. A reading of the sentence ‘two girls ate five sandwiches’ where one of the sandwiches is jointly eaten.

collective.[3] For example, one can interpret (3.5) as in Figure 3.6. This can be expressed in terms of the participancy function as follows:

(3.16) ‘two girls ate five sandwiches’
$g_1 \mapsto \{< i_1, s_{1,5} >, < i_2, s_2 >\}$
$g_2 \mapsto \{< i_3, s_{3,4} >, < i_2, s_2 >\}$

In (3.16) the two girls jointly eat one of the sandwiches but they eat all the others separately.

In the section of Verkuyl’s book which explains the external θ-role, the function π takes as an argument an element of the extension of the subject. This definition, however, does not explain collectivity well. One would like to consider collectivity as implying that it is the set itself which is engaged in the action, that is, no emphasis is given to which extent every one of the components of the set is itself involved in the action. It is even possible to think of a possible interpretation of ‘the team of car engineers repaired the car’, where actually one of the members of the team did not do anything at all. In Verkuyl’s approach, however, collectivity is seen as implying that *all* the components are involved in the action. Furthermore, they do the action regardless of what the other components are doing. No teamwork is implied; they just happen to be doing the same thing, and this is not the real meaning of collectivity. This drawback disappears if the function π takes as an argument an element of the *partition* of the subject, as is actually implied in Verkuyl’s semantic translations of full sentences such as (3.5) in page 48. In our example ‘four boys lifted three tables’, the partition involved in a collective reading would be $\{\{boy_1, boy_2, boy_3, boy_4\}\}$.

---

[3] See also (Lasersohn 1995), chapter 8, for a review of possible types of sentence readings. Lasersohn comments on three possible classifications: just one reading, arbitarily many, or only two (distributive and collective).

One of the reasons why Verkuyl uses these participancy functions is that it is easy to explain the meaning of sentences like (3.16), or for that matter, the one given by Verkuyl (1994:65):

(3.17) 'Hammerstein, Rogers and Hart wrote some musicals'

This sentence may be true even when none of them wrote a musical alone, nor the three of them jointly wrote a musical. For example, Hammerstein and Rodgers might have teamed to write a musical, and later Rodgers and Hart co-wrote another musical. If we use participancy functions, we could express it in this way:

(3.18) 'Hammerstein, Rodgers and Hart wrote some musicals'

$$\begin{array}{ll} \{\text{Hammerstein}\} & \mapsto \{\cdots < i, \text{musical}_1 > \cdots\} \\ \{\text{Rodgers}\} & \mapsto \{\cdots < i, \text{musical}_1 >, < j, \text{musical}_2 > \cdots\} \\ \{\text{Hart}\} & \mapsto \{\cdots < j, \text{musical}_2 > \cdots\} \end{array}$$

If we want to use partitions we encounter the problem that the two desirable elements of the partition, {Hammerstein,Rodgers} and {Rodgers,Hart}, do overlap and thus the partition is incorrect.

One way out of this problem would be the use of **covers** instead of partitions, after Gillon (1987) (See also Naumann 1995a:123; Lasersohn 1995:132). A cover is like a partition but now we allow for overlapping. The definition of a cover is therefore weaker, allowing for the reading expressed in (3.18). The number of possible covers in a set is much bigger than that of possible partitions of the same set, but still a finite set has a finite number of different covers. The aspectual interactions work therefore as well with covers as with partitions.

As it has been said in Section 3.1.3, since the choice of the actual partition is left unspecified, one expression suffices to represent a wide range of readings involving distributivity, collectivity and intermediate readings. Now, with the help of the participancy function, even some of the several scopal readings are also expressed in the above translation. This can be seen in (3.16) above.. In the interpretation of (3.16), there is one partition of $W_1 = \{\{s1, s5\}, \{s2\}\}$ for the first girl, and another partition of $W_2 = \{\{s3, s4\}, \{s2\}\}$ for the second girl. It just happens that there is a sandwich, $s2$, which belongs to both W_1 and W_2.

It could also be that $W_1 = W_2$, in which case we have only five sandwiches involved. That is, the scope of the sandwiches would be at the same level as that of the girls, giving the following interpretation:

(3.19) ‘two girls ate five sandwiches’

$$\exists G, W\,[two.girls(G) \wedge five.sandwiches(W) \wedge ate(G, W)]$$

Verkuyl therefore manages to express a wide range of possible readings involving sentence readings and quantification in only one expression. But there are still some readings which this expression does not cover, like the somewhat odd reading where the five sandwiches have a scope wider than that of the two girls, that is, that there are five sandwiches where for every sandwich, there are two girls who eat them. This reading is very odd for this sentence, but consider a similar reading of the following sentence, whose interpretation is given also:

(3.20) ‘two lawyers hired five cleaners’

$$\exists C\,[five.cleaners(C) \wedge \\ \forall c(c \in C \rightarrow \exists L\,[two.lawyers(L) \wedge hired(L, C)])]$$

3.1.7 PUSH- and [−ADDTO] verbs

PUSH-verbs

The PUSH-verbs comprise a set of verbs like ‘draw’, ‘paint’, ‘push’, ‘drive’,... where the plus-principle does not hold: we can say ‘push a cart for hours’, implying therefore a non-terminative reading for ‘push a cart’, but ‘push’ is [+ADDTO] and ‘a cart’ is [+SQA]. These verbs seem to pose a challenge to Verkuyl’s theory.

Verkuyl (1993) overcomes this problem by treating these verbs as needing some special particle in such a way that the verb plus the particle will form a “complex verb.” If that particle does not exist, then the complex verb itself will be [⇔T], despite the verb actually being [+ADDTO]. For example, ‘push’ is [⇔T], but ‘push away’, because of ‘away’, will be [+T]. Depending on the particle itself, the verb may be [+T] or [⇔T]. Thus,

‘John pushed the cart on’	is [⇔T]
‘John pushed the cart away’	is [+T]
‘John pushed the cart $\emptyset$’	is [⇔T]

This interaction between the particle and the verb itself can be described by means of a variation of the θ-internal role (Verkuyl 1993:314):

‘on’	describes $\theta_{\subseteq}$	$\|\theta_{\subseteq}\| = \lambda \mathrm{NP} \lambda W \exists R[\mathrm{NP}(R) \wedge \bigcup_I W \subseteq R]$
‘away’	describes $\theta_{=}$	$\|\theta_{=}\| = \lambda \mathrm{NP} \lambda W \exists R[\mathrm{NP}(R) \wedge \bigcup_I W = R]$

The second θ-role is no more than our well-known internal θ-role: the partition R corresponds with the set of sets referred to by the path-structure created by the verb. The first θ-role, however, specifies that the set of sets referred to by the path-structure is actually a *subset* of the partition R. Thus, ‘John pushed the cart’ is translated as:

(3.21) ‘John pushed the cart’

$$\exists I \exists! V[V = \|\mathit{John}\| \cap \{j_i\} \wedge$$
$$\exists! W[W \subseteq \|\mathit{cart}\| \wedge |W| = 1 \wedge$$
$$\exists Q \,\mathrm{ps}\, W[Q \supseteq \textstyle\bigcup_{i \in I}\{U \cap \|\mathit{cart}\| : \|\mathit{push}\|(I)(i)(U)(V)]\,]\,]$$

There is indeed a need for a new type of relation between the verb and the NP so that the aspectual transfer is not accomplished. However, Verkuyl’s $\theta_{\subseteq}$ is not the solution. Consider again (3.21). Since there is only one cart, say c, there can be only one partition: $Q = \{\{c\}\}$. However, the semantic interpretation shown in (3.21) specifies that Q is a superset of the set of groups of carts which are actually pushed. Since there is only one cart considered, we can only conclude that:

$$Q = \bigcup_{i \in I}\{U \cap \|\mathit{cart}\| : \|\mathit{push}\|(I)(i)(U)(V)$$

That is, for (3.21), $\theta_{=} = \theta_{\subseteq}$, and as a consequence it will predict terminativity, which of course is a wrong prediction.

A reason why Verkyl uses $\theta_{\subseteq}$ is the intuition underlying partitives. For example, in (3.22) the intuitive interpretation is that the eating event is not over all the sandwiches, but over a part of them:

(3.22) ‘Judith ate from three sandwiches’

Going back to (3.21), it is true that when somebody pushes a cart he does it by exerting the push to only a part of it, but even if Verkuyl wanted to express this property there is no connection between this and the aspectual property of the sentence. After all, even if we effect the push over only a portion of the cart, the whole cart is affected by the push and therefore the whole cart is the object of the action. Another example where we can see this is (3.23), since John may drive the whole car even when he manipulates only a part of the car’s controls. Sentence (3.23) also belongs to the set of the PUSH-verbs and is therefore durative, despite ‘a car’ being $+$SQA:

(3.23) ‘John drove a car’

As we will see in Chapter 4, it is possible to give a far more intuitive interpretation to the PUSH-verbs.

Note, incidentally, that Verkuyl's analysis of (3.22) does not account for the interpretation where the three sandwiches are partially eaten. According to Verkuyl, the partition of the set of sandwiches is a set of sets of sandwiches, and not of sets of parts of sandwiches.

I should also say here that, contrary to what Verkuyl says, the PUSH-verbs do not necessarily need a special particle. Even if the English and Dutch data may give support to this thesis, certainly in Spanish this is not the case. In order to show that I will use the following examples:

(3.24) *Pedro empujó el carro durante horas*
Peter pushed the cart for hours

(3.25) *Pedro pintó la mesa durante horas*
Peter painted the table for hours

On 'push the cart', Verkuyl says that 'push' might be analysed as a complex verb paraphrased as 'to give one or more pushes' or as 'to exert force to,' without implying that the cart actually moves. While this may be true in English for that verb, certainly this is not the case for 'drive a car'. One does not mean 'to give one or more drives,' and still 'drive' is also a PUSH-verb. In Spanish, furthermore, if one says (3.24) the inference is that the cart has moved. If the cart didn't move one would rather say 'Pedro intentó empujar un carro' ('Peter tried to push a cart').

There are other verbs like 'pintar' ('paint') of which we can indeed say 'to put paint on'. Thus, if one says (3.25), the meaning is that Peter applied painting to the table for hours, and still it is possible to infer that the table was not completelly painted. But oddly enough, the Spanish sentence is less natural than (3.24), from which one must infer that the cart moved after the pushing event.

Finally, in Spanish it is ungrammatical to add any resultative particle such as 'away', 'over', 'down'. That is, the only way to translate 'push the cart away' is by means of an embedded clause like the following:

(3.26) *mover el carro empujándolo*
move the cart by pushing it

Therefore, 'empujar' cannot have a particle, but still it does not follow the PLUS-principle.

The fact that the PUSH-verbs do not need a special particle is not essential to Verkuyl's theory, though. One may as well work only with the two different thematic relations $\theta_=$ and $\theta_\subseteq$, the choice being determined by other components of the sentence apart from the particle itself.[4] But still, as I have shown in this subsection, Verkuyl's $\theta_\subseteq$ does not work as it should.

[⇔ADDTO]-verbs

Verkuyl also attempts to provide an explanation of the aspectual properties of sentences with stative verbs, which under Verkuyl's approach have the feature [⇔ADDTO].

Verkuyl explains the behaviour of [⇔ADDTO]-verbs as involving no structuring of time whatsoever. Thus, there is no set of indices dividing the path. Or more precisely, all the indices are grouped at point zero in time. As Verkuyl says:

> [−ADDTO]-verbs are lexically characterized in terms of the same frames as [+ADDTO]-verbs, but . . . their temporal index is kept zero, because all arguments of W are mapped to point zero. (Verkuyl 1993:345)

This can be shown in the following translation of 'Judith hated three yuppies', where the function Ent$^+$ will assign zeroes to I, since i is zero (shown in a box in the expression).

(3.27) 'Judith hated three yuppies'

$$\begin{aligned}&\exists I \exists I_R \exists ! V[V = \|\text{Judith}\| \wedge \{j_i\} \wedge \exists W[W \subseteq \|\text{yuppy}\| \wedge |W| = 3\\ &\quad \wedge \exists Q\, \text{ps} W[Q = \textstyle\bigcup_I \{U \cap \|\text{yuppy}\| : \|\text{hate}\|(I)(\boxed{0})(U)(V)\}]\,]\\ &\quad \wedge I = \text{Ent}^+(I_R) \wedge \text{Tense}_<(I_R)(i^*)]\end{aligned}$$

Verkuyl therefore resorts to tense in order to explain the behaviour of [⇔ADDTO]-verbs. In normal [+ADDTO]-verbs, the function Ent$^+$ maps a set of real numbers (I_R) into a set of their integer parts (I). For [⇔ADDTO]-verbs, this gives a set of zeroes.

If I understand this well, Verkuyl is saying that a [⇔ADDTO]-verb happens in no time. There have been several analyses of states related to temporal points as opposed to intervals. For example, a well-known property of a state is that any part of a state is a state itself (Dowty 1979). It has also been observed that a state involves no time progression in a discourse (Partee 1984). Finally, it can be said that a state can predicate over only a point in time (Egg 1995:322). But according to Verkuyl's analysis, states are seen as occupying no time, in the same sense as an achievement or a semelfactive does not take any time. Clearly, this is not the interpretation we expect of them.

---

[4] Actually, Verkuyl (1995a) does not claim any more that the PUSH-verbs need a special particle.

I also wonder whether Verkuyl's analysis explains the aterminativity [⇔T] of a sentence involving [⇔ADDTO] verbs. Example (3.27) remains stative in the Verkuylian sense that it involves no time update, but does this mean that [⇔T] holds? According to Naumann (1995a:176), Verkuyl's (1993) theory actually wrongly predicts that it is [+T]. This is so because Verkuyl's conditions for terminativity are fulfilled in (3.27), namely that there is an assignment of entities to indexes and the number of entities is finite.

3.1.8 Conclusions to Verkuyl

Verkuyl is perhaps the first researcher who seriously attempted to characterise and analyse the compositional nature of the aspects in a sentence. In his analysis, Verkuyl combines temporal properties of the verb with atemporal properties of the NPs. This is done by means of the features [±ADDTO] and [±SQA], respectively. This interaction is governed asymmetrically, in the sense that first the verb interacts with the inner NP to give [±T], and then the result interacts with the outer NP to give the final [±T] reading.

The NP's [±SQA] feature is governed by the boundedness of the set of elements referred to by the NP. Verkuyl uses the Theory of Generalised Quantifiers to assign the appropriate value to SQA. Since the Theory of Generalised is based on sets, it is necessary to resort to measure functions to analyse masses. Verkuyl's notation is able to express different possible readings regarding distributivity and collectivity in only one expression. In fact, Verkuyl (1994) claims that there should be no distinction between a distributive and a collective reading, and that both of them should be regarded as being basically the same, together with other intermediate readings. This is done by means of partitions, which can be intuitively seen as the sets of the groups of objects which are considered individually. Thus, in a collective reading all the objects are grouped into one set, whereas in a distributive reading all the objects will each form an independent set. Between these two extremes one can find different groupings which will correspond to other intermediate readings.

The verb's [+ADDTO] feature induces a structuring of the path of the action, so that the path is divided according to a set of indices which mark several stages in the action. A stative verb will be [⇔ADDTO], implying that all the indices are kept at zero, that is, all the indices remain amalgamated.

The verb and the inner NP interact by means of the path function ℓ, which assigns one element of the partition to each index of the path. As the action progresses in time more and more elements are considered until we reach a point where there are no more elements, if the NP is [+SQA]. If the NP is [⇔SQA], since the number of entities engaged in the action is not determined, there is no guarantee that the action will finish. Thus, [+SQA] will induce terminativity and [⇔SQA] will induce non-terminativity.

The VP and the outer NP interact by means of the participancy function π, assigning a different path to every element of the outer NP. The very fact that there are two different functions, ℓ for the inner interaction and π for the outer interaction explains the asymmetric behaviour of aspectual composition. This asymmetricity gives way to the PLUS-principle: as soon as there is an [⇔SQA] NP the final sentence will be non-durative [⇔T].

Terminativity therefore occurs when the verb is [+ADDTO] and both NPs are [+SQA], since one can assign elements of the partitions of the NP to every index dividing the path of the action, and all the possible partitions are finite. There is an exception, however. A PUSH-verb will have a different inner aspectual interaction which will prevent any [+SQA] property of the inner NP to go through, depending on a possible resultative particle. As a consequence, with PUSH-verbs the final sentence may be [⇔T] even if all the NPs are [+SQA]. This is clearly an exception to the PLUS-principle.

Durativity can be achieved in different ways.[5] First of all, the PLUS-principle predicts that when at least one of the NPs is [⇔SQA] the whole sentence is durative, as it happens with bare plurals or masses. Alternatively, as I have said in the previous paragraph, any PUSH-verb may override the PLUS-principle because the internal aspectual interaction may be governed by $\theta_{\subseteq}$, in which case the finite cardinality of the inner NP is ignored. The last possibility for a sentence to be durative is that the verb is [⇔ADDTO]; in this case the interaction is of a different nature, giving as a result durativity as well.

Verkuyl's theory seems to be made for the PLUS-principle. Verkuyl (1993) devotes only a chapter to the treatment of the PUSH-verbs, which present a clear challenge to the PLUS-principle. Verkuyl resorts to the use of $\theta_{\subseteq}$ for his account of the PUSH-verbs, establishing a clear connection between the treatment of this type of verb and the use of partitives. However, Verkuyl fails to notice that, when there is only one object involved, $\theta_{\subseteq}$ is reduced to $\theta_{=}$, which follows the PLUS-principle, and therefore the data concerning the PUSH-verbs are not correctly explained. As for stative verbs [⇔ADDTO], Verkuyl's treatment is very short, and a close look at his analysis reveals

---

[5] In fact, Verkuyl (1993:354) qualifies durativity as being a 'garbage can'.

that it is faulty too.

Verkuyl places strong emphasis on the idea that distributive and collective readings are no more than different interpretations of the same action. However, as we have seen in Chapter 1 these two readings are not so similar. A sentence may be considered as being durative or terminative, depending only on which of these readings one assigns to the sentence. This can be seen in (1.17c), which I repeat here:

(1.17) c. ‘he noticed errors’

Here, if we follow a distributive reading one may keep noticing errors for hours and hours. That is, the sentence is atelic. But if we follow a collective reading we are saying that he noticed that there were errors. In such a case the noticing event happens in a sudden, that is, the sentence is not durative, hence terminative. This behaviour cannot be predicted by any theory which claims that a distributive and a collective reading are essentially the same.

3.2 Krifka

3.2.1 Introduction to Krifka

Krifka (1989a, 1989b, 1995) uses lattice structures in his account of the aspectual interaction between verbs and NPs. This approach will be adopted here, and as a result my theory has many resemblances with Krifka’s. In this section I will introduce Krifka’s approach, but any extensive comments on the difficulties of Krifka’s theory will be left to Chapter 4, when my theory is introduced and the differences with Krifka’s approach are stressed.

Due to the fact that Krifka uses lattice structures, the same notation is used for object and for event referents. This fact, together with the fact that Krifka uses a Neo-Davidsonian approach in his semantic notation, emphasises the strong parallelism that exists between the domain of objects and that of events, in line with Bach (1986) and Link (1987). In a Neo-Davidsonian approach (see Davidson 1980 for the original approach and Parsons 1985, 1990 for an example of a Neo-Davidsonian approach), a typical semantic transcription of a simple sentence is as follows, using Krifka’s notation:[6]

---

[6] Krifka’s notation differs slightly between his PhD thesis (Krifka 1989a) and other papers. Here, whenever possible I will use the notation as it stands in (Krifka 1989b).

(3.28) ‘Peter drank beer’
$\exists p, b, d\ [peter(p) \wedge beer(b) \wedge drink(d) \wedge \textsc{ag}(d, p) \wedge \textsc{pat}(d, b)]$

That is, objects and events introduce entities which can be predicated over, and the link between an event and the references of the arguments is provided by means of a thematic relation (AG for ‘agent’ and PAT for ‘patient’ in the semantics shown above). Predicates over objects and events (such as the ones defined by NPs, verbs, VPs or sentences) will have some properties which define the type of structure the objects or events themselves have.

Following Link (1983, 1987) and Bach (1986), Krifka defines a set of properties which can apply both to NPs and to verbs.[7] For example, a definite NP will resemble a telic verb in that both have the property of quantisation (QUA). On the other hand, a bare mass or plural NP will resemble an atelic verb in that both have the property of cumulativity (CUM). Since now NPs and verbs can share the same properties, it is possible for the NP to transfer its properties to the VP. This transference will be possible thanks to the thematic relations. Krifka does not try to characterise the thematic relations (see Fillmore (1968) for an attempt of such a characterisation); he only states that these roles exist, and that they provide the link between the domain of events and that of objects which will allow for the aspectual interaction.

Take the sentence in (3.29a). Here, ‘an apple’ is quantised, and because of the properties of an eating event, the thematic relation will allow for QUA to be transferred to the VP. As a consequence, (3.29a) is quantised and therefore telic. In (3.29b), however, the thematic relation does not allow this transference. As a consequence, the VP inherits the property assigned to the verb ‘watch’, which is CUM. Hence, (3.29b) is atelic.

(3.29) a. ‘eat an apple’
b. ‘watch an apple’

3.2.2 The Predicate Phrase

In the whole of his PhD section on the predicate phrase, Krifka uses a rather classical approach to semantics, with no links to the event-based approach which he develops later in his thesis. The reason for this may be that an event approach is perhaps not needed to explain the theory introduced there. I will follow the same notation in this

---

[7] These properties do not apply to the NPs or the verbs, but to the predicates which are defined by the verbs or NPs themselves. But here I will talk of properties over NPs, or verbs, . . . for the sake of brevity. Later, in Chapter 4 I will use a more consistent notation.

section whenever it does not lead to confusion, that is, if it is not necessary to specify the event itself, since the notation is more compact. Thus, the meaning of (3.30a) can be expressed as (3.30b) in a Neo-Davidsonian approach, or as (3.30c) in a more compact notation:

(3.30) a. ‘x gave y to z’
b. $\exists e\ give(e) \wedge \textsc{ag}(e,x) \wedge \textsc{pat}(e,y) \wedge \textsc{ben}(e,z)$
c. $give(x,y,z)$

Collective and Distributive Predication

Krifka uses the join operator $\sqcup$ to refer to **collectivity.** With the help of this operator, a non-atomic element can be collectively predicated over. As an example, (3.31a) predicates over a plural object, stating that all the elements are engaged in the action:

(3.31) a. *Anna und Otto trafen sich*
Anna and Otto met
$sich.treffen(a \sqcup o)$

It has already been discussed in the literature whether this approach can really express collectivity. Landman (1989) argues for the use of groups instead, as we have seen in Chapter 2. One reason for this approach is that in a collective reading our intended interpretation is that the whole set of objects is involved in the action itself, without actually stating that every one of the components actively participates in the action. This is better seen with the following example:

(3.32) ‘the students wrote a letter to the Head of the Department’

This example is true even if only one of the students (for example, the representative) writes the letter. In other words, not all the participants need to be actively engaged in the action; it is the *group* which matters.

Another argument for using a structure different from the one resulting from plain lattices is that two different groups may contain the same components, but still they remain different. Consider, for example, the case where two different committees, C_a and C_b, have exactly the same members. Still, it would not be the same to say (3.33b) instead of (3.33a).

(3.33) a. ‘committee C_a met yesterday’
b. ‘committee C_b met yesterday’

If we use Krifka's notation (which is actually borrowed from Link), however, there would not be any way we could make a distinction between the two committees.

Landman uses instead the notation $\uparrow$ to denote a group (see Section 2.4). Thus, $\uparrow (a \sqcup o)$ is the group which consists of Anna and Otto. Following a group-account, the semantics of Sentence (3.31) would be:

(3.31) b. *Anna und Otto trafen sich*
Anna and Otto met
$sich.treffen(\uparrow (a \sqcup o))$

Since now a group is different from the join of its members, none of the problems mentioned above arises.

Krifka also talks of **distributive predication.** As opposed to collective predication, there will be now a set of independent events, one for every one of the objects, as we see in Example (3.34a) below. Krifka (1989a) claims that the distributive predication can originate either from the NP structure or from the distributive interpretation of the predicate. The examples provided by him, however, do not shed any light on his claim. Consider the examples provided by Krifka (1989a:86-87):

(3.34) a. *sowohl Anna als auch Otto schlafen*
both Anna as also Otto sleep
'not only Anna but also Otto are sleeping'

b. *die Äpfel wiegen 1kg*
the apples weigh 1kg

In Sentence (3.34a) the distributive interpretation is claimed to be introduced by 'sowohl ... als auch', but actually the verb itself 'schlafen' also favours a distributive reading: each person is sleeping individually. A much better example would be as follows, where now the verb is ambiguous with respect the distributive / collective reading, but still the sentence has a distributive reading because of the NP:

(3.35) 'not only Anna but also Otto wrote a letter'

Now, although it is possible that several people team to write together a letter, in (3.35) this is not so because of the construction 'not only ... but also'.

Sentence (3.34b) is also problematic; Krifka claims it is distributive because of the VP 'wiegen 1 Kg', but actually this sentence is better interpreted as involving a collective reading: it is the whole set of apples which weights 1 Kg since , according to our knowledge of the world, single apples do not usually weigh 1 Kg. Actually, an example of a distributive predication introduced by the VP is always more difficult to find, since a distributive reading may quite often have a collective possibility as well. All the sentences in (1.17) have been commented in Chapter 1 as being ambiguous with respect to a distributive or a collective reading:

(1.17) a. 'he pushed two carts'
b. 'he noticed two errors'
c. 'he noticed errors'
d. 'he lost money'

Despite the possible ambiguity, we may still find sentences which are only distributive purely because of the VP. Sentence (3.36), for example, is distributive because we all know from knowledge of the world that one cannot drive several cars at the same time:

(3.36) 'John drove the cars'

Krifka allows for distributive readings where the unit of distribution is a group of elements or a quantised portion of mass. He gives the following examples, where (3.37a) distributes over groups of twelve eggs, and (3.37b) distributes over portions of milk whose volume is one litre.

(3.37) a. *die Eier kosten fünf Mark das Dutzend*
the eggs cost five marks a dozen
b. *die Milch kostet eine Mark der Liter*
the milk costs one mark a litre

We see, thus, that Krifka does not commit to "pure" distributivity (my term) in that it is not necessary to distribute over individuals. In that sense this is similar to Verkuyl's treatment. But still, and as opposed to Verkuyl, Krifka explicitly separates distributive from collective interpretations. As I have said at the end of Section 3.1 and we will see in Chapter 4, such a differentiation is necessary.

Krifka also provides a compositional derivation of the semantics of many of his examples. Such an approach should add more strength to his theory; however, some of the semantic interpretations provided are introduced in an *ad-hoc* way. For example, the semantics of 'wiegen 1 kg' is interpreted as introducing distributivity, but this reading may depend on context, and in the example provided ('die Äpfel wiegen 1 Kg') the most plausible reading is actually one of collectivity instead of distributivity, as I have said above.

Cumulative and Quantised Verb Predicates

Krifka explains the structure of events and objects by means of a lattice theory, in a way similar to other researchers like Link (1983), Hinrichs (1985), or Eberle (1990). In Krifka's analysis, objects and events form two different lattices. The elements of these lattices can be predicated over, and thus we can establish a set of categories which classify these objects and events. For example, all the running events can be categorised by means of a predicate: a running event x is such that $run(x)$ is true.

A predicate itself (such as $\{x : run(x)\}$, which we will abbreviate as run) has some properties. In the area we are concerned with there are two of these properties which are especially important, since they determine the structure of the objects or the events. These properties are **cumulativity** and **quantisation.** They are defined as:

(3.38) $\forall P[\text{CUM}(P) \leftrightarrow \forall x, y[P(x) \wedge P(y) \rightarrow P(x \sqcup y)]]$

(3.39) $\forall P[\text{QUA}(P) \leftrightarrow \forall x, y[P(x) \wedge P(y) \rightarrow \neg y \sqsubset x]]$

Predicates over events or objects may have one of these properties (though not both, since they are mutually incompatible). In fact, Krifka views 'telic predicates simply as quantized event predicates, and atelic predicates as strictly cumulative event predicates' (Krifka 1989b:6). According to Krifka, a strictly cumulative event predicate is an event predicate which has the properties $\text{CUM}(pred)$ and is not singular $\neg\text{SNG}(pred)$, where SNG is as defined in (3.41) and SCUM is Krifka's abbreviation for strictly cumulativity in (3.40):

(3.40) $\forall P[\text{SCUM}(P) \leftrightarrow \text{CUM}(P) \wedge \neg\text{SNG}(P)]$

(3.41) $\forall P[\text{SNG}(P) \leftrightarrow \exists x[P(x) \wedge \forall y[P(y) \rightarrow x = y]]]$

Now, Mourelatos's (1981) analogy between events and objects is explained: both a quantised NP and a telic verb are QUA, whereas both a bare plural or mass NP and an atelic verb are SCUM, as we can see in the table below.

object	**event**
$wine \subseteq O \wedge \text{SCUM}(wine)$	$run \subseteq E \wedge \text{SCUM}(run)$
$five.apples \subseteq O \wedge \text{QUA}(five.apples)$	$run.a.mile \subseteq E \wedge \text{QUA}(run.a.mile)$

Krifka remarks that all the distributive predicates are cumulative (‘cost 1 mark a piece’) and that collective predicates may be either quantised (‘weight (in total) one kilogram’) or cumulative (‘meet’). As a consequence of this, a classification of the verbal predicates is introduced. First of all, a verbal predicate may be **inherently cumulative,** in which case both the distributive and the collective interpretations fall together. If this happens, an explicit coding of the collective or the distributive interpretation leads to ungrammaticality, as in (3.42).[8]

(3.42) a. **die Äpfel liegen insgesamt im Korb*
the apples lay together in the basket

b. **die Äpfel liegen je im Korb*
the apples lay each in the basket

A verbal predicate may otherwise be **inherently quantised,** in which case the collective and the distributive interpretations will have different truth-conditions and therefore there is no ungrammaticality in the explicit coding of either distributivity or collectivity:

(3.43) a. *die Äpfel kosten insgesamt fünf Mark*
the apples cost in total five marks

b. *die Äpfel kosten je fünf Mark*
the apples cost each five marks

I must say that, contrarily to Krifka, some atelic predicates are *not* CUM.[9] This is especially true when we consider verbs which have arguments in the predicate phrase. Consider the following predicate:

(3.44) ‘push a cart’

Two different pushing events described by this predicate may involve two different carts. For example, if John pushes a cart and Mary pushes a cart, then John and Mary do not push a cart but two (if the carts are different). One might argue that the join of John’s cart pushing and Mary’s cart pushing is also a cart pushing event if we treat the cart as a generic one. While this explanation would assign the CUM property

---

[8] Although this may be true of German, the English translations of (3.42) are not actually ungrammatical, only a little funny.

[9] The argument against the use of cumulativity for event predicates will be further developed in Section 4.3.1, page 106.

to atelic predicates like $push.a.cart$, it would assign also 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 Krifka's use of CUM.

The trouble would disappear if there is a way to enforce that both pushings are of the same cart. In a predicate like the following,

(3.45) 'push the cart'

since there is only one cart, the result would be a complex event whose object is one cart. In this case the problem seems to disappear, but now we confront another subtler problem, namely the possibility of contrasting two independent events. In (3.45), we have seen that the join of two instances of pushing the cart is a complex event whose object is the cart. This complex event is the join of two pushes, but it is not itself a push: it is two pushes. Unless one establishes a connection between the two pushes so that they can be identified as two parts of the same push, the join of two pushes will remain two pushes and not one. For example, if John pushes a cart, he stops and then he resumes the pushing, the join of the two pushes will be normally considered as being only one push. But there may be a context in which the two pushes are independent. For example, if John is participating in a competition in which one must push a cart as many times as possible, these two pushes will be independent.

The thematic relations and their properties

Under Krifka's approach, objects and events are connected by a homomorphism. This homomorphism was also introduced, in one or other fashion, by other scholars (Link 1983; Hinrichs 1985; Eberle 1990); Krifka's innovation was that the homomorphism is actually implemented by the *thematic roles* between verb and complements. Krifka follows a Neo-Davidsonian approach, and therefore the interpretation of a thematic relation as a homomorphism is easy to express, by writing the thematic relation as a predicate over pairs of events and objects. I repeat here the semantics of (3.28):

(3.28) 'Peter drank beer'
$\exists p, b, d\ [peter(p) \wedge beer(b) \wedge drink(d) \wedge \text{AG}(d, p) \wedge \text{PAT}(d, b)]$

Krifka is not interested in the general semantic properties of these thematic relations, but only in those which are relevant for explaining the aspectual interactions, as we will see below. In Krifka's (1989b) paper, he is not interested even in giving a name

example	*summativity*	*graduality*	*uniq. events*	*label*
write a letter	$\surd$	$\surd$	$\surd$	gradual effected patient
eat an apple	$\surd$	$\surd$	$\surd$	gradual consumed patient
read a letter	$\surd$	$\surd$		gradual patient
touch a cat	$\surd$			affected patient
see a horse	$\surd$			stimulus

Table 3.3. A list of some of the relation properties for some predicates.

to them. Thus, he just assigns an arbitrary name to the thematic relations, giving as a result an interpretation which resembles Parsons's (1990):

(3.46) 'Peter drank beer'

$$\exists p,b,d\ [peter(p) \land beer(b) \land drink(d) \land R_1(d,p) \land R_2(d,b)]$$

Different homomorphisms may have different properties, which in full will characterise completely the thematic relations being described. Thus, there will be properties to characterise what is meant by agency in an agentive thematic relation, what is the meaning of patiency, and so on. At the end of the day one may end up with the same problem as with the case of Fillmore's deep cases: there may be too many properties, too difficult to establish their semantics in terms of Predicate Logics, or even too difficult to classify (Dowty 1991). Still, it is possible to establish a rough classification if one looks only at a few of the properties, only the ones which are needed for the explanation of the aspectual interactions. Krifka (1989b:10) provides a characterisation of some of the properties which will be discussed here, summarised in Table 3.3.

Among others, Krifka (1989a) uses the following examples in his argument about the properties assigned to the thematic relations:

(3.47) a. 'Wein trinken'

b. 'ein Glas Wein trinken'

(3.48) a. 'Wein sehen'

b. 'ein Glas Wein sehen'

First of all, Krifka claims that 'trinken' is cumulative: the join of any two events under 'Wein trinken' is again an event under 'Wein trinken'. As I have already explained above and I will develop further in Section 4.3.1, page 106, cumulativity may be problematic for predicates over events.

Krifka also assumes that the relation between ‘wine’ and ‘drink’ is one of patient, PAT, but a special case of patiency: in ‘drink wine’, the object is gradually affected by the verb event, and therefore the thematic relation is one of *gradual patient* or SUK (for *Sukzessiv-Patients*). Krifka manages to express graduality in first-order predicate logic. In order to do so, Krifka mentioned first that in a gradual relation, every subevent[10] of the main event has a subobject assigned such that they stand in the same thematic relation. This property is called **mapping to objects:**

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

In our example (3.47), every subevent of the drinking event will be a drinking of some portion of the wine.

The inverse to MAP-O also applies: for every subobject there is a subevent which stands with the same thematic relation, giving the property of **mapping to events:**

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

Again, in our example (3.47), every portion of the wine which is drunk is drunk by means of a subevent of the drinking event.

Finally, it can be observed that for every event, there are not two different objects related to the event under the thematic relation specified. Thus, the property of **uniqueness of objects** also applies:

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

Thus, if one drinks wine, one can drink a specific portion of wine and nothing else; Sentence (3.47) can only refer to a unique object which is drunk.

The corresponding property applied to events, UNI-E, does not necessarily apply. One can see this in Example (3.52), since a book can be read many times:

(3.52) ‘read a book’

Graduality will be defined, therefore, as the conjunction of uniqueness of objects, mapping to objects and mapping to events:

(3.53) $\forall R\,[\text{GRAD}(R) \leftrightarrow \text{UNI-O}(R) \wedge \text{MAP-O}(R) \wedge \text{MAP-E}(R)]$

---

[10] A subevent and a subobject are defined in terms of their lattice structure. Thus, a subevent of e is any event e' of which we can say $e' \sqsubseteq e$. A similar definition would apply to the objects.

We can say, therefore, that GRAD(SUK).

Krifka then proceeds to analyse the verb 'sehen' in (3.48). As opposed to SUK, in 'Wein sehen' 'the object denotation is simultaneously affected by the verb event':[11] simultaneous patient or SIM. It is not clear what properties the thematic relation SIM has. If we follow Krifka's argumentation, SIM will not have UNI-O (one can see several objects at once) nor UNI-E (the same objects can be seen several times), nor MAP-E (one object can be completely seen at once). Of the ones already considered, the only property which can apply is MAP-O. But MAP-O will apply in a trivial way, since as we will see in Chapter 4, for every subevent it will be generally related to not just one subobject but to the whole object. Take a car-driving event:

(3.54) 'drive a car'

In (3.54), every subevent of the driving event will be a driving of the whole car, not just of one part of it. This property, which I will later call COLL, is also analysed by Krifka, who formalises it as follows:

(3.55) $$\mathrm{SIM}(e,x) \wedge e' \sqsubset e \rightarrow \mathrm{SIM}(e',x)$$

However, Krifka argues that this property does not actually happen in the real world, and he is right indeed. Take an example like 'run'. A person may run for a while and stop a few seconds for a rest and then go on running. While our person is resting, it is obvious that (s)he is not running; therefore, not all the subevents in a running event are running. This is a variation of the *minimal parts* problem (Taylor 1977; Bunt 1979). I will comment more on this in Chapter 4, but for now it suffices to say that this problem vanishes if we consider that in language we are not aware of those bits in time where the person is not actually running, following Bunt's (1979) argumentation for masses. As I have said in different parts of this dissertation, the point is not to build a model of the real world but rather a model of what we interpret of the world.[12]

Krifka's argumentation against the truth of (3.55) is the interpretation of sentences like the following:

---

[11] Translated from Krifka 1989a:161.

[12] Note, by the way, that when one sees a rose one does not see the whole a rose but only a part of it (only the rose's visible parts, and not all of them: the back of the rose is not seen, for example). Still, it is true that the whole rose is considered to be seen in a conceptual way; the parts of the rose that we do not actually see are somehow implied as being there.

(3.56) *Otto hat in einer Stunde 46 Zebras gesehen*
Otto has in one hour 46 zebras seen
'Otto has seen 46 zebras in one hour'

Sentences like the one above are acceptable even if Otto never sees the 46 zebras together but two herds of 19 and 27 zebras instead. While this is true, Krifka fails to take in account the fact that, now, there are two independent seeing events happening and not just one. Every one of the two independent seeing events will be a seeing of simultaneously all the zebras in their respective herd, in such a way that (3.55) applies to the individual seeing events independently. The join of both events, however, is not a simple seeing event but a complex one. As we will see in Chapter 4, this complex seeing event stands in a distributive relation with the join of the two herds, and this distributive relation has a set of properties which is very similar to Krifka's properties assigned to graduality, which does not necessarily have (3.55).

In order to explain the transmission of the aspectual properties, Krifka describes one more property, that of **summativity:**

(3.57) $$P(x_1, \cdots, x_n) \wedge P(y_1, \cdots, y_n) \rightarrow P(x_1 \sqcup y_1, \cdots, x_n \sqcup y_n)$$

However, Krifka fails to notice that this property presents some problems. These problems appear when we want to interpret the join of two events. Later in his PhD thesis, when Krifka introduces the event-logic which forms the basis of his aspectual theory, summativity is redefined as follows:

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

What is the interpretation of the join of e and e'? As we have seen above, it is problematic to deal with the join of events: the join of two runs over a mile is not necessarily a single run but a complex run. If we are talking of an event of a different type, it is unnatural to think that this new event stands in the same relationship with the join of both miles. But I will discuss this with greater depth in Chapter 4.

3.2.3 An Analysis of the Temporal Constitution in an Event Semantics

The Semantic Model Structure

Krifka's formal approach, as I have said already, is based on lattices. More specifically, there will be three complete join-semilattices with the bottom element removed,

$< O, \sqcup >$, $< E, \sqcup >$, and $< T, \sqcup >$. Their semi-ordering will be denoted by $\sqsubseteq$ and $\sqsubset$, and the overlap with $\circ$. The three parallel semilattices will structure the domains of objects, events and times, respectively.

The semilattice of times, although very similar to the other ones, will be different in that, as opposed to those of objects and events, it has minimal elements or atoms. There will be therefore a set T_a of linearly-ordered atoms whose closure under the join operation will generate T. The elements of T_a will be called **temporal points,** and the order relation established between them will be $\leq$.

There will be a function τ which maps elements of E into T. Thus, $\tau(e)$ will be the temporal trace of e. The temporal trace τ will preserve the lattice structure:

$$\tau(e \sqcup e') = \tau(e) \sqcup \tau(e')$$

The predicates will be treated in the usual manner of First-Order Predicate Logic. A predicate, therefore, denotes the set of all the entities to which the predicate applies; run, for example, denotes the set of running events, and thus $run(e)$ may be either true or false.

As we have seen, Krifka uses a Neo-Davidsonian approach to the semantics of events. Thus, an example of the semantics of a sentence may be (ignoring time):

(3.59) ‘ein Mädchen iβt einen Apfel’
$\exists e, x, y\ (essen(e) \wedge 1.Mädchen(x) \wedge 1.Apfel(y) \wedge \text{AG}(e,x) \wedge \text{PAT}(e,y))$

The Transmission of the Reference Manner

This is perhaps the most important section in Krifka’s PhD. Indeed, the theory presented in Chapter 4 of this thesis is partly based on this section of Krifka’s theory, which later was extended to (Krifka 1989b).

So far, we have assigned a set of properties to the predicates over objects and over events. We have also a set of properties for the homomorphisms which link the events with the objects. The only thing we need is to prove that the properties assigned to the homomorphisms suffice to explain the range of possible aspectual interactions. This is relatively easy: since all the properties are formalised in terms of standard predicate logic enriched with lattice structures, we only need to apply the normal deduction rules such as the methodology of Natural Deduction; the only care we must take is to consider the properties assigned to the lattice structures we are working with.

The kind of expressions which are to be proved is the result of combining the semantics of a verb with that of an NP. For example, it can be proved that ‘read letters’ is cumulative, if we have the assumptions that ‘read’ is cumulative, ‘letters’ is cumulative, and the relevant thematic relation has the property of summativity (Krifka 1989b:8):

$$\begin{aligned} &\forall P, Q, R\,[\mathrm{CUM}(P) \wedge \mathrm{CUM}(Q) \wedge \mathrm{SUM}(R) \\ &\qquad \to \\ &\qquad \mathrm{CUM}(\lambda e \exists x, [P(e) \wedge Q(x) \wedge R(e,x)])] \end{aligned} \tag{3.60}$$

I am not going to give any detail on how these deductions can be established; the interested reader may wish to consult instead Krifka’s original work (1989a, 1989b). Here I would only like to mention the fact that Krifka heavily relies on the use of summativity and cumulativity of event predicates (Equation (3.60) is an example) and, as we have seen above, these properties are rather problematic. In Chapter 4 we will see how it is possible to account for the same data without using cumulativity nor summativity, by means of an alternative set of formal deductions.

3.2.4 Conclusions to Krifka’s theory

Krifka attempts to explain the aspectual interactions between the verb and the inner NP by using lattice structures. In contrast with Verkuyl, Krifka emphasises the similarities between the domains of objects and events. For example, he manages to define the same properties for predicates over objects (NPs) as for predicates over events (verbs, VPs).

An important feature of Krifka’s theory is his treatment of the thematic relations as involving a homomorphism from the domain of events to that of objects. By means of this homomorphism it is possible for an NP to affect the aspectual properties of the VP in which the NP is included. Apart from the properties one may expect of a thematic relation which characterises their general features, these homomorphisms also have some properties which determine the structure of the objects and events which are related. It is these properties which will allow for the transference from the NP to the VP.

Krifka succeeds in explaining why there are verbs like ‘eat’ or ‘read’ whose NP interacts with the structure of the event, while in other verbs like ‘see’ or ‘push’ there is no such an interaction: the difference between them relies on the properties assigned to the aspectual relation between the verb and the argument. Thus, a gradual relation will be in use in verbs such as 'read', but verbs like 'see' will have a simultaneous relation.

An added achievement in Krifka's theory is that the properties he uses are defined by expressions in predicate logic in such a way that it is possible to formally prove the interactions by using the standard procedures of formal deduction such as Natural Deduction, as he has done in his work (Krifka 1989a; Krifka 1989b)

Although Krifka's theory is very promising, when it comes to the details it fails in several points. First of all, Krifka's use of cumulativity is not adequate for event predicates. One of the reasons is the appearance of the join of events. Krifka is only one of the many researchers who, trying to show the parallelism between objects and events, pushes this similarity too far. It is straightforward to see that mass nouns are cumulative. Take the example 'cards'. If a is cards and b is cards, then the join $a \sqcup b$ is cards too. But the same does not happen with events. If c is run and d is run, then the join $c \sqcup d$ is not necessarily run; if one does not want to establish a connection between the two runs, the result will be a plural run, which is different.

Another problem related with the use of the join operator and cumulativity is seen more clearly when there is an object involved in the event, as in 'push a cart'. If one considers two independent pushes over two independent carts, the result will be an event which involves not one cart but two. Thus, 'push a cart' will never be cumulative if we follow Krifka's definition of cumulativity.

The trouble is not that a predicate over events cannot be cumulative, but how to define cumulativity. For example, in the previous example of running, the join of two parts of the same run will be an individual run, and in the same line the join of two events of the same push will also be an individual push. We could therefore try a definition of cumulativity where only events which are part of a bigger event are considered, and therefore the possibility of joining two independent events is ruled out. Such an attempt has been performed by Eberle (forthcoming), by resorting to two parallel lattice structures, one over individuals (like the one used by Krifka), and another over stuff (similar to Link's lattice over stuffs). But the resulting definition is rather complex, and it loses all the appeal of Krifka's simple formulations; it would be very hard to use Eberle's expressions to formally prove the aspectual interactions in the way Krifka manages to do.

A similar problem happens with Krifka's use of summativity. Since summativity is based on the join of elements in both domains, that of objects and that of events, new entities are created over which one cannot predict their exact thematic relations. For example, if John ran a mile and Mary ran two miles, what can we say of the join made by John and Mary? Do they run two miles? Do they run three miles? Their joint event, is it a running as an individual event, or it is rather a plural running event?

All of these problems will be addressed in Chapter 4, and solutions will be proposed.

3.3 Naumann

3.3.1 General ideas

Naumann (1995a,1995b) is based on Dynamic Logic. In Dynamic Logic the meaning of a sentence represents a change of the environment shared between the speaker and hearer. Naumann introduces a quote from Barwise, which I include here too:

> The most basic change is that we must view the utterance of an expression more dynamically, as having an effect on the environment shared by speaker and hearer, the effect being represented by various sorts of changes in variable assignments.
> (Barwise 1987:2)

A sentence, therefore, is interpreted as a relation between states. In the area of the verb semantics, this approach is not very different in spirit from that of Dowty (1979), since Dowty considered the non-stative verbs as procedures which modify a state by means of operators (DO, BECOME, CAUSE in Dowty's theory). Naumann's formalisation, based in Dynamic Logic, will be different from Dowty's, however. In Naumann's theory the change is effected by means of a **program** which (possibly) modifies some of the variables used to represent the current status.

There are two strongholds upon which the whole of Naumann's theory is based. First of all, there is a strong stress on the verb semantics. A verb is interpreted as a program π which modifies a state ϕ, giving as a result another possibly different state ψ:

$$\{\phi\}\pi\{\psi\}$$

The second stronghold is a consequence of the first one: the other constituents of the sentence perform a secondary role in the aspectual interaction. They will only refine the program introduced by the verb in a very specific manner which will be introduced later in this discussion.

Naumann's approach is different from that of Krifka and Verkuyl in that the weight of the task does not rely on the interpretation of the semantics of the NP nor on the features of the link between the verbs and NPs. As Naumann says:

$$\begin{array}{cccccc}
 & i_1 & i_2 & i_3 & i_4 & \ldots \\
u_1 & \{j\} & \{j\} & \{j\} & \{b\} & \\
u_2 & \{1\} & \{2\} & \{3\} & \{4\} & \\
u_3 & \{a\} & \{c\} & \{c\} & \{a\} & \\
u_4 & \{j,b\} & \{m,j\} & \{m,b\} & \{j,b,m\} & \\
\vdots & & & & &
\end{array}$$

Figure 3.7. A representation of pigeon-holes and their evolution in time (Naumann 1995a:284).

> One can say that Krifka and Verkuyl tend to the opposite extreme [from Naumann's]: the nominal arguments become all-important whereas the verbal argument is reduced to a kind of temporal parameter the function (sic).
> (Naumann 1995a:184)

3.3.2 Change

In Naumann's account, following the tradition of Dynamic Logic (Dynamic Predicate Logic or DPL, in short), a verb denotes a change of some property of a specific entity which may be specified by another constituent of the sentence. Each of the following example sentences show the relevant property which is subject to change:

(3.61) John drank a glass of wine $\Leftrightarrow\!\!\rightarrow$ The CONTENT of the glass
Bill dyed his hair $\Leftrightarrow\!\!\rightarrow$ The COLOUR of the hair
John crossed the street $\Leftrightarrow\!\!\rightarrow$ The LOCATION of John
(Naumann 1995a:204)

These properties will be represented as values which are stored in **registers** (also called **pigeon-holes**, **stores** or **variables**). In the first of the examples above, the content of the glass is a value which is stored in a pigeon-hole so that it can be modified at different states. For example, Figure 3.7 represents some possible pigeon-holes $u_1, u_2, \cdots$, and how their values change at different states $i_1, i_2, \cdots$.

Each of the values of the pigeon-holes is a set which can be retrieved by means of the constant V.[13] Thus, in Figure 3.7, we can get: $V(u_2)(i_1) = \{1\}, V(u_3)(i_1) = \{a\}$, and so forth. When there is only one element in the set the brackets will be dropped (this is only a notational abbreviation).

---

[13] Naumann calls V a constant, but it is clearly a function which returns different values depending on the parameters to which it applies.

In this manner, by using sets in the expression of the value of a pigeon-hole, we can model plurality. Naumann never considers using lattices instead of sets. This is striking, since later Naumann actually uses generalisations over lattices (posets) to model the change in time, as we will see later. If we used lattices to structure the values which can be stored in the pigeon-holes there would be no need to add an extra level (from entity to set of entities) in order to model plurality. Even Naumann is confused at some point about the type of the elements stored in the pigeon-holes: in page 285 Naumann uses the expression $farmer(V(v)(j))$. As he says, '$farmer$ is of type (e,t) and thus $V(v)(i)$ is of the correct (argument) type.' But if $farmer$ is of type (e,t) then $V(v)(j)$, which is the value of the pigeon-hole v at state j, is of type e. This is clearly a contradiction with Naumann's requirement that the value of a pigeon-hole should be a set, that is, of type (e,t). This problem may be only a typo, but it would certainly disappear if we used complete atomic semilattices instead of sets to model plurality. In that case, the registers would be of type e and multiple values would be expressed by means of the join operator, just like in the case of the semantics of plurals.

The pigeon-holes may have different values at different states. This can be expressed by means of the notation:

$$i[u_1 \cdots u_n]j$$

Which means that 'the states i and j agree on the values of all stores except possibly on the values of $u_1 \cdots u_n$.' (1995a:284). If we want to express that there is no change at all between i and j we can use the expression $i[]j$.

The change in the registers can be modelled by means of an assignment function of the form:

$$x := x \oplus 1$$

This expression says that x, which is a property of a specific object, acquires its next value. The values which x may take, Naumann argues, are partially ordered. More specifically, they constitute a **chain.** This is not to say that all the possible values of the object's property form a chain. Rather, it is more accurate to say that they form a **poset** from which a chain is selected. For example (Naumann 1995a:209), the chain $\{a, b, c, d\}$ may be one of the possible change sequences in the values of an element structured in the poset expressed in Figure 3.8.

An example of the possible chains assigned to a poset can be seen with an event of apple eating. There will be many different ways one can eat an apple: one can start eating from any part of the apple, and after the first bite there is no restriction on where

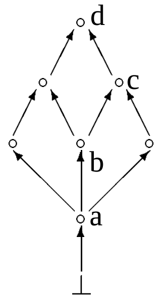

Figure 3.8. A possible chain in the poset over all the possible values a register may have.

is the second bite, and the same with the subsequent bites. The matter of apple which is left after every one of these bites can be ordered in a poset like the one in Figure 3.8, but in the actual apple-eating event only one of the multiple existing chains is chosen. Naumann, therefore, considers the possibility of a gradual event whose domain is not linear. In this sense, Naumann's theory is more complete than Verkuyl's or Krifka's.

3.3.3 Aktionsarten

Accomplishments

An informal definition of a program describing an apple-eating event is as follows:

> "As long as there are (still) parts of the apple, continue eating." (1995a:219)

This can be translated in a more formal fashion, by specifying the gradual change of the values of a register along a chain:

$$\text{WHILE Mass}_x(a) \neq 0 \text{ DO } x := x \oplus 1$$

Which in DPL makes, finally:

(3.62) 'eat an apple'
$(\text{Mass}_x(a) \neq 0?; x := x \oplus 1)^*; \text{Mass}_x(a) = 0?$

This program means:

Mass$_x(a) \neq 0?$ Test whether the mass of a is not 0. The subindex $_x$ is used to denote that a's mass is stored in register x; this is only a notational device.

$$\begin{tikzcd}
s_0 \arrow[r, "\pi"] & s_1 \arrow[r, "\pi"] & s_2 \arrow[r, "\pi"] & s_3 \arrow[r, "\pi"] & s_4 \\
1 & 3/4 & 2/4 & 1/4 & 0
\end{tikzcd}$$

$$\pi \equiv u := u \oplus 1$$

$$V(u)(s_0) = 1, V(u)(s_1) = 3/4, V(u)(s_2) = 2/4, V(u)(s_3) = 1/4, V(u)(s_4) = 0$$

Figure 3.9. How the value of a store changes in ‘eat an apple’.

$x := x \oplus 1$ The object’s property is updated. The object is a, and x is a register where a’s mass is stored. This register will be updated according to one of the possible chains.

$(\pi)^*$ Repeat indefinitely the program π. Although it is not specified how many, there will always be a finite number of iterations n of the program π. In our example, in every one of the iterations a’s mass is different from 0, and the register x is increased in value.

$\mathbf{Mass}_x(a) = 0$? After all the repetitions of consuming part of the apple, a’s mass will be 0.

In other words, the verb meaning is formalised as a program by means of which a store is modified. This store will represent a property of an object denoted by the NP. Figure 3.9 shows an example of the subsequent modifications involved in ‘eat an apple’ (Naumann 1995a:292-293). Starting from the state s_0, the store u gradually changes from 1 (we still have the full apple) to 0 (there is no apple left), through several stages; this change is represented by the instruction $x := x \oplus 1$, which updates the value of a register which represents the portion of the apple which remains. As we have seen above, the values assigned to x are ordered into a chain. Thus, after executing the command in every iteration, x receives the next value in the chain.

Here we can see some parallelism with Verkuyl’s use of **W**. According to Verkuyl (1993), the action establishes a path and a sequence of indices which divide the path. Each one of the indices will have assigned the set of the elements which have been already involved in the action. In our example with the apple, this set is represented by the value of Naumann’s u store. The advantage of Naumann with respect with Verkuyl is that Naumann explicitly states that the domain which is effected does not have to be of dimension 1, since we can always decide for one of the multiple chains which make up the structure itself.

Naumann also expresses the semantics of some of his examples with a different notation, borrowed from Muskens's (1994) 'Logic of Change'. Muskens' logic is a three sorted Type logic, containing the usual types e and t, plus s for the states and π for pigeon-holes. Here I will not explain this logic in depth — see instead Naumann (1995a) and Muskens (1994). The only mention I will insert here is on how to express the semantics of an assignment function, as it appears in Naumann (1995b). Thus, (3.63a) is the proper semantics, and (3.63b) is its application to states i and j.

(3.63) a. $[u := u \oplus 1] = \lambda ij[V(u)(j) = V(u)(i) \oplus 1 \wedge \forall v[v \neq u \rightarrow V(v)(i) = V(v)(j)]]$

b. $i[u := u \oplus 1]j$

The expression in (3.63a), which is applied to the incremental change of register u, states that the value of u at state j is the next value of u at state i, and any other register remains unmodified. In our example, $V(u)$, which is the value of u, is the apple's mass. In order to make it easier to read, it may also appear as: $\text{Mass}_u(y)$, where y refers to the apple. A full semantics of 'eat' in this new notation is:

(3.64)
$$\begin{aligned}&\lambda y \lambda x \lambda ij \exists n \exists \sigma \exists s_0 \cdots s_n\\ &\quad [i = s_0 \wedge j = s_n \wedge \sigma = s_0 \cdots s_n \wedge s_0[u := u \oplus 1]^* s_n\\ &\qquad \wedge \forall k : 0 \leq k < n : \text{Mass}_u(y)(s_k) \neq 0\\ &\qquad \wedge \text{Mass}_u(y)(s_n) = 0 \wedge \text{Agent}(x) \wedge \text{Patient}(y) \wedge \text{Sub}(u)(y)]\end{aligned}$$

(Naumann 1995a:294)

Informally, (3.64) says that there is a sequence of states $s_0 \cdots s_n$ such that the instruction $u := u \oplus 1$ is repeatedly executed along these states. In each of these states the mass of the consumed object is non null, and when the iteration is finished the mass is null. Furthermore, there is an eater x and an eaten y, and the register u is related to the object y by means of the predicate $\text{Sub}(u)(y)$.

Let us now analyse some of the parts of (3.64). First of all, there is a termination condition associated to 'eat': there must not be any remain of the object, that is, the object must be completely consumed. This termination condition is also called a 'liveness property', and it will not hold during the iteration: during the iteration, there is still some mass remaining. The liveness property is what makes (3.64) terminative.

The use of the liveness property, however, represents a major problem in Naumann's theory. Since it is encoded into the semantics of the verb 'eat', the sentence will always be terminative. Thus, one must conclude that all the following sentences are terminative:

(3.65) a. ‘John ate an apple’
b. ‘John ate two apples’
c. ‘John ate apples’
d. ‘John ate apple’
e. ‘John ate’

Whereas (3.65a) and (3.65b) are correctly interpreted, the rest are wrongly interpreted as terminative. Here we will not discuss (3.65c), since Naumann develops an analysis of plurals which will be discussed in Section 3.3.5. But Naumann does not say anything about (3.65d) nor (3.65e), which are clearly durative despite having an accomplishment verb.[14]

One reason why Naumann does not say anything about (3.65d) is that he does not provide any semantics for masses. However, masses play an important role in determining the sentence aspect since, as we have already discussed, a bare mass, as is also the case with a bare plural, may turn an otherwise accomplishment into an activity, and this is indeed the case with (3.65d). One possible form of allowing this possibility consists of removing the liveness condition in the semantics of the verb, giving as a result a semantics which resembles Naumann’s account of the push- and unergative verbs, which we will discuss in Section 3.3.3. However, this solution has its drawbacks. First of all, the class of accomplishment verbs would have no difference (in terms of the aspectual semantics) from that of push- and unergative verbs, but there is a difference: whereas in a push- or an unergative verb the argument does not affect the aspectual properties of the sentence, in an accomplishment verb the argument plays a decisive role in the determination of the final sentence aspect. Secondly and more importantly, if we do not codify terminativity in the semantics of the verb, we must place it into the semantics of other components of the sentence. A possible candidate is the NP (‘an apple’ in 3.65a). However, the NP for itself cannot predict the existence or absence of terminativity, since the interaction will depend on the verb as well. We can see it with the following sentences:

(3.66) a. ‘John ate an apple in ten minutes’
b. *‘John ate an apple for ten minutes’

(3.67) a. ‘John watched an apple for ten minutes’
b. *‘John watched an apple in ten minutes’

---

[14] Naumann’s denomination ‘Accomplishment verb’ for verbs such as ‘eat’ is rather misleading, since as we have seen these verbs may form sentences which are not accomplishments but activities.

In these sentences, the combination ‘eat’ plus ‘an apple’ gives terminativity, whereas the combination ‘watch’ plus ‘an apple’ gives non-terminativity. Another candidate for where to codify terminativity is the verb phrase itself so that it is terminative when a specific type of verb and a specific type of NP are combined. Under such an approach, however, we do not need any elaborate semantics to model the interaction between the verb and its arguments, since a listing of all the possible combinations of types of verbs and NPs is enough. This approach would be rather *ad-hoc* in the sense that no explanation of why the aspectual interaction occurs would be provided.

As a final comment on (3.64), Naumann uses the terms Agent(x) and Patient(x), without specifying the event itself. This is so because Naumann does not follow an event-based approach. The problem is: x is an agent of what? y is an agent of what? The fact that no event appears as an argument of these functions means that these functions mean a different thing depending on their position in the sentence. A clear example where this type of problem appears is the following:

(3.68) ‘John saw Mary and Mary saw John’

The semantics of this sentence would be, in terms of the roles of John and Mary, as follows:

(3.69) $\exists j, m, \cdots [\cdots \text{Agent}(j) \wedge \text{Patient}(m) \cdots \text{Patient}(j) \wedge \text{Agent}(m) \cdots]$

Since we cannot specify what they are agents or patients of, we arrive at the uneasy conclusion that both j and m are agents and patients at the same time. Under an event approach no contradiction would appear, since it is easy to see that j and m are not agents and patients in the same event. How to express this, however, in an eventless approach like Naumann’s?

Push- and unergative verbs

Push- and unergative verbs are treated alike, since they behave similarly regarding aspect. Some of Naumann’s data containing push- and unergative verbs are:

(3.70) a. ‘John pushed the cart (for two hours / *in two hours)’

b. ‘John walked (for two hours / *in two hours)’

(3.71) a. ‘John pushed the cart to the station (*for two hours / in two hours)’

b. ‘John walked to the station (*for two hours / in two hours)’

As we see from these data, a push-verb (a) typically behaves like an unergative verb (b) when it comes to the distinction between terminativity and durativity. For this reason, both types of verbs are grouped into the class of **activity verbs.**

An activity verb will typically give a durative sentence, as we can see in (3.70). Durativity will be guaranteed by means of an **invariance property** (also called safety property), as opposed to the liveness property of an accomplishment verb. The difference between an invariance property and a liveness property is that now the invariance property is always true regardless of the number of iterations performed. In Naumann's words:

> An invariance property is a property of states which holds at each state of the execution of a program . . . A liveness property, on the other hand, is a property that does not hold in all states of a given execution of a program π.
>
> (Naumann 1995a:299)

Since an invariance property holds at each state of the execution of the program, the program will always successfully terminate. This feature mimics the traditional definition of atelicity: if X is V-ing, then X has V-ed (Comrie 1976; Kenny 1963b; Dowty 1979).

The whole meaning of a verb such as ‘push’ will therefore be as follows (Naumann 1995a:304), where the invariance property appears enclosed in a box:

(3.72) ‘push’

$$\begin{aligned}&\lambda y \lambda x \lambda ij \exists n \exists \sigma \exists s_0 \cdots s_n\\ &\quad [i = s_0 \wedge j = s_n \wedge \sigma = s_0 \cdots s_n \wedge s_0[u := u \oplus 1]^* s_n\\ &\qquad \wedge \boxed{\forall k : 0 \leq k \leq n : \exists p\, \text{Location}_u(y)(s_k) = p}\\ &\qquad \wedge \text{Agent}(x) \wedge \text{Patient}(y) \wedge \text{Sub}(u)(y)]\end{aligned}$$

If an activity verb is modified by a locative adverbial the result may be an accomplishment, as we can see in (3.71).[15] The reason for this is that the adverbial itself may introduce a further specification to the termination condition which will turn it into a liveness property. With respect to the sentence ‘push X to the station’, Naumann says that:

> after the modification with a PP-adjunct the whole expression has as a part a while-loop such that the program π and the iteration command * are contributed by the interpretation of the unmodified expression, whereas the terminating condition b as well as the minimality condition are contributed by the interpretation of the adjunct. (1995a:305)

---

[15] Again, the term ‘activity verb’ is also misleading, since an activity verb may give an accomplishment.

Thus, like in the case of accomplishment verbs, activity verbs do not always give as a result an activity. But now, unlike accomplishment verbs, the behaviour of activity verbs is easier to explain. An activity verb introduces a very general termination condition which is always true at any iteration. However, when an adjunct is introduced, the termination condition may be restricted, giving as a result a liveness property. The same explanation, however, cannot be provided for the behaviour of accomplishment verbs with masses. Under Naumann's account, an accomplishment verb will always introduce a liveness property. This liveness property, however, can never change into a safety property, independently of the semantics of other parts of the sentence. The reason for this is that a safety property is weaker than a liveness property: a safety property is always true after any iteration, whereas a liveness property is true only after a specific number of iterations. Whereas it is possible to turn a safety property into a liveness property by adding more restrictions to it, it is impossible to turn a specific property (a liveness property) into a more general property (a safety property) unless one introduces disjunctions. As an example, the conjunction of (3.73) and (3.74) is equivalent to (3.74), which is a liveness condition, but not to (3.73), which is a safety condition :

(3.73) $\forall k : 0 \leq k \leq n : \exists m[\text{Mass}_u(y)(s_k) = m]$

(3.74) $\forall k : 0 \leq k < n : \text{Mass}_u(y)(s_k) \neq 0 \wedge \text{Mass}_u(y)(s_n) = 0$

3.3.4 Thematic roles, graduality, and DPL

As we have seen above, Naumann explains the aspectual interaction by determining the type of termination condition of the iteration imposed by the event. In other words, the verb introduces the general event structure, and the NP refines this structure.

Naumann is explicit in that this aspectual interaction has nothing to do with the thematic relations. This markedly contrasts with Krifka's approach, where all the aspectual interactions are explained by means of properties assigned to the thematic relations. Naumann considers the thematic relations to be of a static nature. As he says,

> Simply changing the thematic relation of the verb which is assigned to the internal argument (or any other argument) amounts in effect to treating the meanings of the two verbs as unrelated to each other. (Naumann 1995a:298)

Thus, a thematic relation is something that never changes. A thematic relation, Naumann argues, is a static feature which is deeply coded into the semantics of the verb.

It is therefore awkward to have a verb which sometimes has one thematic relation and sometimes it has a different thematic relation. In this sense, Naumann follows the classic line regarding aspectual relations (such as Fillmore 1968).

Similarly, according to Naumann (1995a:250), there is a clear difference between properties such as graduality and what makes NPs determine the final aspectual interaction. Whereas graduality is linked to the interpretation of the verb itself abstracting from its arguments, giving the iterative program we have already seen, the distinction between terminativity and durativity is only a difference in the terminating condition of the program specified by the verb.

Naumann is right in that a thematic relation is deeply coded in the semantics of the verb. However, the arguments are also important in determining the thematic relation. There is an obvious difference in the thematic relation of the subject in the following sentences:

(3.75) a. ‘John broke the glass’
b. ‘The hammer broke the glass’
c. ‘the glass broke’

In (3.75a) the subject is the agent, whereas in (3.75b) the subject is the instrument and in (3.75c) the subject is the patient. But still, in all three cases the verb ‘broke’ is used, and one can arguably say that, at least in the cases (b) and (c), the verb has the same meaning.

Aspectual relations, also, are not as static as Naumann seems to imply. Two different verbs may use the same thematic relation with their arguments, but their semantics is still very different. Dowty (1991) mentioned the troubles one may find if one tries to completely characterise the semantics of the thematic relations. The role of agent, for example, is an amalgamation of very different properties that not all the verbs necessarily use, some of which are listed below:

a. volitional involvement in the event or state
b. sentience (and / or perception)
c. causing and event or change of state in another participant
d. movement (relative to the position of another participant)
e. exists independently of the event named by the verb (Dowty 1991:572)

Dowty shows that these properties do not necessarily apply to the agent of every possible sentence by means of a series of examples where only one of them is characteristic. The examples are:

a. VOLITION ALONE:
  - ‘John is being polite to Bill’
  - ‘John is ignoring Mary’
  - ‘what he did was not eat [anything] for two days’

b. SENTIENCE / PERCEPTION ALONE:
  - ‘John knows / believes / is disappointed at the statement’
  - ‘John sees / fears Mary’

c. CAUSATION ALONE:
  - ‘his loneliness causes his unhappiness’
  - ‘teenage unemployment causes delinquency’

d. MOVEMENT ALONE:
  - ‘the rolling tumbleweed passed the rock’
  - ‘the bullet overtook the arrow’
  - ‘water filled the boat’
  - ‘he accidentally fell’

e. INDEPENDENT EXISTENCE:
  - ‘John needs a new car’ (Dowty 1991:572-573)

Even with the same verb one may find different variations in the thematic relations. The two following examples have indeed the same thematic relation, but there is a slight difference in them:

(3.76) a. ‘John loves Mary’
b. ‘John loves playing the guitar’

One may argue that the two senses of ‘love’ are entirely different, thus giving two different verbs. But if one follows this line of argumentation one may arrive at the conclusion that in every different sentence the verb used has a different meaning, and therefore they must be considered as different verbs, giving way to the old problem of deciding between polysemy or homonimy, in this case applied to verbs (Lyons 1977:550f). But it would be very difficult to justify saying that the verbs in the following sentences are different:

(3.77) a. ‘John hired two secretaries with one contract’
b. ‘John hired two secretaries with two different contracts’

These examples correspond to a collective and a distributive hiring, respectively. Again, the role of the NP ‘two secretaries’ is one of patient, but there is a slight difference in how the hiring is performed.

Even if one assumes that the thematic relations are deeply coded into the semantics of the verb, there is no harm in thinking that some of their properties may change, depending on the other components of the sentence, or even on context. The thematic relations (whatever that means) will still remain basically unmodified. After all, both a red car and a black car are cars.

3.3.5 The plural

Naumann (1995a:252) defines two levels where the interactions between the verb and NPs apply. In the **atomic** level, the interaction happens in the internal structure of the action. All the analysis explained so far falls into this level. Thus, a program iteration models the atomic level. In the **non-atomic** or **plural** level, plurality of objects and actions is modelled, as we will see in this section.

Naumann establishes a link between plurality and parallel programs (page 271). This is formalised in (1995a:317ff), where parallelism is expressed by means of '=>', as we see in the following example:

(3.78) If a farmer owns a donkey, he beats it.
$[x :=?; \text{farmer } x?; y :=?; \text{donkey } y?; \text{own } x\ y?] => \text{beat } x\ y?$

In (3.78), the antecedent of '=>' is a program which can run from one state and give one of many states, according to random assignments. If for every one of the possible output states the program at the consequent successfully terminates, then (3.78) terminates. This is very similar to Kamp & Reyle's (1993) DRT's use of '=>' and embeddings.

As a consequence of now having a set of states, all the semantics of programs must be redefined to account for sets of states. In page 327 of Naumann's thesis all the operators are redefined (which I will not include here), and a new operator $_\forall$ is defined so that all the possible states resulting from a program are collected. The definition of $_\forall$ is:

(3.79) $$s[\pi_\forall]U \textit{ iff } U = \{s' \in S | s[\pi]s'\} \neq \emptyset$$

That is, after executing $\pi_\forall$ from a set of states s we arrive to a set of states U which spans all the possible states we can arrive from s after executing π. This set, U, by definition is not empty.

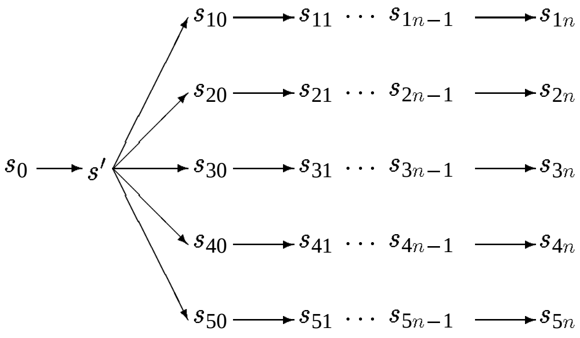

Figure 3.10. The sentence 'eat five apples' as a parallel program. Here, the parallel program is of the form: $\pi \equiv [u_i :=?]; \chi?$.

The operator '$=>$' can now be defined in DPL as:

(3.80)
$$\pi => \pi' =_{def} (\pi_{\forall}; \pi') + \neg\pi$$

We need the disjunction '$+ \neg\pi$' so that we cover the case where π cannot be executed.

For example, 'eat five apples' will have the semantics:

(3.81)
$$[u :=?]; \phi?; \psi?; ([u_i :=?]; \chi?)_{\forall}; P(u_i)$$

Where:

- ϕ is the restriction of the noun 'apples'.
- ψ is the restriction of the determiner 'five'.
- χ tests whether the value of store u_i is a singleton subset of the value of store u.
- $P(u_i)$ is the interpretation of the verb.

Let us now take a closer look at this representation, which is graphically expressed in Figure 3.10. After executing $[u :=?]; \phi?; \psi?$ we are in a state s' in which u is assigned a set of 5 entities (because of the restriction of ψ) which represent 5 apples (because of the restriction of ϕ). From s' we arrive to a set of states s_{i0}, due to the parallel span introduced by $\forall$ in $([u_i :=?]; \chi?)_{\forall}$. The state s_{i0} will be a set of five states: $s_{i0} = \{s_{10}, s_{20}, s_{30}, s_{40}, s_{50}\}$, since five are the possible states one may get after the program $[u_i :=?]; \chi?$. In each one of these states, u_i contains one of the possible 5 singleton values which appear in u. Finally, for every one of the states in s_{i0} the semantics of the verb

P is applied to the value stored in u_i. Thus, we arrive to five states in the final state: $s_{in} = \{s_{1n}, s_{2n}, s_{3n}, s_{4n}, s_{5n}\}$. In other words, all the 5 apples are effectively 'eaten'.

Different types of plurals will determine different terminating conditions. Thus, in 'ate 5 apples' the cardinality condition restricts the possible number of values for the pigeon-hole to 5:

$$|V(u)(k)| = 5$$

This restriction is actually a type of liveness condition, which will be true only when exactly five apples are eaten. As opposed to that example, in 'ate apples' the information given by the cardinality condition is undetermined (Naumann 1995a:345):

$$\exists n\, |V(u)(j)| = n$$

This means that now we have an invariance, since it will be true for any number of eaten apples, as long as at least one apple is eaten.

As a consequence from the previous analysis, when considering the plural level, all the actions described must be terminative if we want to end up with a final plural terminative action. Thus, in the example 'push five carts' (page 342) the sentence is regarded as being atelic. This atelicity is explained because now every one of the subprocesses has an invariant as the terminating condition.

The explanation for 'push five carts' is fine if we assume a collective reading, which is the reading assumed by Naumann. However, Naumann's parallel programs do not explain the aspectual behaviour of this sentence under a distributive reading. Under such a reading, as we have seen in Chapter 1, 'push three carts' is *not* durative but terminative.

Naumann establishes a parallelism between the atomic and the plural level. As an example, he compares the following sentences:

(3.82) a. 'eat an apple'
b. 'eat five apples'

In both cases there is a progression of the eating event. However, whereas in (3.82a) the objects considered are parts of apple, in (3.82b) the objects are entire individual apples. Let us consider this parallelism. According to Naumann's implementation of plurality as involving parallel programs, several apple-eating events may occur at the same time. However, in the parallelism just shown there may be some apple-eating events which occur sequentially in time. As a result there is even more similarity with

W: $\sum \rightarrow W$
W is defined by:

(i) $\mathbf{W}(\varepsilon) = \emptyset$

(ii) $\mathbf{W}(n+1) = \mathbf{W}(n) \cup F(n+1)$

The auxiliary function F is defined as follows:

$$F(i) = P_i|_x^3 \text{ for } i \geq 1$$

Here $P_i|_x^3$ is the set of all x which are involved in the predication at state (or index) i.

Figure 3.11. Naumann's redefinition of Verkuyl's **W.**

Verkuyl's use of **W**: at every index there may be a set of apples which are consumed at the time signalled by the index. Actually, Naumann redefines **W** in page 255 so that this parallelism is clearer. This redefinition is shown in Figure 3.11. In a sense, Naumann's account can be seen as an extension to Verkuyl's such that we can also look at the inner division of the objects.

If we accept Naumann's parallelism between the atomic and the plural level it is possible to find a link between a gradual and a distributive reading: a gradual reading will correspond to Naumann's atomic level, whereas a distributive reading will correspond to Naumann's plural level. As we will see in Chapter 4, this similarity between graduality and distributivity is seen even more clearly if we also consider the sentence's aspectual properties.

3.3.6 Conclusions to Naumann

Naumann expresses the semantic of verbs in terms of change of states. Following Dynamic Logic, the semantic interpretation of a verb is a program which may modify the values of a set of registers. In accomplishment and activity verbs, this program will consist of a loop such that at every iteration the values of the registers are modified.

The semantics of accomplishment and activity verbs models gradual progression of some parameter during time. Typical parameters were shown in page 82, which I repeat here:

(3.61) John drank a glass of wine. $\Leftrightarrow\!\!\!\!\rightarrow$ The CONTENT of the glass
Bill dyed his hair. $\Leftrightarrow\!\!\!\!\rightarrow$ The COLOUR of the hair
John crossed the street. $\Leftrightarrow\!\!\!\!\rightarrow$ The LOCATION of John

This means that, for example, in the semantics of ‘John drank a glass of wine’ the program will gradually modify a variable which represents the contents of the glass. In order to do so, Naumann structures in a poset the set of all the possible values the variable may have. One of the possible chains of this poset is chosen, and the variable will successively take all the values of this chain. This is symbolised by means of the instruction:

$$v := v \oplus 1$$

An advantage of Naumann over Krifka and Verkuyl is that now we allow a gradual change over a multidimensional domain: every chain is no more than a linear representation of the changes which happen in a possibly complex domain.

The distinction between terminativity and durativity is no more than a distinction in the terminating phase of the gradual change imposed by the verb. Thus, a terminative verb is one which, after the loop is over, we arrive at a state which was not available during the iterations. In contrast with this, after any of the iterations of a durative verb the state reached can be also a terminating state (liveness *versus* safety properties). Naumann assigns terminativity or durativity directly to the semantics of a verb. Thus, a verb like ‘eat’, ‘read’, ‘build’ will always be terminative if the argument is singular. This is not the desired effect, since this explanation does not explain the behaviour of masses (In fact, Naumann completely ignores the treatment of masses). A possible solution for this involves treating accomplishment verbs like activity verbs, in the sense that an accomplishment will never define by itself a liveness condition: it is always decided by an argument. But if one follows this approach one will have to decide when an argument introduces a liveness condition and when it does not. We may arrive at the conclusion that we may need to use thematic relations to explain the aspectual interactions, and this is a move Naumann is very reluctant to make.

In the area of thematic relations, Naumann believes that they have nothing to do with aspectual interaction. Nothing in the properties of a thematic relation determines the aspectual influence of the NPs in the semantics of the verb. In claiming this, Naumann fails to consider work such as Dowty’s (1991) paper, in which one can see that a thematic relation is not a monolithic property which never changes. Thematic relations are actually collections of sets of properties, which are different from verb to verb, and even within the same verb under different contexts.

Finally, Naumann provides the semantics of plurals as involving parallel programs. Whereas this approach can account for the semantics of a wide range of sentences with plural arguments, it does not provide the correct explanation when the independent events are forced to happen one after the other. A clear example is:

(3.83) ‘Peter drove three cars’

Sentence (3.83) is telic, since the car driving events must happen one after the other. This distributivity of the driving events imposes delimitedness in all the driving events, giving as a result a terminative event.

3.4 Final comments on Verkuyl, Krifka and Naumann

The models here commented introduce three different approaches to the analysis of aspectual composition. They are successful in some types of data, but still one or another example remains unexplained. Verkuyl’s approach, for example, successfully explains those sentences which follow the PLUS- principle, but the PUSH- verbs are unsatisfactorily covered. On the other hand, Krifka’s approach successfully explains both the PLUS- principle and the PUSH- verbs, but he is interested only in singular NPs and therefore there is no coverage of sentences involving plurals. And Naumann’s approach explicitly addresses the plurals and the singulars with two different approaches, but it needs an explanation of masses.

Verkuyl’s framework is centred on sets and the Theory of Generalised Quantifiers, and as a consequence it provides an in-depth analysis of the influence of plurals in the determination of the sentence aspect. Masses and incremental interaction (such as in the VP ‘run a mile’) are discretised by means of measure functions or indices which divide a path, respectively. This treatment provides a uniform analysis to all the types of interactions which Verkuyl covers.

Naumann’s approach treats singulars differently from plurals. When the argument is singular, the analysis is based on the expression of the change effected by the action of some of the parameters of the environment, which are modelled as variables which characterise a state. As a consequence, Naumann’s approach provides a thorough analysis of sentences where the object is gradually affected by the event in one or another fashion. Plurals, however, interact in a very different form. A plural introduces parallel events, one for every individual object, effectively creating a distribution of the action.

Both in Verkuyl's and Naumann's approach there is a clear difference between what we can call the internal and the external interaction. In Verkuyl, for example, the internal interaction is characterised by the path-function ℓ, whereas the external interaction is characterised by the participancy function π. In Naumann, the internal interaction is modelled by means of change of the values of variables, whereas the external interaction involves parallel programs. In both approaches, the external interaction introduces a set of events, and each of these events is analysed in terms of the internal interaction.

Krifka's analysis is centred only on the internal interaction, and as a consequence neither plurals nor distributivity are covered with the depth of the other two approaches. But his approach provides a series of features worth commenting on, principally that now verbs and predicates have the same types of properties, and the thematic relations may allow some of these properties to be transferred to the VP. An important difference of Krifka with respect to Verkuyl is that now lattices are used, and therefore masses (which by definition are not made of individual elements) are straightforwardly covered by his framework. The other important difference is that it is easier to explain the behaviour of PUSH- verbs by simply assigning to them a different type of thematic relation property which does not allow the transference of the NP properties to the VP. In terms of the internal interaction, therefore, Krifka's approach is the most promising.

An ideal approach would combine Krifka's general analysis but enriched to cover the case of plurals and distributive readings. This approach is the central part of this thesis, and it will be introduced in the next chapter.

Chapter 4

The (aspectual) interaction between verbs and NPs

4.1 Introduction

In this chapter, an analysis of the aspectual interaction between verbs and NPs by means of a lattice approach will be introduced.[1] It will also be shown how this analysis is related to the distributive and collective readings of plurals. First of all, a general introduction to how it is possible to represent the structure of objects and events by means of lattices will appear in Section 4.2. In Section 4.3 we will use predicates over objects and events, such that the problem of distinguishing between telicity and atelicity will be rephrased as that of distinguishing between quantisation and homogeneity. The connection between objects and events will be explained in Section 4.4, where several thematic relation properties will be introduced and commented upon. In Section 4.5 the aspectual interactions will be explained, together with some further discussions in Section 4.6. Some general conclusions will finally be drawn in Section 4.7.

Before introducing the theory itself, it would be convenient to specify what it is that we aim to explain. In Chapter 2, and more extensively in Chapter 3, we have examined the works of other researchers in the area of aspectual composition. The conclusion we can draw from them is that, despite the growing interest in the area, so far no clear solution has been found.

---

[1] There are early versions of this chapter published (Mollá Aliod 1994; Mollá Aliod 1996b), of which this chapter is an update which includes the formal proofs. Another publication which stresses the intuition on which the theory is based is found in (Mollá Aliod 1996a).

Most of the work has focused on the gradual actions, where the NP determines the aspectual properties of the sentence. This can be seen in examples like the following:

(4.1) a. 'John ran'
b. 'John ran a mile'
c. 'John drank beer'
d. 'John drank a pint of beer'

Here, (4.1a) and (4.1c) are atelic, whereas (4.1b) and (4.1d) are telic. Several theories have been provided to explain this interaction by specifying a progression of some sort. Thus, Krifka (1989b) and Verkuyl (1989) study the interaction as involving progression of the action along a path, whereas Naumann (1995b) explains similar data by referring to progression in the change of the value assigned to a state.

In (4.1c-d) a mass noun is used. With respect to masses, it is disappointing to find that in general they are neglected or they are treated on a secondary level. We can see this happen in works such as Verkuyl's (1993) where masses are reduced to the case of plurals by using a measure function, or Naumann's (1995a) where masses are not considered at all. Mass nouns, however, are very common in natural language sentences and therefore they deserve a full analysis in the same level as count nouns.

The case of PUSH-verbs is also less covered — following Verkuyl (1993), a PUSH-verb is one whose argument does not affect the aspectual properties of the verb. Typical examples of sentences with PUSH-verbs are:

(4.2) a. 'John pushed a cart'
b. 'Peter watched TV'
c. 'Mary stroked the cat'

Here, regardless of the nature of the NP, the sentence will be atelic. The PUSH-verbs represent a clear challenge to theories such as Verkuyl's PLUS-principle. According to this principle, whenever all the NPs are quantised and the verb expresses an action (as opposed to states), the final sentence will be terminative, i.e., telic. The sentences in (4.2), obviously, do not follow this principle.

It is also desirable to be able to describe the aspectual interactions with plural NPs. When plurals are involved everything becomes more complicated, since now we must consider several possible readings of the action. This is clearly seen in the following examples:

(4.3) a. ‘John noticed errors’ (collective reading)
b. ‘John noticed errors’ (distributive reading)

(4.4) a. ‘John pushed two carts’ (collective reading)
b. ‘John pushed two carts’ (distributive reading)

Under a distributive reading, (4.3) is atelic whereas (4.4) is telic. However, under a collective reading, (4.3) is telic whereas (4.4) is atelic. Some scholars (e.g. Verkuyl 1994) claim that there is no difference between distributivity and collectivity: both of them are actually a variation of the same reading. But as we have seen in (4.3) and (4.4), there is a clear difference which shows up in the aspectual properties of the sentence.

As we can also see in (4.3) and (4.4), the same verb may allow for the NP to affect the aspectual properties under one reading, but under another reading such an interaction is blocked. We can see it better with more samples involving the verb ‘push’:

(4.5) a. ‘John pushed two carts’
b. ‘John pushed carts’

If we follow a collective reading, both (4.5a) and (4.5b) are atelic. However, under a distributive reading, (4.5a) is telic while (4.5b) is atelic. It is therefore necessary to characterise the difference between distributivity and collectivity so that we can explain why a distributive reading allows this interaction whereas a collective reading prevents it.

The option for choosing either a distributive or a collective reading depends on such intractable factors as world knowledge and context. Depending on context and our knowledge of the world, the hearer assigns one or other reading to the sentence, and he will assign one or another structure to the objects referred to.

Before introducing the theory, I would like to remark that in this chapter, any utterance example and any natural language sentence example or any part of a sentence (verb, NP, etc) will be ‘single quoted’, and any predicate (in the sense of First-Order Predicate Logic) will be italicised, $replacing.blanks.with.dots$.

4.2 Lattices and our interpretation of the world

As it has been shown in Chapter 2, several lattice theories have been used in several attempts to explain the parallelism existing between object and event structure.

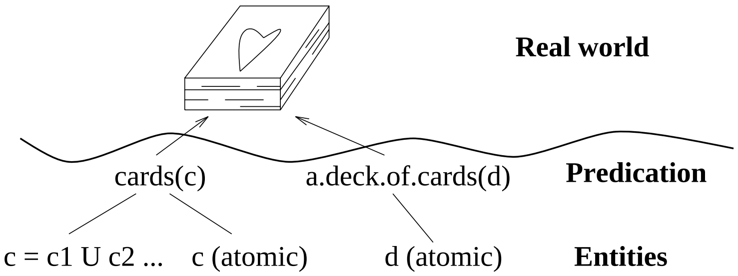

Figure 4.1. Different interpretations of the same real-world object.

Link was concerned with how to explain plurals and mass terms by means of lattice structures. He used several lattices. One of them models matter fusion, so that 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 our purpose in this chapter, the one which models sets of individuals. For example, a group of two rings, if we see it as the set which contains two rings, is an element which is made of 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, i.e. it will be an atomic element.

A representation of different interpretations of the same real-world object can be seen in Figure 4.1, in which a deck of cards is considered. If we look at the inner structure of a deck of cards we can say that it is made of 52 objects. But one may also consider it as just one object, if we look at the entity represented by the deck of cards in itself. Under Link's notation, the first interpretation would be represented by the join of the 52 objects $c_1 \sqcup c_2 \sqcup \cdots \sqcup c_{52}$, whereas the second interpretation would be represented by just one entity d. Link (1983:304) attributes the different entities to different linguistic expressions. For example, the two entities above would be the result of using (4.6a) and (4.6b), respectively:

(4.6) a. 'the cards'
b. 'the deck of cards'

I will argue that even with the same linguistic expression 'cards', the object can be collectivised as well and be treated as an atomic entity, as shown in Figure 4.1. The argument will be developed in Section 4.5.

Link (1983) says nothing about the relation between the entities referred to by (4.6a) and (4.6b), respectively. However, there is a clear connection between them. In Chapter 2 we have already seen Landman's use of groups. Under Landman (1989), these two entities will be related by means of the group operation: $d = \uparrow (c_1 \sqcup \cdots \sqcup c_n)$. In fact, Naumann is more explicit about the different interpretations of the structure of a real-world object, by allowing groups to be made themselves of groups, and therefore implying the existence of several levels of granularity. This approach follows the intuition sought in this thesis, since, as we have briefly pointed out in the introductory chapter, we humans interact with the world in a special way: we never process all the information which is available. Rather, we manage to use just the necessary information so that we can successfully interact with our environment without taking an expensive time processing information which is not relevant. If necessary, we take an object and again decompose it into smaller objects, and these objects can again be decomposed into other objects, and we can do it an indefinite number of times, until we are satisfied. Landman's concept of groups whose members are again groups is no more than a possible way of expressing this granular processing of information. In that sense, a lattice approach where there are no atoms which generate the whole domain is more intuitive than, say, set theory. Take any element of the world; this element will almost certainly be able to be decomposed into other elements, and these elements will always be able to be decomposed into further elements, and so on *ad infinitum*. The fact that at the end these elements may be composed of minimal elements[2] is not relevant since, after all, these minimal elements are beyond our normal perception and it is safe to assume that *linguistically* they do not exist. This is indeed the case for masses, as we will discuss in Section 4.3.3.

4.3 Predicates and their properties

Apart from their lattice structure, objects can also have other properties. These properties establish a further structuring of the set of objects, categorising them as belonging to one or another subset (henceforth **category**). One can refer to these properties by using a **predicate**. Following standard First Order Predicate Logic (Gamut 1991; Partee *et al.* 1990), a predicate will allow us to determine whether an object belongs to a category or not by means of its extension: the extension of a predicate is the whole set of objects for which the predicate is true. Thus, if we say that, for example, $P(a)$, we are saying that a is an element of the set defined by a predicate called P. The use of

---

[2] Note, however, that every now and then there is a discovery in Nuclear Physics revealing that what had been the minimal elements so far can be decomposed into even "more minimal" elements.

these categories can help us to try to express how 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 entity that we classify as being an object (*c*), and furthermore, a special kind of object: a card.

Predicates themselves may have their own properties (Krifka 1989a; Krifka 1989b). As an example, take two different apples, a_1 and a_2. Each one of them 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, therefore, the join of two elements of a category gives an element of a different category. In some predicates, however, the join of two of their elements always gives an element under 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 1989b; see also Chapter 3). CUMulativity is a property of predicates such that every predicate P is cumulative if and only if the join of any two elements of P still is P:

Def. 4.3.0.1 (Cumulativity) $\forall P[\mathrm{CUM}(P) \iff \forall x, y[P(x) \wedge P(y) \rightarrow P(x \sqcup y)]]$

QUAntisation is defined, not in terms of the join operation, but of the restricted *part-of* relation ($\sqsubset$). We can say that an object is part of the join of the object with 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 $\forall x, y[x \sqsubset y \Leftrightarrow x \sqsubseteq y \wedge \neg(x = y)]$.

With this definition of the restricted *part-of* operation we could define quantisation: A predicate P is quantised if and only if no two elements of P are related by means of $\sqsubset$:

Def. 4.3.0.2 (Quantisation-1) $\forall P[\mathrm{QUA}(P) \iff \forall x, y[P(x) \wedge P(y) \rightarrow \neg(y \sqsubset x)]]$

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:

Def. 4.3.0.3 (Quantisation-2) $\forall P[\mathrm{QUA}(P) \iff \forall x, y[P(x) \wedge y \sqsubset x \rightarrow \neg P(y)]]$

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

It is easy to prove that these two definitions are equivalent:

Lemma 4.3.0.4 *Definitions 4.3.0.2 and 4.3.0.3 are equivalent.*

Proof: We only need to convert the implications into their equivalent disjunctive form and apply commutativity and *de Morgan*, and finally reintroduce the implication:

$$\boxed{\begin{array}{lll}
\multicolumn{2}{l}{P(x) \wedge P(y) \rightarrow \neg(y \sqsubset x)} & ; \\
\Leftrightarrow & \neg(P(x) \wedge P(y)) \vee \neg(y \sqsubset x) & ;\ \text{disjunction introduction} \\
\Leftrightarrow & \neg P(x) \vee \neg P(y) \vee \neg(y \sqsubset x) & ;\ \textit{de Morgan} \\
\Leftrightarrow & \neg P(x) \vee \neg(y \sqsubset x) \vee \neg P(y) & ;\ \text{commutativity} \\
\Leftrightarrow & \neg(P(x) \wedge y \sqsubset x) \vee \neg P(y) & ;\ \textit{de Morgan} \\
\Leftrightarrow & P(x) \wedge y \sqsubset x \rightarrow \neg P(y) & ;\ \text{implication introduction}
\end{array}}$$

□

4.3.1 Problems with cumulativity

Let us now consider the property of cumulativity for object and event predicates. The description of the property of cumulativity originated from the analysis of plurals and masses, that is, only the domain of objects was considered. An example involving bare plurals is the expression ‘cards’. If one has cards on one hand and cards on the other hand, then the join of all of them is cards. And the same can be said of masses: if one has water in a glass and water in another glass, the result of joining both entities of water is again water. This is quite intuitive and, as we see, works well under the domain of objects.

The trouble comes when one tries to use the same property for predicates over events. As we have seen, Krifka talked of the cumulative property for (atelic) predicates like *run*, *push*, *drive*. It is true that the join of two events exists and it is the event consisting of both events, in the same sense as the join of two objects is an entity which consists of both objects. In many cases, this new event is of the same type. 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:

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

What happens now if a donkey pushes a cart in York and a horse pushes a different cart in Sidney? The event which is the join of these events is not a pushing of a cart, since now *two* carts are involved. Of course, if there is a way to force the pushing to be of only one cart this problem disappears, as in the predicate $push.the.cart$. But our definition of CUM cannot force this wide-scope reading of the cart.

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 being a generic one, that is, if the donkey is doing cart-pushing and the horse is doing cart-pushing as well, then the join of both events is also cart-pushing, although they are pushings of two different carts. 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 $run.a.mile$: if John is doing mile-running and Mary is doing mile-running as well, then the join of both events is also mile-running. Thus, a "generic explanation" of $a.cart$ is still useless in the task of differentiating between atelic and telic events, which is the initial goal of the CUM property in Krifka's (1989b) paper.

In conclusion, CUM cannot be used to distinguish between atelic and telic events, since telic events do not have CUM either. We will see this with the predicate $run.a.mile$: we can think of two running events over a mile whose join is not a run over a mile, but over two. Thus, $run.a.mile$ does not have CUM and it is telic as well.[3]

First possible solution

We can see better the problem of Krifka's CUM and scope if we resort to his actual definition, which I repeat here:

---

[3] Incidentally, note that Krifka (1989b) tries to define telicity and atelicity from CUM and QUA (see also Section 5.3). In order to do so, he defined two properties, singularity and strictly cumulativity, which I have already introduced in page 71 and I repeat here:

(3.40) $\forall P[\text{SCUM}(P) \leftrightarrow \text{CUM}(P) \wedge \neg\text{SNG}(P)]$

(3.41) $\forall P[\text{SNG}(P) \leftrightarrow \exists x[P(x) \wedge \forall y[P(y) \rightarrow x = y]]]$

Krifka later claimed the validity (without proving it) of:

$$\forall P[\text{QUA}(P) \rightarrow \neg\text{SCUM}(P)]$$

However, this last expression is **not** true: we can imagine a model where $\exists P[\text{QUA}(P) \wedge \neg\text{SNG}(P) \wedge \text{CUM}(P)]$ is true, namely when P equals the empty set.

(Def. 4.3.0.1) $\forall P[\mathrm{CUM}(P) \iff \forall x, y[P(x) \wedge P(y) \rightarrow P(x \sqcup y)]]$

If we now try to prove the cumulativity of $push.a.cart$, we will have to prove the following:

$$\forall p, p' \, [\exists c(a.cart(c) \wedge push(p) \wedge r(p,c)) \\ \wedge \\ \exists c'(a.cart(c') \wedge push(p') \wedge r(p',c')) \\ \rightarrow \\ \exists c''(a.cart(c'') \wedge push(p \sqcup p') \wedge r(p \sqcup p', c''))] \tag{4.7}$$

In (4.7), the only object which is a candidate of being pushed by the join event $p \sqcup p'$ is the join of carts: $c'' = c \sqcup c'$. However, $a.cart$ is not cumulative. Therefore, generally it is not true that $a.cart(c \sqcup c')$.

A possible solution to Krifka's CUM definition would be to try not to specify the object in the definition of what is to be cumulative. For example, in the example $push.a.cart$, what is cumulative is the pushing event itself:

$$\exists p, c \, [push(p) \wedge R(p,c) \wedge a.cart(c)] \wedge \forall x \, \mathrm{CUM}(\lambda e \, push(e) \wedge R(e,x)) \tag{4.8}$$

Now, since the cumulativity is forced over the push of the same cart, the problem involving the cart scope does not appear:

$$\forall p, p', x \, [push(p) \wedge R(p,x) \wedge push(p') \wedge R(p',x) \\ \rightarrow push(p \sqcup p') \wedge R(p \sqcup p', x)] \tag{4.9}$$

This proposal, however, generates more problems than solutions. Since now the object is not included, the following examples would be erroneously considered cumulative as well:

(4.10) $John.ran.a.mile$

$$\forall r, r' \, [run(r) \wedge R(r,m) \wedge run(r') \wedge R(r',m) \\ \rightarrow run(r \sqcup r') \wedge R(r \sqcup r', m)]$$

(4.11) $John.ate.an.apple$

$$\forall e, e' \, [eat(e) \wedge R(e,a) \wedge eat(e') \wedge R(e',a) \\ \rightarrow eat(e \sqcup e') \wedge R(e \sqcup e', a)]$$

In other words, with this proposal the object would not affect the aspectual properties of the sentence at all.

Second possible solution

Instead of trying to restrict what part of the predicate is the cumulative one, another solution would consist in redefining cumulativity itself so that we consider only subevents of the same event. That is, now only two events which share the same context are considered:

(4.12) $$\forall P\,[\mathrm{CUM}_2(P) \Longleftrightarrow \forall x, y, \vartheta\,(P_\vartheta(x) \wedge P_\vartheta(y) \rightarrow P_\vartheta(x \sqcup y))]$$

We will have now to formalise the expression of ϑ and $P_\vartheta(x)$. Intuitively, (4.12) has to be paraphrased as: 'other things being equal, for every pair of events x and y such that $P(x) \wedge P(y)$, then $P(x \sqcup y)$'. Therefore, in $push.a.cart$ the cart must remain the same.

Intuitively this new definition seems correct, since in sentences like 'John pushed a cart for hours', the object referred to by $a.cart$ is normally the same in the whole pushing event. However, this solution does not fare better than the previous one. Consider 'John ran a mile for hours'. The predicate $John.ran.a.mile$ normally is telic, but because of the adverbial 'for hours' it is coerced into atelicity by iterating the action (Moens & Steedman 1988). Since the action is iterated to give an atelic predicate, we have now that $John.ran.a.mile$ is an atelic predicate but it is true of a set of independent events. Therefore, it is atelic but not CUM_2.

Apart from this problem, (4.12) would be very difficult to paraphrase in true predicate logic, since ϑ and $P_\vartheta(x)$ depend on pragmatics and knowledge of the world, which as far as I know nobody has yet successfully formalised.

Cumulativity and independent events

Apart from the problem of scope there is another, perhaps more important, problem. Take run. Does the join of two events under run fall under run as well? Consider two completely unrelated events of running, say, take John running in Australia and Mary running in Italy. Could we say that the join of both runs is a run as well? Note that, in this case, the runs are so independent that, whereas the join of both runs exists as a plural run, this plural run is different from the other, individual, runs. I would not therefore categorise them as falling under the same predicate run.

This problem is even more difficult to solve, and it appears even in the "solutions" proposed above. In concrete, in (4.9) we have the expression $push(p \sqcup p')$ which, in the light of what has been exposed in this short subsection, does not hold.

Note that, again, this problem does not appear for predicates over objects. As I have said already, if one has cards on one hand and cards on the other hand, the join of both entities will be another entity which is cards as well. And the same can be said of masses: if there is water in a glass and water in the Atlantic Ocean, the join of both objects is again water. In other words, the problem of the distinction between individual objects and plural objects does not arise for bare plurals or for masses. For the case of bare plurals, they always refer to plural entities, whereas for the case of masses they always refer to entities which belong to a generic substance like WATER, BEER, GOLD and so on, very much like Carlson's (1977) treatment of plurals as kinds.

4.3.2 The definitive predicate properties

From Section 4.3.1 we can see that the trouble with cumulativity is that it is very difficult to specify that the join should be of two subevents of the same event. This problem disappears if, instead of trying to use the join of events, we try to define atelicity in terms of parts of the event. The following definition will use the $\sqsubset$ relation:

Def. 4.3.2.1 (Homogeneity) $\forall P[\mathrm{HOM}(P) \Longleftrightarrow \forall x, y[P(x) \wedge y \sqsubset x \rightarrow P(y)]]$

This formulation is no more than the specification of what has been called **homogeneity**, **subinterval property** or **divisibility**. According to Carlson (1981:48), for example, Bennett & Partee (1972) defines the subinterval property as follows:

> Subinterval verb phrases have the property that if they are the main verb phrase of a sentence which is true at some interval of time I, then the sentence is true at every subinterval of I including every moment of time in I. Examples of subinterval verb phrases are: *walk, breathe, walk in the park, push a cart.*
>
> (Bennett & Partee 1972:17)

The property of homogeneity as defined in Def. 4.3.2.1 does not have any of the problems mentioned in Section 4.3.1. First of all, if an event which is predicated by means of an atelic predicate has a specific object in a specific role, any of its subevents will have the same object. In our example 'push a cart', it is unrealistic to assume that there may be any subevents of pushing of a cart which involve different carts.

Things get complicated when the object is plural, like in the following examples:

(4.13) a. 'John pushed two carts' (distributive reading)

b. 'John pushed carts' (distributive reading)

The problem does not really arise in (4.13a) because it is telic, as we have seen in Chapter 1 and in the introduction of this chapter. But the case of (4.13b) is different. Now we have a predicate which is homogeneous but which predicates over a succession of pushing events such that for every event there is a different cart which is pushed. While this is true, it is also true that, as I will argue in Section 4.3.3, the issue that the pushing is made of individual pushings over individual carts is not relevant. Any subobject of an object which falls under $carts$ also falls under $carts$, and any subevent which falls under the plural interpretation of $push$ (which in Section 4.5.3 we will call $push^*$) also falls under the same predicate. Therefore, $push.carts$ is homogeneous.

The problem of joining independent events does not arise either since it is a matter of fact that any two subevents of an event are always related in that they are part of the main event, and therefore their join will also belong to the same predicate. As I have said already, if a donkey pushes a cart from 2 to 3 o'clock and then, during the same overall push, he pushes the cart from 3 to 4 o'clock, then the donkey is pushing the cart from 2 to 4 o'clock. In other words, the join of these two (individual) pushing events is again an (individual) pushing event. Note that, in fact, the example I used to explain cumulativity for events in page 106, $push.the.cart$, takes two pushing events which are part of a bigger pushing event. The join of two such pushing events will be of course a pushing event as well.

Apart from homogeneity and Krifka's quantisation and cumulativity, we will also need to specify another property which holds for events which are considered as taking no time. Some of the possible predicates over non-durative events follow:

(4.14) a. $notice.an.error$
b. $arrive$
c. $recognise.a.person$
d. die
e. $enter.the.room$
f. $type.the.letter.$'p'

All of these predicates are of events which are considered as taking no time at all. This is not to say that the events themselves take no time. In fact, all of them happen during a specific time which can be measured in theory, and actually it has been argued whether durativity is a real linguistic distinction (see page 12). It is indeed true that the same sentence can be seen as durative or not depending on the context — thus, (4.14d), which is normally non-durative, may acquire a durative sense in the context of a medical paper on the study of the processes which are involved in death. Still, ambiguity does exist in predicates and therefore the same predicate may have different interpretations.

If a predicate is non-durative it is because it predicates only over atomic entities. This will be described by means of the property of **atomicity:**

Def. 4.3.2.2 (Atomicity)

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

We could say that an atomic predicate is one which is simultaneously homogeneous and quantised:

Lemma 4.3.2.3 *Being atomic is the same as being homogeneous and quantised at the same time.*

$$\forall P(\text{atomic}(P) \Longleftrightarrow \text{HOM}(P) \wedge \text{QUA}(P))$$

Proof: We will prove both ways of the equivalence:

$\Rightarrow$: Since there is no x such that $P(x) \wedge x' \sqsubset x$, the antecedents of the implications of Defs. 4.3.2.1 and 4.3.0.3 are always false. Therefore, the implications are trivially true.

$\Leftarrow$:

$$\boxed{\begin{array}{lll}
 & \text{QUA}(P) \wedge \text{HOM}(P) & ; \\
\Rightarrow & \forall x, y[(P(x) \wedge P(y) \rightarrow \neg(y \sqsubset x)) & ; \\
 & \wedge(P(x) \wedge y \sqsubset x \rightarrow P(y))] & ; \\
\Rightarrow & \forall x, y(\neg P(x) \vee \neg P(y) \vee \neg(y \sqsubset x)) & ; \ \textit{de Morgan} \\
 & \wedge(\neg P(x) \vee \neg(y \sqsubset x) \vee P(y)) & ; \\
= & \forall x, y(\neg P(x) \vee \neg(y \sqsubset x) \vee (\neg P(y) \wedge P(y))) & ; \ \text{distributivity} \\
= & \forall x, y(\neg P(x) \vee \neg(y \sqsubset x)) & ; \ \text{contradiction} \\
= & \forall x, y(P(x) \rightarrow \neg(y \sqsubset x)) & ; \\
= & \text{atomic}(P) & ;
\end{array}}$$

□

So far, I have introduced four properties: CUM, QUA, HOM and atomic. These properties can apply to predicates over objects and over events, and even to complex predicates like $push.a.cart$ or $john.drive.a.car$. Some examples are represented in Table 4.1. In that table, I have assigned only one interpretation to every one of the

predicate	CUM	QUA	HOM	atomic
run			√	
drink			√	
an.apple		√		
eat.an.apple		√		
beer	√		√	
a.pint.of.beer		√		
pints.of.beer	√			
drink.beer			√	
an.error		√	√	√
errors	√			
notice		√	√	√
notice.an.error		√	√	√
notice.errors	√			

Table 4.1. Examples of predicates with their properties.

predicates. One might argue that this is not always the case. One could say ‘he suddenly noticed errors in the paper’, as implying that he noticed that there were errors in the paper, or ‘he drank beer in three seconds’, if we assume that he has drunk a specific amount of beer (e.g. in a beer drinking competition where a specific amount of beer is to be drunk). In the first example, *notice.errors* must be seen as being atomic, whereas in the second example, *drink.beer* should be interpreted as quantised. The second case is an example of forcing boundedness to an unbounded predicate, which is not the topic of this thesis — see, for example, Moens & Steedman’s (1988) concept of coercion or Bach’s (1986) packaging and grinding. The first case, however, is an example of taking a collective reading instead of the normal distributive reading that one would assume for plural objects, and it will be discussed in Section 4.5.

4.3.3 The minimal parts problem

Although Homogeneity manages to tackle all the problems discussed previously, it generates another type of problem, as a consequence of using the *part-of* relation. Consider the predicate *waltz*: there may be a subevent of a waltzing event which does not fall under *waltz* simply because it is too small to consider it as being a waltzing event, i.e. when only two steps have been performed. However, *waltz* is atelic, as the following sentences show:

(4.15) a. ‘John waltzed for hours’

b. *‘John and Mary waltzed in ten minutes’

This is the **minimal parts problem** (Taylor 1977; Bunt 1979). The trouble now is that in Def. 4.3.2.1 *all* the subevents must fall under the predicate, and obviously there is a moment where the subevents are so small that one cannot consider them as being of the same type. This problem has already been discussed in the literature for masses. Take, for example, fruit cake. There are parts of a fruit cake which are not fruit cake anymore. For example, a sultana which is part of a fruit cake is not fruit-cake. Bunt (1979) has already addressed this problem, and his solution can also apply to our problem for events: what we want to model is not the real world but our interpretation of it. Thus, for masses, Bunt specified the ‘Homogeneous Reference Hypothesis’:

> A mass noun refers in such a way that no particular articulation of the referent into parts is presupposed, nor the existence of minimal parts. (Bunt 1979)

In other words, and formalised with the framework of a lattice theory, the object referred to by $fruit.cake$ is structured into a lattice which has no minimal parts: a fruit cake is not made of atoms at all; any part of a fruit cake can be further decomposed into more parts of fruit cake. This proposal is anything but a model of the real world, and even it seems to be against our knowledge of the world: everybody knows that a fruit cake has minimal parts. But still, even when this cannot be refuted, when one uses the expression ‘fruit cake’ in a sentence, does one think in these minimal parts? This is very unlikely: whenever one uses ‘fruit cake’ as a mass noun, the hearer can extract the same conclusions regarding structure as when one refers to a more homogeneous object, like in the expression ‘water’.

Homogeneity will also apply to bare plurals like $cars$. Note that the ‘minimal parts’ problem seems to arise again: if $cars(x)$, there is a part of x which does not fall under $cars$, namely when it is actually one car. Is that so? Again, linguistically this is not the case: every subobject of x falls under $cars$, even the single cars, since when we use the plural we are not thinking of these border cases. As a matter of fact, one can see only one donkey and say that one has seen donkeys! This approach of treating singular elements as falling under the extension of plural predicates is not new; as we have seen in Chapter 2, in Link’s (1983) theory the extension of a plural also contains individuals. For example, if the extension of $judge$ is the set containing the referents of John and Bill, $\{b, j\}$, then the extension is $^{*}judge$ will contain the referents of John, Bill and the join of both,$\{b, j, b \sqcup j\}$. Bare plurals like $judges$[4] or $cars$, or plural events like $push^*$ are therefore homogeneous.

4.4 Thematic relations and their properties

So far we have seen that objects and events refer to entities arranged in two different lattices. These two lattices, however, can relate one to the other. Krifka explained the relation between objects and events by means of a *homomorphism* which has associated a set of specific properties inherent to it. This homomorphism is expressed in the sentence by means of a thematic relation. For example, take the complex predicate $run.a.mile$. Here, an event of running and an object, a mile, are related by means of a thematic relation, which we could call as $distance$. The result is as follows:

(4.16) $run.a.mile = \lambda r[\exists m(a.mile(m) \wedge run(r) \wedge distance(r, m))]$

There have been several attempts to classify thematic relations, defining roles such as agent, patient, etc (see Fillmore 1968 for a classical work on thematic roles). However, Krifka did 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 1989b). I will follow Krifka's approach, and thus, in our previous example, the thematic relation is given an arbitrary name R:

(4.17) $run.a.mile = \lambda r[\exists m(a.mile(m) \wedge run(r) \wedge R(r, m))]$

This thematic relation, R, will have some specific properties which determine completely the link between the running event and the distance of a mile. Some of these properties will characterise the aspectual interactions, and these are the properties Krifka is interested in.

The thematic properties used by Krifka have already been discussed in Section 3.2.2, page 73. However, I will not use all of Krifka's properties, and some of the properties taken from Krifka have been modified slightly. This set of properties will lead to a theory of aspectual composition which is clearly different, as we will see in Section 4.5. But now, let us focus on the properties themselves, without considering their use in the analysis of aspectual composition.

---

[4] Note that, whereas a plural predicate over events will be written with a star, a plural predicate over objects usually does not need to have this distinction, since a plural noun is usually different from a singular: $judges$ versus $judge$. Thus, whereas Link uses the expression $^*judges$ we will use $judges$ instead.

First of all, we have the property of **uniqueness of objects.** A thematic relation is UNI-O whenever the same event cannot relate to two different objects by means of the same thematic relation:

Def. 4.4.0.1 (Uniqueness of Objects)

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

Clear examples of sentences where this property holds for the thematic relation are those where the object is created or destroyed: ‘the car exploded’, ‘John ate the apple’, ‘the workers built the house’. In all these examples, clearly no two different objects can be involved in the same event. But UNI-O also holds for other sentences where the object is neither created nor destroyed. Thus, in the example ‘John read the book’, obviously the book can be read as many times as one wishes; even the same person, say John, can read the book several times if he so wishes. But every time the book is read a different reading event is involved. In the expression of Def. 4.4.0.1, whenever the book is read, a new event appears: e, e', e'' and so on.

Another interesting property is that of **mapping to objects.** A thematic relation is MAP-O$_R$ if for every subevent of the event which is related to the object, there is a subobject which stands in the same relationship with the event:

Def. 4.4.0.2 (Mapping to Objects)

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

In Def. 4.4.0.2 we use the restricted *part-of* relation $\sqsubset$, instead of the more general $\sqsubseteq$ which appears in Krifka’s MAP-O. As a consequence, MAP-O$_R$ is more restrictive than MAP-O, but it also explains the intuitions we want to express. A reason for using MAP-O$_R$ is that the formal proofs are much neater, as we will see below. Also, as we will see later (see Footnote 6 page 128), collectivity is a border case of Krifka’s MAP-O, and therefore it is possible to find a predicate which is at the same time collective and gradual if we use Krifka’s definition (see also Section 4.5.2). This is not the case if we use $\sqsubset$ instead.

Clear examples of sentences where MAP-O$_R$ appears are those where the object is gradually affected by the event, as is the case where the event follows a path. In ‘John ran a mile’, the running event gradually spans over the distance of a mile. Another example of path appears in sentences like ‘Mary ate an apple’, where the eating event gradually affects all the parts of the apple.

Similar to MAP-O_R is the property of *mapping to events.* In this case, for every subobject there is a subevent involved in the same thematic relation with the subobject:

Def. 4.4.0.3 (Mapping to Events)

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

Again, sentences like ‘John ran a mile’ and ‘Mary ate an apple’ have this property in the semantic relation between the event and the inner object.

One more property is that of **summativity.** This property applies whenever the relationship between the join of the objects and the join of the events is the same as that between the objects and events themselves:

Def. 4.4.0.4 (Summativity)

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

The last property I would like to mention in this section is that of **collectivity.** In this case, every subevent of a given event is related with the whole object:

Def. 4.4.0.5 (Collectivity)

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

Clear examples can be seen with the so-called PUSH-verbs. In ‘the donkey pushed the cart’, it is the whole cart which is pushed at every subinterval of the pushing event. As we will see later, the object itself may have a clear structure, but this structure is ignored and the object might well be considered atomic. For this reason I call this property collectivity, in a clear reference to a collective reading of sentences like ‘four people lifted a piano’.

Note incidentally that collectivity is a border case of Krifka’s MAP-O. Here I reproduce MAP-O and its border case, which is actually a paraphrase of COLL:

$$\begin{array}{rcl}\forall R[\text{MAP-O}(R) & \Longleftrightarrow & \forall e, e', x\,[R(e,x) \wedge e' \sqsubseteq e \rightarrow \exists x'(x' \sqsubseteq x \wedge R(e',x'))]\,] \\ \forall R[\text{COLL}_2(R) & \Longleftrightarrow & \forall e, e', x\,[R(e,x) \wedge e' \sqsubseteq e \rightarrow \exists x'(x' = x \wedge R(e',x'))]\,]\end{array}$$

Example	UNI-O	MAP-O$_R$	MAP-E$_R$	SUM	COLL
$run.a.mile$	$\surd$	$\surd$	$\surd$		
$eat.an.apple$	$\surd$	$\surd$	$\surd$		
$eat.apples$	$\surd$	$\surd$	$\surd$	$\surd$	
$eat.apples$	$\surd$				$\surd$
$drive.a.car$	$\surd$				$\surd$
$drive.fifty.cars$	$\surd$	$\surd$	$\surd$	$\surd$	
$see.a.chair$					$\surd$

Table 4.2. The properties of some thematic relations.

As we see, COLL$_2$ is the same as MAP-O with the added restriction that $x' = x$. When this happens, we do not need to introduce the variable x', since we can use x instead of x' in the expression of COLL$_2$. If we do that, the introduction of the existential quantifier over x' is redundant, and therefore COLL$_2$ is reduced to COLL, since the expression $e' \sqsubseteq e$ can be reduced to $e' \sqsubset e$ in the context in which it appears in COLL$_2$.

The relevant properties of the semantic relations of some example predicates are shown in Table 4.2 (see also section 4.5). In this table we can see that $eat.apples$ has two different interpretations. These different interpretations correspond to different readings of the same sentence, very much like in the case of our discussion of Table 4.1 in page 112. As we will discuss in Section 4.5, these two interpretations correspond to a distributive and a collective reading of a sentence such as ‘John ate apples’.

4.4.1 Problems with summativity

As we can see in Def. 4.4.0.4, summativity relies on the join operation: Def. 4.4.0.4 specifies that there will be a thematic relation between a join of events and a join of objects. However, I have argued in page 109 that the join of two events may give an event of a different type, even when the events fall under a cumulative predicate. As an example, the join of two running events is not running if there is no link between these events. Thus, if John ran a mile in Sidney and Mary ran two miles in Australia, the relationship between the join of John and Mary and the join of the distances, if there is such a relationship, is not the same as between a plain running event and its distance.

Since the result of the join of events is an event of a different type, the thematic relation between this complex event and the join of objects is different also. Thus, contrarily to Krifka who claims that the patient thematic relations, if not all the thematic relations in general, are summative, it turns out that there are very few thematic relations of which we can safely say that they are summative.

As we will see later, the property of summativity will apply to *plural* events and structures only. Thus, if there is a plural event of running over several paths (maybe even over the same path), then the join of these events with other plural running events can relate in the same way with the join of all the respective distances, because the results are again a plural event and a plural object. I clearly establish a difference between an individual object and a plural object, but we will see this in Section 4.5.

4.5 The aspectual interactions

As can be seen from Table 4.2, not all the relation properties apply to all the semantic links. Krifka already noticed that sometimes the relation between an event and an object is one of graduality, sometimes one of simultaneity. He tried to establish the relevant properties of several kinds of thematic relations; in doing so, Krifka already started to define subdivisions in the thematic role classification. For example, he described the *Sukzessiv-Patients* (SUK) as the object of predicates like $wein.trinken$, and the *Simultan-Patients* (SIM) as the object of predicates like $wein.sehen$. This is a very slippery area, and some researchers have even argued that it is pointless to try to make an exhaustive analysis of all the possible deep cases like agent, patient, experiencer and so on (Dowty 1991). I follow a slight modification of Krifka's properties and do not commit to any specific deep case. Instead, I will establish a connection with the possible interpretations of a sentence in the sense of the distributive-collective readings. In doing so, only three types of thematic relation properties appear: graduality, collectivity and distributivity. These three types of thematic relation properties are necessary and sufficient to account for all the possible aspectual interactions. I do not claim that only three types of thematic relations exist. Rather, what I want to push for is that only three fundamental properties are needed to account for the aspectual interaction. And these properties are very closely related to the actual reading of the sentence in the sense of collectivity / distributivity, which in turn depends on what we want to say of the structure of the object and the event.

4.5.1 Graduality

The first property we will consider is **graduality.** This property has already been studied by Krifka (1989b, 1989a), and in one or another fashion by other scholars when

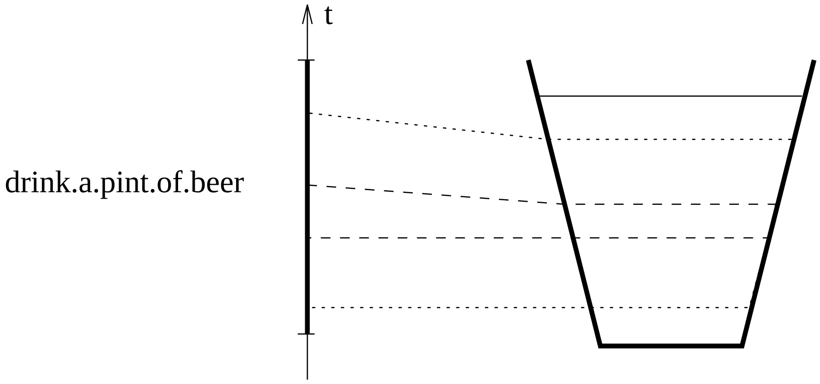

Figure 4.2. A gradual reading of the predicate $drink.a.pint.of.beer$.

they studied the verbs of motion (White 1993) or expressions defining a path (Verkuyl 1989, 1993; Naumann 1995a). An example where the graduality property (GRAD) is seen at work is the predicate $drink.a.pint.of.beer$. In this example, there is a close relationship between every part of the beer and every subevent of the drinking event, as Figure 4.2 shows. The approach followed here is borrowed from Krifka, which we have already discussed in Section 3.2.2, page 73. However, I depart from Krifka in that I do not want to relate GRAD with any semantic relation like PAT, since this (GRAD) property depends on how we interpret a sentence, and thus it depends on context and world knowledge. In concrete, not all the objects related by a PAT semantic relation have a gradual interpretation (like in the example 'drive a car').

This relationship between the object and the event structure is actually an isomorphism preserving the lattice structure: for every subpart of the beer there is a subevent in which the beer is drunk, but also for every part of the drinking event itself there is a portion of the beer which is drunk. This is no more than our properties of mapping to events and mapping to objects, respectively, which I repeat here:

(Def. 4.4.0.2) $\forall R[\text{MAP-O}_R(R) \Longleftrightarrow \forall e,e',x[R(e,x) \wedge e' \sqsubset e \rightarrow \exists x'[x' \sqsubset x \wedge R(e',x')]]]$

(Def. 4.4.0.3) $\forall R[\text{MAP-E}_R(R) \Longleftrightarrow \forall x,x',e[R(e,x) \wedge x' \sqsubset x \rightarrow \exists e'[e' \sqsubset e \wedge R(e',x')]]]$

Let us now consider what these properties imply. Since there is an isomorphism between the object and the event, the object structure and the event structure are exactly the same in terms of lattices. However, in our example $drink.a.pint.of.beer$, $a.pint.of.beer$ is quantised whereas $drink$ is homogeneous. Since none of the predicates are atomic, we have that both predicates have incompatible properties. How can this be? The answer is that the properties here described apply to *predicates* and not to events or objects. The expression $drink(e)$ means that an event e can be categorised as $drink$, but this does not prevent us from categorising it as $drink.a.pint.of.beer$ as well. In this example of beer drinking, it is actually the predicate which refers to the object drunk which decides the temporal structure: an event referred to by $drink$ may be either bounded (telic) or unbounded (atelic), but $a.pint.of.beer$ always refers to a bounded object. Hence, $drink.a.pint.of.beer$ is temporally bounded, i.e., quantised. We can imagine this interaction as that the verb categorises the event as being one of drinking, but leaves open the question about possible telicity. The verb phrase, however, decides this question with the help of the NP $a.pint.of.beer$. This explanation has some resemblances with Sanfilippo's ontology for events (Sanfilippo 1991), though I do not follow his ontology.

Note also that the relation of graduality may present another kind of problem. Take the predicate $eat.an.apple$. Here again, there is a close relationship between every part of the apple and the subevent where this part is eaten. But now, what happens with the apple core? Here we find a part of the apple which is not eaten. Is there a contradiction here? This problem has already been noticed in Krifka's analysis (Krifka 1989b; Naumann 1995a). The same happens with the predicate $peel.an.apple$, where the relationship is not with the apple itself, but with its surface, and a similar problem appears in $build.the.house$. In this case, there are parts of the event which do not relate to the house itself, like building the scaffolding, or the whole design stage. All of these examples show that the isomorphism is not with the object itself, but with some *projection* of the object into another domain, giving as a result the entity which is actually being directly affected by the event, and therefore it is the structure of this entity that is transferred to the VP. For example, in $peel.an.apple$ the object which is directly affected is the skin of the apple. This can be represented as:

(4.18) $peel.an.apple$
$\lambda p \exists a[peel(p) \wedge an.apple(a) \wedge R(p, \pi(a))]$

Such an approach has some resemblance with Landman's use of registers (see Chapter 3): Naumann (1995a:204ff) models graduality in a sentence by expressing the change of value of a register r which is related to an object x by means of the predicate $sub(r)(x)$. The values of this register will be structured into a poset, of which one chain is selected. This chain represents the actual changes which apply to the action we are talking about. It is therefore possible to integrate Landman's insight into the theory presented in this thesis. The details of such an integration, however, are not a major point in this thesis and they will not be developed here.

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

(Def. 4.4.0.1) $\forall R[\text{UNI-O}(R) \Longleftrightarrow \forall e, x, x'[R(e,x) \wedge R(e,x') \rightarrow x = x']]$

As I have already said, this property applies even to predicates where the object is not created nor destroyed, like in the example $read.a.book$. In this example, the book can be read as many times as we wish, but every time we do it we use a different event.

The full definition of graduality is, therefore:

Def. 4.5.1.1 (Graduality)

$$\forall R[\text{GRAD}(R) \Longleftrightarrow \text{UNI-O}(R) \wedge \text{MAP-O}_R(R)]$$

Note that in Def. 4.5.1.1 I have not included the property MAP-E_R. Although we have seen that a gradual relation has this property, it is not necessary to include it in order to prove the transference of the aspectual properties, as we will soon see, and therefore it is not included in the definition.

We are now in a position where we can show the interaction between the NP and the verb. We will do it by means of the following theorem:[5]

Theorem 4.5.1.2 *The result of combining a verb with a quantised NP in a gradual reading is a quantised complex predicate ('drink a pint of beer', 'run a mile', 'a pill dissolved'):*

$$\text{QUA}(NP) \rightarrow \text{QUA}(\lambda v\, \exists n(NP(n) \wedge verb(v) \wedge \text{GRAD}(v,n)))$$

---

[5] In this and the subsequent theorems I will write GRAD(v, n) as a shorthand for $R(v,n) \wedge \text{GRAD}(R)$. Note that we can have R and R', $R \neq R' \wedge \text{GRAD}(R) \wedge \text{GRAD}(R')$. Thus, $\lambda x \lambda y \text{GRAD}(x,y)$ does NOT mean "the R such that GRAD(R)."

Proof: We will follow a *reductio ad absurdum* procedure of natural deduction:

1.	$\neg\text{QUA}(run.a.mile) \wedge \text{QUA}(a.mile)$	; Assumption
2.	$\exists r_v, r'_v[run.a.mile(r_v) \wedge run.a.mile(r'_v)$	; QUA definition
	$\wedge\, r'_v \sqsubset r_v]$	;
3.	$\exists r_v, r'_v, m_v, m'_v[run(r_v) \wedge run(r'_v)$	; meaning of $run.a.mile$
	$\wedge\, a.mile(m_v) \wedge a.mile(m'_v)$	;
	$\wedge\, R(r_v, m_v) \wedge R(r'_v, m'_v) \wedge r'_v \sqsubset r_v$	;
4.	$run(r) \wedge run(r') \wedge a.mile(m) \wedge a.mile(m')$	; $\exists$ elimination
	$\wedge\, R(r, m) \wedge R(r', m') \wedge r' \sqsubset r$	;
5.	$\exists m'_v[m'_v \sqsubset m \wedge R(r', m'_v)]$	; $r' \sqsubset r$ and $R(r, m)$ and MAP-O$_R(R)$
6.	$m' \sqsubset m \wedge R(r', m')$	; UNI-O(R)
7.	$\neg(m' \sqsubset m)$	; QUA$(a.mile)$
8.	$m' \sqsubset m \wedge \neg(m' \sqsubset m)$	; from 6 and 7
9.	CONTRADICTION	;

□

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

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

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

I have said that, in a GRAD reading, the structure of the NP is transferred to the complex action. The same occurs with a gradual reading of a mass noun, to some extent. A (bare) mass noun like $beer$ has both CUM and HOM, but only HOM is transferred to the complex predicate. In the next theorem we will prove that HOM is transferred:

Theorem 4.5.1.3 *When a homogeneous verb is combined with a homogeneous NP in a gradual reading the result is a homogeneous complex predicate ('drink beer'):*

$$\text{HOM}(verb) \wedge \text{HOM}(NP) \rightarrow \text{HOM}(\lambda v\, \exists n(NP(n) \wedge verb(v) \wedge \text{GRAD}(v, n)))$$

Proof: We will use $drink$ as $verb$, and $beer$ as NP.

$$\boxed{\begin{array}{lll}
\multicolumn{2}{l}{\mathrm{HOM}(drink) \wedge \mathrm{HOM}(beer)} & ; \\
\Rightarrow & \forall d, d'[drink(d) \wedge d' \sqsubset d \rightarrow drink(d')] & ; \\
 & \wedge \forall b, b'[beer(b) \wedge b' \sqsubset b \rightarrow beer(b')] & ; \\
\Rightarrow & \forall d, d'[\exists b(beer(b) \wedge R(d,b)) \wedge drink(d) \wedge d' \sqsubset d & ; \\
 & \rightarrow \exists b'(beer(b') \wedge R(d,b') \wedge drink(d'))] & ; \\
 & \wedge \forall b, b'(beer(b) \wedge b' \sqsubset b \rightarrow beer(b')) & ; \\
\Rightarrow & \forall d, d'[\exists b(beer(b) \wedge R(d,b)) \wedge drink(d) \wedge d' \sqsubset d & ;\ \mathrm{MAP\text{-}O}_R(R) \\
 & \rightarrow \exists b'(b' \sqsubset b \wedge beer(b) \wedge R(d',b')) \wedge drink(d') \wedge \mathrm{HOM}(beer) & ; \\
\Rightarrow & \forall d, d'[\exists b(beer(b) \wedge R(d,b)) \wedge drink(d) \wedge d' \sqsubset d & ;\ \mathrm{HOM}(beer) \\
 & \rightarrow \exists b'(beer(b') \wedge R(d',b')) \wedge drink(d') & ; \\
\Rightarrow & \mathrm{HOM}(drink.beer) & ;
\end{array}}$$

□

I will now comment why CUM cannot be transferred. First of all, the verb itself is not cumulative, but homogeneous. If we wanted to prove that the complex predicate is cumulative, we would have to prove that (for $drink.beer$):

(4.19) $$\begin{array}{l}\forall d, d'[\exists b(beer(b) \wedge R(d,b) \wedge drink(d)) \wedge \exists b'(beer(b') \wedge R(d',b') \wedge drink(d')) \\ \rightarrow \\ \exists b''(beer(b'') \wedge R(d \sqcup d', b'') \wedge drink(d \sqcup d'))]\end{array}$$

In (4.19) we have the term $drink(d \sqcup d')$, which does not hold for every d, d' simply because $drink$ is not cumulative. Thus, (4.19) cannot be proved.

While the proof above suffices for our purposes in this chapter, in Chapter 5 I will consider the case of several NPs, and in doing so I will group the verb and inner NP at some point. The complex predicate which results may be cumulative. Therefore, we still need to prove that even so the more complex predicate which results from combining the cumulative predicate and the outer NP is not cumulative. This is easy to prove, since $R(d \sqcup d', b'')$ cannot be proved of (4.19). The reason for this is that the thematic relation does not have the property of summativity. A gradual relation does not have summativity for the same reason that a verb cannot be cumulative. The property of summativity, I repeat here, is:

(4.4.0.4) $$\forall R[\mathrm{SUM}(R) \Longleftrightarrow \forall e, e', x, x'\,[R(e,x) \wedge R(e',x') \rightarrow R(e \sqcup e', x \sqcup x')]\,]$$

In this formula we see that $R(e \sqcup e', x \sqcup x')$ appears, establishing a thematic relation between the join of two events and the join of two objects. But the join of two events is an entity which may belong to a category different to that of the events themselves, and therefore this new event can hardly be related in the same fashion with the join of objects. In any case we would call this relation with a new name, say $R'(e \sqcup e', x \sqcup x')$. I definitely depart from Krifka, who claims that cumulativity is transferred because the verb is cumulative and the thematic relation is summative.

As a final remark, note that 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 object is HOM, hence the final verb phrase is HOM. In the second and third examples the objects are QUA, hence their verb phrases are QUA.

4.5.2 Collectivity

The name **collectivity** (COLL) to characterise a thematic relation property is inspired from the use of collective readings of plurals (Landman 1989; see also Chapter 2). In a collective reading, the possible structure of the object referred to by the NP is not considered. Take, for example, a collective reading of the following sentences:

(4.20) a. 'three people carried the piano upstairs'
b. 'the students wrote a letter to the Head of the Department'

In (4.20a), the three people form a group, and it is the group which lifts the piano. The use of groups is clearer in (4.20b). In a normal reading of this sentence, it is clear that not all the students are actively engaged in the physical act of writing the letter. Only the representative will write it, but it is the whole group which is responsible for the action.

The concept of collectivity can be used to explain a type of sentence where there is no transfer of aspectual properties. Consider the following sentences:

(4.21) a. 'John watched three cars'
b. 'John drove a car'
c. 'John pushed a cart'

To explain the aspectual interactions in sentences like the ones in (4.21), Krifka uses the thematic relation *simultans patient* or SIM, since the whole object is simultaneously

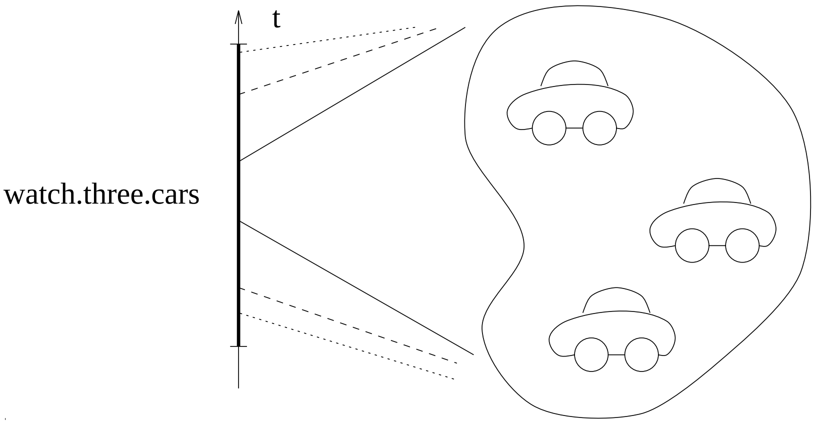

Figure 4.3. A collective reading of the predicate $watch.three.cars$.

affected by the action. However, as I have already said in Chapter 3, Krifka's description of the properties assigned to SIM is rather vague. This does not need to be so, however. Take (4.21c), for example. Here, in every subevent of the pushing event the whole cart is pushed. And the same is true of (4.21b). Now, in every subevent of the driving event, it is the whole car which is driven, and not part of it. That is, as opposed to graduality, now the inner structure of the object is not considered at all.

Sentence (4.21a) may seem problematic. During John's process of watching, he may first start watching one of the cars and then watch another, then go back to the first one, and finally watch the third one. While this is true in the real world (one cannot focus with the eyes to two different objects), one must consider what is the linguistic interpretation of it. Going back to Sentence (4.21c), in the real world John does not push the whole cart but just the surface of the cart which is in contact with his hands, but we never consider this fact of the real world. And the same with (4.21b). Here, John only manipulates some elements in a car (the driving wheel, the speed pedal, and so on). In (4.21a), even when John may watch first one car and then another, we are referring to the three cars as an individual object. If one wants to specify that the cars are being watched at different times, one must say it with a sentence like:

(4.22) a. 'John watched three cars consecutively'

In conclusion, in the same way as in a collective reading, the structure of object referred to by the NP is not considered, since for every subevent of the main event, it is the whole object what is affected (see also Figure 4.3):

(Def. 4.4.0.5) $\forall R[\mathrm{COLL}(R) \Longleftrightarrow \forall e, e', x[R(e,x) \wedge e' \sqsubset e \rightarrow R(e',x)]]$

If we examine Def. 4.4.0.5 and Def. 4.5.1.1, we can see that a collective thematic relation cannot be gradual, since either it will not have MAP-O$_R$ or it will not have UNI-O. Informally, the proof runs this way: If R is MAP-O$_R$, then for every subevent of e there is a subobject of x which is related to that subevent. This subobject, say x', cannot be x because MAP-O$_R$ does not allow it. However, if we assume that R is COLL, then every possible subevent of e is related to x. This therefore contradicts the restriction imposed by UNI-O.

In the previous proof we have taken the implicit assumption that there are indeed subevents of e. This assumption does not always hold, since there may be atomic predicates, as we will see later in this section. The following theorem is a formalisation of what we have said above:

Theorem 4.5.2.1 *A thematic relation can never be GRAD and COLL at the same time, if the predicate over events is not atomic.*

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

Proof:

1.	$R(e,x) \wedge e` \sqsubset e$	; First assumption
2.	$\mathrm{GRAD}(R) \wedge \mathrm{COLL}(R)$	; we negate the consequent ...
3.	MAP-O$_R(R)$	; From 2. and GRAD(R)
4.	$\exists x'_v(x'_v \sqsubset x \wedge R(e', x'_v))$	; From 1., 3. and MAP-O$_R(R)$
5.	$x' \sqsubset x \wedge R(e', x')$	; Ell. of existential from 4.
6.	$R(e', x)$	; From 1. and COLL(R)
7.	$R(e', x) \wedge R(e', x')$	; From 1. and 6.
8.	$x = x'$	; From 7. and UNI-O(R)
9.	$x = x' \wedge x' \sqsubset x$	; From 5. and 8.
10.	CONTRADICTION	;
11.	$\neg(\mathrm{GRAD}(R) \wedge \mathrm{COLL}(R))$	; *reductio ad absurdum*

$\square$

There are however some collective thematic relations which have UNI-O. An example is (4.21b), which is UNI-O because normally one cannot drive anything apart from the car which is specified. The thematic relation will not be MAP-O$_R$, as expected:

during all the subevents of the main event of car driving, what is driven is always the whole car and not parts of it.[6]

There may be also some collective thematic relations which have MAP-O$_R$ but not UNI-O. An example is the following:

(4.23) 'Mary ate from the sandwich'

Here, every subevent of the eating event is a subevent of eating from the sandwich. We have, thus, a collective thematic relation. This thematic relation will also be MAP-O$_R$, since every subevent of the eating event will also be a subevent of eating from a portion which is smaller than the whole sandwich, and the same will happen with any portion of the sandwich: every subevent of an event of eating from a portion of the sandwich is a subevent of eating from an even smaller portion of the sandwich. But since this subevent will also be an event of eating from all the portions which cover the eaten portion, the thematic relation will not be UNI-O.

Finally, there may be also some collective thematic relations which are neither UNI-O nor MAP-O$_R$. One such example is (4.21c). The relevant thematic relation in this sentence is not UNI-O because during the same push John may push other things which are connected to the cart, e.g. another cart which is situated behind the cart which is pushed. The thematic relation is not MAP-O$_R$ either because there is not a portion of the cart which is pushed during a subevent of the main event: it is the whole cart which is pushed (together perhaps with other elements, as we have just seen).

As opposed to GRAD readings, when COLL holds it is the HOM structure introduced by the verb what is transferred. This can be seen in the following theorem:

Theorem 4.5.2.2 *When a homogeneous verb is combined with an NP in a collective reading the result is a homogeneous complex predicate ('drive a car'):*

$$\mathrm{HOM}(verb) \rightarrow \mathrm{HOM}(\lambda v\, \exists n(NP(n) \wedge verb(v) \wedge \mathrm{COLL}(v,n)))$$

---

[6] Any collective reading which is also UNI-O would be gradual if we used Krifka's MAP-O property instead of MAP-O$_R$. This is so because collectivity is a particular case of MAP-O. This is one reason why I prefer to use MAP-O$_R$ instead of MAP-O, as I have briefly commented in page 116.

Proof: We will use $drive$ as the verb and $a.car$ as the NP.

$$\begin{array}{|lll|}
\hline
\multicolumn{2}{|l}{\mathrm{HOM}(drive)} & ; \\
\Rightarrow & \forall d, d'(drive(d) \wedge drive(d') \wedge d' \sqsubset d \rightarrow drive(d')) & ;\ \text{HOM definition} \\
\Rightarrow & \forall d, d'(drive(d) \wedge \exists c(car(c) \wedge R(d,c)) \wedge d' \sqsubset d & ; \\
 & \rightarrow drive(d')) & ; \\
\Rightarrow & \forall d, d'(drive(d) \wedge \exists c(car(c) \wedge R(d,c)) \wedge d' \sqsubset d & ;\ \mathrm{COLL}(R) \\
 & \rightarrow drive(d') \wedge R(d',c) & ; \\
\Rightarrow & \forall d, d'(drive(d) \wedge \exists c(car(c) \wedge R(d,c)) \wedge d' \sqsubset d & ;\ \exists\ \text{introduction} \\
 & \rightarrow drive(d') \wedge \exists c'(car(c') \wedge R(d',c')) & ; \\
\Rightarrow & \mathrm{HOM}(drive.a.car) & ; \\
\hline
\end{array}$$

□

In Theorem 4.5.2.2 nothing is said of the NP properties. Thus, regardless of the NP, the verb will transfer its HOM property to the complex predicate. This explains the fact that in a PUSH-verb, the object NP does not affect the aspect of the sentence: a collective reading is implied in the thematic relation.

However, not all the structural properties associated with the verb phrase may be transferred. If the verb is CUM the final sentence will not be CUM, and the reason for this is similar as to why CUM is not transferred in a gradual reading: the lack of summativity in the collective interpretation. For example, take ‘a teacher drove cars’, where CUM($drive.cars$) holds (in order to make the notation shorter I will use the predicate dc; thus, we have that CUM(dc)). If we want to prove CUM($a.teacher.drive.cars$), we will have to prove the following:

(4.24)
$$\begin{array}{ll}
\forall e, e'[& \exists x(a.teacher(x) \wedge dc(e) \wedge \mathrm{COLL}(e,x)) \\
 & \wedge \exists x'(a.teacher(x') \wedge dc(e') \wedge \mathrm{COLL}(e',x')) \\
 & \rightarrow \exists x''(a.teacher(x'') \wedge dc(e \sqcup e') \wedge \boxed{\mathrm{COLL}(e \sqcup e', x'')})]
\end{array}$$

In (4.24) it is impossible to prove the portion which appears in the box, since COLL does not necessarily have SUM. Note also that, in the previous expression, we need the extra condition that CUM($a.teacher$) if we want to ensure $a.teacher(x'')$ by identifying x'' with $x \sqcup x''$. But the NP sometimes is not CUM (it is not indeed in our example $a.teacher$), and thus the transference of CUM from the verb cannot be completed, even in the case of the thematic relation having SUM.

Atomic predicates. 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 as introduced in page 112, which I repeat here:

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

That is, an atomic predicate is one that only holds for atomic elements. In a collective reading, an atomic predicate will also transfer its structure to the complex predicate, as is described in the following theorem:

Theorem 4.5.2.3 *An atomic verb, when combined with an NP in a collective reading the result is an atomic complex predicate ('notice an error', 'notice errors' (collective reading)):*

$$\text{atomic}(verb) \rightarrow \text{atomic}(\lambda v\, \exists n(NP(n) \wedge verb(v) \wedge \text{COLL}(v, n)))$$

Proof: We will use *beat* as $verb$, and *donkey* as NP.

$$\boxed{\begin{array}{lll} \text{atomic}(beat) & & ; \\ \Rightarrow & \forall b, b'(beat(b) \rightarrow \neg(b' \sqsubset b)) & ; \\ \Rightarrow & \forall b, b'(beat(b) \wedge [\exists d(donkey(d) \wedge R(e, d))] \rightarrow \neg(b' \sqsubset b)) & ; \\ \Rightarrow & \text{atomic}(beat.a.donkey) & ; \end{array}}$$

□

Actually, it is easily provable that, whenever an event predicate is atomic, this property is transferred to the final complex predicate, regardless of the object predicate or even the thematic relation. This is stated in the following theorem:

Theorem 4.5.2.4 *Any atomic verb combined with any kind of NP in any possible reading renders an atomic complex predicate.*

$$\forall P[\text{atomic}(P) \rightarrow \text{atomic}(\lambda e\, P(e) \wedge \exists x\, (Q(x) \wedge R(e, x)))$$

Proof: The proof follows trivially from theorem 4.5.2.3, since no references to any thematic relation properties have been used in that proof. □

As a consequence, if atomic($notice$) then atomic($notice.an.error$). This consequence is rather straightforward if we examine the property of collectivity (Def. 4.4.0.5), which always holds when the predicate over events is atomic, since in such a case the antecedent of Def. 4.4.0.5 is always false.

As a final comment on atomic predicates over events, note that Theorem 4.5.2.1 does not prevent a collective reading being gradual too when the predicate over the event is atomic. In fact, the thematic relation will always have MAP-O_R (again, because the antecedent in Def. 4.4.0.2 would be false). As a consequence, if the thematic relation has the property of uniqueness of objects, then it will be also gradual, assuming the predicate is atomic. Some examples are shown below, where the sentences in (4.25) will be collective and gradual at the same time, but those in (4.26) will be collective only:

(4.25) a. ‘Mary inserted the coin into the machine’
b. ‘Henry typed a word’
c. ‘Peter reached the top of the hill’

(4.26) a. ‘Mary noticed water on the floor’
b. ‘Sally dropped the jar’
c. ‘John saw the solution to the problem’

The difference between the sentences in (4.25) and (4.26) is that, whereas in (4.25) the events referred to can only be related to one object, in (4.26) the same event can be related to more objects. For example, Mary can drop a jar plus other things in the same event of dropping (for example, if Mary is holding the jar and the other objects and then suddenly she releases them), but she cannot insert anything else than the coin being described in (4.25a) during the same inserting event; as soon as she starts inserting another coin a new event is created for the insertion of that other coin.

The aspectual interactions in (4.25) and (4.26) will be the same, however, because both the object referred to by the verb and that referred to by the NP are atomic, and therefore it does not matter which transfers its referential properties. The event described by the sentence will be atomic anyway.

4.5.3 Distributivity

The last property is that of **distributivity,** which will be based on the classical interpretation of distributivity (see, for example, Scha 1984). Consider a distributive reading of (4.27):

(4.27) a. ‘three people lifted a table’
b. ‘John drove three cars’

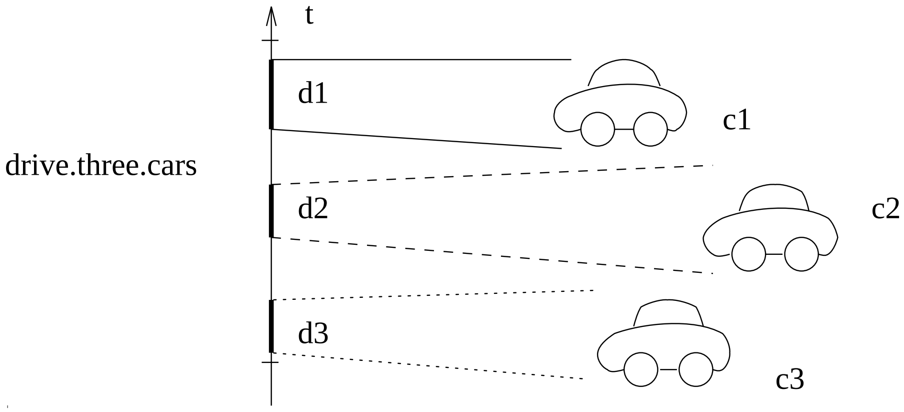

Figure 4.4. A distributive reading of the predicate $drive.three.cars$.

In (4.27a) there will be three different lifting events, and each one of the events will be an event of lifting a table. In the same way, in (4.27b) there will be three independent driving events, one for every car. Thus, as opposed to COLL, now the structure of plurals is being considered: each one of the objects indicates an independent event, as we can see in Figure 4.4.

Distributivity is not very different from graduality in that the structure of the object is taken into account. In fact, a distributive thematic relation will have both MAP-O$_R$ and UNI-O. Take, for example, (4.27b). The multiple event is the join of three independent driving events: $d = d_1 \sqcup d_2 \sqcup d_3$. Every one of these subevents will have one car assigned to it. In fact, if we call R the thematic relation, the following is true:

(4.28)
$$\begin{gathered} R(d_1, c_1) \wedge R(d_2, c_2) \wedge R(d_3, c_3) \\ \wedge \\ R(d_1 \sqcup d_2, c_1 \sqcup c_2) \wedge R(d_1 \sqcup d_3, c_1 \sqcup c_3) \wedge R(d_2 \sqcup d_3, c_2 \sqcup c_3) \\ \wedge \\ R(d_1 \sqcup d_2 \sqcup d_3, c_1 \sqcup c_2 \sqcup c_3) \end{gathered}$$

Furthermore, d_1, d_2 and d_3 are related by means of R only to c_1, c_2 and c_3, and they do it only as specified in (4.28). In other words, UNI-O holds too.

There is an important difference with graduality, however. In an event which is related to an object by means of a gradual reading, all the subevents are part of the same individual event. Thus, when John is eating an apple all the subevents are part of an individual event of eating. And the same will hold for the subobjects; all the parts of the apple which is being eaten are part of an individual object, namely the apple itself. The difference with distributivity is that now the subevents are individual events, and the subobjects are individual objects. In a distributive interpretation of (4.27b), for example, the subevents of the driving event are individual events, namely drivings of a subset of the three cars. In other words, in a distributive interpretation the granularity is more coarse than in a gradual interpretation, and therefore in a distributive interpretation of (4.27b) we are not thinking of the subevents inside the individual driving events.

A consequence of this is that now, since we are working with plural objects and events, a predicate over plural events may be cumulative. Some examples are:

(4.29) a. ‘Peter lifted tables’
b. ‘John noticed errors’ (distributive reading)
c. ‘Mary pushed carts’

Take, for example, (4.29c). Here, even when $push.a.cart$ is not cumulative, $push.carts$ (in a distributive reading) is cumulative. This can be seen in the specification of cumulativity for $push.carts$:

(4.30)
$$\begin{aligned} &\mathrm{CUM}(push.carts) \leftrightarrow \forall p, p'[\\ &\qquad \exists c\,(push^*(p) \wedge carts(c) \wedge R(p,c)) \\ &\wedge \quad \exists c'\,(push^*(p') \wedge carts(c') \wedge R(p',c')) \\ &\rightarrow \quad \exists c''\,(push^*(p \sqcup p') \wedge carts(c'') \wedge R(p \sqcup p', c''))] \end{aligned}$$

In (4.30) we see clearly that now the predicate over plural events is different from that over singular events: whereas a push over a singular event is represented by $push$, a push over plural events is represented here by $push^*$, in a clear reference to Link’s (1983) starred predicates (see Chapter 2). There is a difference, however, with Link’s approach. Link defined * as an operator over predicates, so that the extension of $^*P$ is the closure under the join operation of all the elements of the extension of P. In the approach followed here, P and P^* are two different predicates.

Since now we have plural events and therefore cumulativity may apply, a distributive thematic relation will also have the property of summativity. This can be seen in the interpretation shown in (4.28), where d_1 is related to c_1, $d_1 \sqcup d_2$ is related to $c_1 \sqcup c_2$, and so on. The definition of distributivity is, therefore, as follows:

Def. 4.5.3.1 (Distributivity)

$$\forall R[\mathit{DISTR}(R) \Longleftrightarrow \mathit{GRAD}(R) \wedge \mathit{SUM}(R)]$$

In a distributive reading, very much like in a gradual one, it is the NP structure which is transferred to the final complex predicate. This is trivial for the properties of homogeneity and quantisation, since distributivity borrows all the properties of graduality. This is stated in the following theorems:

Theorem 4.5.3.2 *When a verb is combined with a quantised NP in a distributive reading the result is a quantised complex predicate ('drive three cars'):*

$$\mathrm{QUA}(NP) \rightarrow \mathrm{QUA}(\lambda v\, \exists n(NP(n) \wedge verb(v) \wedge \mathrm{DISTR}(v,n)))$$

Proof: The proof is exactly the same as for Theorem 4.5.1.2, since in that proof we did not need to use the verb's homogeneity property nor DISTR's SUM property. □

Theorem 4.5.3.3 *When a homogeneous verb is combined with a homogeneous NP in a distributive reading the result is a homogeneous complex predicate:*

$$\mathrm{HOM}(verb) \wedge \mathrm{HOM}(NP) \rightarrow \mathrm{HOM}(\lambda v\, \exists n(NP(n) \wedge verb(v) \wedge \mathrm{DISTR}(v,n)))$$

Proof: The proof follows from theorem 4.5.1.3, since DISTR has all the properties of GRAD plus SUM. □

As for cumulativity, the relevant theorem is:

Theorem 4.5.3.4 *When a cumulative verb is combined with a cumulative NP in a distributive reading the result is a cumulative complex predicate ('drive cars'):*[7]

$$\mathrm{CUM}(verb) \wedge \mathrm{CUM}(NP) \rightarrow \mathrm{CUM}(\lambda v\, \exists n(NP(n) \wedge verb(v) \wedge \mathrm{GRAD}(v,n)))$$

---

[7] This theorem does not take in account alternative scopes of the NP. Later (page 152) we will see that this theorem does not hold when a certain scope distribution appears. This is one more argument against the use of Krifka's CUM.

Proof: We will use $drive^*$ as $verb$ and $cars$ as NP.

$$\begin{array}{|lll|}
\hline
\multicolumn{2}{|l}{\mathrm{CUM}(drive^*) \wedge \mathrm{CUM}(cars)} & ; \\
\Rightarrow & \forall d, d'(drive^*(d) \wedge drive^*(d') & ; \\
 & \rightarrow drive^*(d \sqcup d')) \wedge \mathrm{CUM}(cars) & ; \\
\Rightarrow & \forall d, d'(\exists c(cars(c) \wedge R(d,c)) \wedge drive^*(d) & ; \\
 & \wedge \exists c'(cars(c') \wedge R(d',c')) \wedge drive^*(d') & ; \\
 & \rightarrow \exists c, c'(cars(c) \wedge R(d,c) \wedge cars(c') \wedge R(d',c')) & ; \\
 & \wedge drive^*(d \sqcup d')) \wedge \mathrm{CUM}(cars) & ; \\
\Rightarrow & \forall d, d'(\exists c(cars(c) \wedge R(d,c)) \wedge drive^*(d) & ;\ \mathrm{CUM}(cars), \mathrm{SUM}(R) \\
 & \wedge \exists c'(cars(c') \wedge R(d',c')) \wedge drive^*(d') & ; \\
 & \rightarrow \exists c, c'(cars(c \sqcup c') \wedge R(d \sqcup d', c \sqcup c')) \wedge drive^*(d \sqcup d')) & ; \\
\Rightarrow & \mathrm{CUM}(drive.cars) & ; \\
\hline
\end{array}$$

□

In a distributive reading, therefore, a complex predicate like $hire.secretaries$ may be CUM. However, I have already said that predicates like $push.a.cart$ are not CUM. What is the difference between these two atelic predicates? One difference is that, as I have been stating in this section, $hire.secretaries$ is a predicate over plural events, whereas $push.a.cart$ is a predicate over only one event. And whereas the join of two plural events of the same kind gives again a plural event, the join of two singular events, even if they are of the same kind, does not give another singular event if there is no extra-linguistic link between the events. Also, note that, whereas $secretaries$ is cumulative, $a.cart$ is not.

Note also, since it is the NP which decides the final structure, there will be cases where the verb is atelic but the combination is telic. 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, which is atelic. However, in $drive.two.cars$, if we reject the habitual reading, the only possible reading is one of distributivity (one cannot drive two cars at the same time), and hence $drive.two.cars$ acquires its structure from the NP, giving a telic process, which is what the data in Chapter 1 predict.

Note also that a verb which is usually regarded as atomic may be involved in an action which is not atomic. For example, in the distributive reading of 'noticed errors', atomic($notice$) but ¬atomic($notice.errors$). However, by means of theorem 4.5.2.4 we have seen that this is impossible: $notice.errors$ should be atomic. What is wrong here? In fact, nothing is wrong, since 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 $errors$. In fact, under our notation we clearly distinguish between the noticing event under a collective reading ($notice$) and a distributive one ($notice^*$).

After examining the above one could draw the conclusion that the verbs should therefore have two lexical entries, one for the singular reading and another for the plural one. This is not the case, however. A verb introduces only the singular meaning, but when distributivity appears, a set of events is created, in a way which resembles the use of quantifiers. For example, a sentence like ‘John ate an apple’ could be translated as:

(4.31) $\exists j, a, e\,[john(j) \wedge an.apple(a) \wedge eat(e, j, a)]$

Whereas a sentence like ‘John ate three apples’ would have a translation such as:

(4.32) $\exists j, A, E\,[john(j) \wedge three.apples(A) \wedge \forall a\,(a \in A \rightarrow \exists e\,(e \in E \wedge eat(e, j, a)))]$

The quantification shown here (the one which is mostly used in the literature) is not exactly the property of DISTR; it is easy to see that (4.32) does not necessarily have MAP-O$_R$ nor UNI-O, it has only MAP-E$_R$ which, ironically, is not used in our definition of distributivity. The notation in (4.32) has been used to show the difference in the structuration of the events as it is done in the literature (see Scha 1984, for example). A more exact notation showing the distributive relation is the one we have been using in this chapter (though see Chapter 5, Section 5.1 for the definitive notation). For the previous example it would be as follows:

(4.33) $\exists j, A, E\,[john(j) \wedge three.apples(A) \wedge eat^*(E) \wedge R(E, A) \wedge DISTR(R)]$

Mixed distributive readings

There is one class of distributive readings which does 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. Consider, for example, the following sentence:

(4.34) ‘I hired secretaries and janitors independently’

This sentence involves only two hiring events, one for secretaries and another for janitors. Under this reading, there are therefore two groups, one of secretaries and another of janitors, but these groups are treated as individual elements.

A useful way of modelling the possibility of mixed distributive readings is by defining an operator which creates atoms out of structures. Landman (1991), for example, uses the concept of packaging and grinding of masses, and Link uses a group operator which has been described in Chapter 2 (see also Landman 1989). Verkuyl (1993) also allows for the possibility of mixed distributive readings, when he introduces the partitions (see Chapter 3). In this thesis, the difference between a distributive and a mixed distributive reading is established by means of the level of granularity we apply to the interpretation of the sentence. Thus, in a distributive reading the granularity stops at the level of singular individuals, whereas in a mixed distributive reading the granularity is more coarse and therefore the atomic entities are actually groups of entities.

The existence of mixed distributive readings allows us to establish a further similarity between a distributive and a gradual reading. Consider the following sentence:

(4.35) ‘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 predicate over 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 which form atomic individuals (the apples).

We see, therefore, that distributive, gradual, and mixed distributive readings are very much the same thing, with very few differences. There is, however, a clear difference which I have commented on earlier in our discussion of distributive readings. In a (mixed) distributive reading the subobjects and subevents are independent individuals and therefore they are part of a plural individual, whereas in a gradual reading the subobjects and subevents are dependent in that they are part of a (bigger) singular individual. In this, a gradual reading resembles a collective reading.

And there is of course a major difference between a collective and a distr / grad / mixed reading: whereas in a distr / grad / mixed reading the NP affects the aspectual properties of the sentence, in a collective reading this is not the case.

4.6 Ambiguous predicates

An important point all along this thesis is that the same predicate may have several interpretations. In this section we will extend on this and comment some examples. Consider the following sentences:

(4.36) a. ‘John pushed three carts’
b. ‘Sally noticed two errors’

(4.37) a. ‘Peter ate three apples’
b. ‘Peter marked three exams’

(4.38) a. ‘Henry drank beer’
b. ‘Sally ate apple’

(4.39) a. ‘John read a book’

All the examples in (4.36) are ambiguous between a distributive and a collective reading. In (4.36a), for example, one can apply a collective reading if, say, John is pushing three carts at the same time, but one may also want to say that John pushed the three carts independently, by means of three separate pushes, in which case (4.36a) would acquire a distributive reading. A similar comment can be said of (4.36b) so that, for example, one may want to say that Sally noticed two errors with the same noticing event (collective reading) or with two independent events (distributive reading).

The examples in (4.37), on the other hand, are ambiguous between a distributive and a gradual reading. Under a distributive reading, for example, Peter ate three apples in three clearly different events, whereas under a gradual reading there is only one event in which all the three apples are eaten. Note that now the collective reading is not available, as none of the sentences in (4.37) is atelic:

(4.40) a. *‘Peter ate three apples for hours’
b. *‘Peter marked three exams for hours’

All the examples in (4.38) are ambiguous between a collective and a gradual reading. The gradual reading is obvious, but the collective reading is also available if we consider the predicate *apple* or *beer* as referring to a general substance such as APPLE or BEER (similar to Carlson’s (1977) kinds, but applied to masses) instead of the actual apple or beer which is consumed during the event.

It is also possible to find ambiguity between collectivity and graduality in examples like (4.39), where one can imply that John read the book completely (gradual reading), or John read *from* the book (collective reading).

There is one last possibility, in theory. Nothing prevents a sentence being three-way ambiguous and therefore having any of the three possible readings: collective, gradual or distributive. However, this type of sentence is not easy to find. A possible candidate would be any sentence whose NP contains a plural noun and which admits a gradual reading, like those in (4.37). However, by means of the in / for test we have seen that they do not admit a collective reading. The possibility of a third reading in any (4.36) or (4.38) is more difficult to find. Since the aspectual transference mechanism is very similar between a distributive and a gradual reading, we cannot use the in / for test in the sentences of (4.36), which allow either a distributive or a collective reading; nor in those of (4.38), which allow either a collective or a gradual reading. A particularly difficult example is the following sentence:

(4.41) ‘Peter ate apples’

Here, regardless of the actual reading, the sentence will always be atelic because both the verb and the NP are homogeneous and therefore either a distributive, a gradual or a collective reading is possible: only context will decide which is the actual reading. This sentence is very similar to (4.37a), which we have seen is not collective. However, if we take $apples$ as being a predicate over kinds this sentence is very much like those in (4.38), which admit a collective reading. This example, therefore, might have any of the three readings available. But still, as we have seen, the aspectual interactions will remain the same regardless of the actual reading chosen.

Although there are ambiguous sentences, not all the sentences are ambiguous. The following sentence will not be ambiguous:

(4.42) ‘Mary drove two cars’

Sentence (4.42a) describes an event of Mary driving two cars. We know by world knowledge that normally one cannot drive two cars at the same time, and therefore one cannot apply a collective reading to the sentence. We can test the impossibility of a collective reading by means of the in / for test. If one says the following,

(4.43) ‘Mary drove two cars for two hours’,

the only interpretation we can apply is that Mary first drove one car, then the second, then again the first car, and so on. In other words, the event described is iterative and therefore (4.42) is only distributive.

It is obvious that the fact that a sentence may have one or another interpretation may affect the aspectual properties of the sentence itself. This is clearly seen in the sentences which are ambiguous between a reading which allows for two different types of aspectual interaction. Thus, the sentences in (4.36) admit either an in- or a for- adverbial, but depending on the adverbial the interpretation is either distributive or collective, respectively. Also, the ambiguity in (4.39) disappears if we add the appropriate adverbial. For example, if one says 'John read a book in an hour', the intended interpretation is collective, whereas if one says 'John read a book for hours' the reading is gradual. There will be other sentences, on the other hand, which despite being ambiguous the ambiguity is not reflected on the final aspectual properties. This is clearly the case of the sentences in (4.37) and (4.38), where any of the interpretations will lead to telicity (4.37) or atelicity (4.38). In this type of sentence it may be really difficult to decide which reading is the one used, as we have seen with (4.41).

4.7 Conclusions and problems

A parallelism is drawn between the structure of the domain of objects and that of the domain of events: both of them are complete join semilattices with the bottom element removed (Link 1987; Krifka 1989b). The lattice structure itself depends on how we interpret the world. Thus, we may interpret the same object as being 'the cards' or as 'the deck of cards'.

The elements of these lattices are categorised by means of predicates having some specific properties, of which CUMulativity, QUAntisation, HOMogeneity and atomicity are discussed. Since these properties apply both to predicates over objects and to predicates over events, these predicates may interact so that the properties assigned to an NP may be transferred to the VP which contains it. According to how we interpret the object, we assign one or other structure to it. This in turn will determine one or another property of the predicate to whose extension the object belongs. As an example, even when we call an object 'cards' we may consider it as being structured (made of cards) or atomic (a set of cards). As Link says:

> The introduction of a collective term like 'the deck of cards' is indicative of connotations being added enough for it to refer to a different individual [as opposed to 'the cards']. (Link 1983:p303)

The selection of one or another predicate property will depend on the actual interpretation given to the thematic relation between the object and the event. Thus, in a collective (COLL) interpretation the object structure is not considered, and therefore a highly structured object is regarded in the same way as an atomic object when it comes to deciding the aspectual interaction between the NP which refers to this object and the verb. This neglection of the object structure in a collective reading is compatible with a group approach such as Landman's (1989). In a distributive reading (DISTR), however, the plural structure of the object will show itself, and the actual reading would be very similar to that in classical theories of plurals such as Link's (1983) or the DRT approach (Kamp & Reyle 1993). Finally, in a gradual reading (GRAD), the object will be structured but it will preserve its individuality. That is, no plural structure is involved. The gradual reading is extensively commented on Krifka's theory (Krifka 1989a; Krifka 1989b).

This three-way classification of the thematic relations is exhaustive regarding aspect. As opposed to this, in an approach like Krifka's one must assign specific properties to every semantic case, forcing subdivisions in the classification of the thematic roles. As an example, a patient thematic relation will be subdivided into two types, those thematic relations having graduality (Krifka's SUK) and those having simultaneity (Krifka's SIM). If one were going to follow such an approach one would have to specify which properties hold for *every* thematic relation, not only the patient thematic roles, but it is really difficult to provide an extensive listing of all the thematic relations, let alone to specify their formal properties (Dowty 1991). In the approach introduced in this thesis no attempt in that direction is made. Instead, a well-defined and reduced set of properties of the thematic relations are considered, without trying to establish a new classification of the thematic relations themselves. The focus here is not on the actual full interpretation of the thematic relations, but only on the specific properties which allow for the several types of aspectual interactions.

According to these properties (DISTR, COLL and GRAD), argument structure will influence the sentence aspect in different ways. In a collective reading, the final aspect is mainly provided by the verb, whereas 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 approach is more robust than Verkuyl's plus-principle. Verkuyl had to define two different thematic relations, $\theta_{=}$ when the plus-principle holds and $\theta_{\subseteq}$ when it does not hold (an example of the last is the PUSH-verbs), but as it has been explained in Chapter 3, $\theta_{\subseteq}$ is not satisfactory. In that sense, the definition of COLL introduced in this thesis is more appropriate.

Argument structure is not always determined by plurality. We have seen that some arguments which normally are interpreted as atomic under classical theories of plurals are actually structured, and interact with the inner verb structure as in ‘John ate an apple’, whereas the structure introduced by other plural arguments is not considered at all, as we can see in the collective reading of ‘Mary noticed errors’. There may even be a complex structure different from what a classical theory of plurals would expect a specific plural to have, as it is the case with a mixed distributive reading like the one which applies to a sentence like ‘three thousand people gathered at Edinburgh’, where there may have been several gatherings in such a way that the total number of of people involved amounts to 3000.

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 is both HOM and CUM —, though both are considered to be atelic events (see Chapter 5, where I comment the link which exists with the distinction between telicity and atelicity).

I cannot put enough stress on 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 structure the event on domains different from that of time but temporally 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 last noticing event is logically compound in the sense that it depends on the previous noticing events, but it is regarded as taking no time and therefore 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, and nothing else). This approach therefore manages to tackle a problem which other treatments might have considered intractable.

Chapter 5

Further extensions and conclusions

In the previous chapter we have analysed the different ways a predicate over objects can interact with a predicate over events to give the aspectual properties of a more complex event predicate. In this chapter we will study some consequences of such an analysis, pointing out also possible extensions of the theory and further research to be done on the area. Thus, in Section 5.1 we will examine the possible combinations of two NPs to give the final aspectual interpretation of simple sentences with a transitive verb. In Section 5.2 we will briefly consider an alternative to our definition for homogeneity, and we will comment why this alternative is not valid. In Section 5.3 we will examine how the theory introduced in this thesis can be related to the classic distinction between telicity and atelicity. The last section will be devoted to the final conclusions and further research.

5.1 Extension to the whole sentence

The analysis exposed in Chapter 4 focused on the inner argument of a sentence, that is, on the VP of a sentence with a transitive verb. This analysis can be extended so that simple sentences with transitive verbs are covered. In this section an attempt to provide such an extension will be outlined.

5.1.1 Notation

When two NPs are introduced the analysis gets more complicated, as we will see shortly. And the notation is more complicated too, particularly when distributivity appears. In page 136 the following sentence was introduced, together with its semantics under a distributive reading:

(4.32) ‘John ate three apples’

$$\exists j, A, E\, [john(j) \wedge three.apples(A) \wedge \forall a\, (a \in A \rightarrow \exists e\, (e \in E \wedge eat(e, j, a)))]$$

However, this notation fails to express the properties inherent to distributivity, namely MAP-O$_R$ and UNI-O. We need, therefore, a more accurate notation. The notation we will use is an extension of what we have used in Chapter 4. For the example above, it will be as follows:

(5.1)

$$\begin{aligned} &\exists j, A, E\, [john(j) \wedge three.apples(A) \wedge eat^*(E) \wedge R_{r_c}(E, A) \wedge \mathrm{DISTR}(R) \wedge \\ &\qquad \forall e(e \in E \rightarrow r_c'(e, j))] \end{aligned}$$

Here, in the first line the relevant predicates are introduced (*john*, *three.apples* and eat^*), together with the relevant distributive thematic relation. In the second line we specify that every individual eating event is related to the eater, j, by means of a collective thematic relation r_c. The specification of DISTR and R must also be formalised, so that R is guaranteed to have the properties of MAP-O$_R$ and UNI-O:

(5.2)

$$\begin{aligned} &\forall E, A, r\, [R_r(E, A) \wedge DISTR(R) \\ &\qquad \Leftrightarrow \\ &\qquad\quad \forall e\, (e \in E \rightarrow r(e, A)) \\ &\qquad\quad \wedge \\ &\qquad\quad \forall e, A'\, [r(e, A) \wedge r(e, A') \rightarrow A' = A]] \end{aligned}$$

Thus, $R_r(E, A)$ is no more than a shorthand for the specification of a relation $r(e, A)$ for every atomic subevent of E. The advantage of this abbreviation is that we can treat it as a special type of complex thematic relation, namely the one we have used to explain distributivity in Chapter 4, and therefore we can use the theorems of that chapter, as we will see below.

In the expression above we have used the thematic relation r_c. This is no more than a short-hand for attributing collectivity to the relation r. Normally, we will use the following notational short-hands:

- $r_c(x, y)$ for $r(x, y) \wedge \mathrm{COLL}(r)$
- $r_g(x, y)$ for $r(x, y) \wedge \mathrm{GRAD}(r)$

In our example above, r (the relation between an individual eating event and its corresponding apple) is collective. This so because, since every eating event is atomic, it has the COLL property.

Finally, an object or event which represents a plural entity will be normally represented with an uppercase letter (A in our example for the object which represents the three apples). This entity, however, is not a set but an element in our lattice of objects such that it is the join of other entities. Still, we will keep using the set-like relation $\in$ to pick up an atomic subobject of the complex object. Thus, $a \in A$ is a shorthand for $a \sqsubseteq A \wedge \neg\exists b(b \sqsubset a)$.

5.1.2 External and internal interaction

When combining the arguments in subject and object position one can easily notice some parallelisms and differences in the types of interactions between the different arguments and the verb. For example, a remarkable feature of the argument positions is that the subject of an intransitive verb sometimes is assigned a semantic role which resembles that of the subject of a transitive verb, whereas in other occasions it is semantically closer to that of the object of a transitive verb. An example extracted from van Voorst (1988:126-129) follows:

(5.3) a. ‘he was drinking beer’

b. ‘he was drinking’

(5.4) a. ‘he opened the box’

b. ‘the box opened’

In (5.3) the intransitive sentence is obtained from the transitive one by removing the syntactic object ‘beer’. However, if we want to intransitivise (5.4a) we must follow a different procedure: instead of removing the object of (5.4a) we have to remove its subject, and move the object to the subject position.

Perlmutter (1978) used this phenomenon to motivate unaccusativity (van Voorst 1988), and he defined the **Unaccusative Hypothesis,** which here is introduced as defined by Sanfilippo:

> Intransitive verbs whose subject exhibits the (morpho)syntactic functionality of a transitive object role — *unaccusatives* — lack an initial subject or external role. The (surface) subject of these verbs is effectively linked to an initial object or internal argument. The subject role properties of other intransitives — *unergative verbs* — instead parallel those of transitive subjects. (Sanfilippo 1991:9)

A consequence which is related to the unaccusative hypothesis is the following:

> the intransitive predicates argued to be unaccusative on syntactic grounds usually turned out to entail relatively patient-like meanings for their arguments (e.g. $arrive$, die, $fall$), while those argued to be syntactically unergative were usually agentive in meaning ($smile$, $walk$, $talk$, etc.). (Dowty 1991:605)

Thus, (5.4b) contains an unaccusative verb, whereas (5.3b) an unergative verb. The subject of an unergative verb will therefore be agent-like, whereas the subject of an unaccusative verb will be patient-like.

Since what we are seeking is a pure semantic analysis, instead of analysing the NPs by their syntactic position it is more convenient to classify them with respect to their closeness to an agent or a patient-like meaning (in Dowty's sense). In the light of this there will be two types of NPs.

First of all, an NP in object position in a transitive sentence or in subject position in a sentence with an unaccusative verb will be a **semantic object** or **s-object.** There is a very close relation between an s-object and the verb, and it is here where a gradual property may appear. A gradual property represents the strongest possible level of intimacy between the object and the event, since here, as we have seen in Chapter 4, the object and the event have the same structures, and the thematic relation itself is an isomorphism which connects both structures:

(5.5) a. 'John drank beer'
b. 'Mary ran a mile'

This level of intimacy led some researchers to use the concept of **internal aspect interaction** for the aspectual interaction between an s-object and a verb (Sanfilippo 1991; Verkuyl 1993).

As opposed to this type of NP, an NP in subject position in a transitive sentence or in an intransitive sentence with an unergative verb will be a **semantic subject** or **s-subject.** The link between this type of NP and the verb is not as tight as that of the internal argument: the interaction is governed by an **external aspect interaction.** When the external interaction applies the argument cannot be related to the verb by means of a gradual reading, as we will see later.

The distinction between internal and external aspect, however, may lead to confusion. Although only a s-object may be related to the verb by means of a gradual reading, all the other types of readings may apply to either the s-subject or the s-object. Some examples are (more examples will appear later in this section):

(5.6) a. ‘John drove a car’

b. ‘Mary pushed a cart’

Here, both the s-object and the s-subject are related to the verb by means of a collective relation. In this case, the aspectual interaction between the verb and the s-object as between the verb and the s-subject is the same. In this chapter, therefore, I will not use the distinction between internal and external aspectual interaction, although I will use the names s-subject and s-object when it is necessary to distinguish an argument according to its semantic relation to the verb. If this distinction is not necessary, the shorter names **subject** and **object** will be used, which will always refer to the argument in the syntactic subject and object position, respectively.

5.1.3 The aspectual interactions

Let us now have a closer look at the possible interactions involving several NPs, namely the subject and the object.

COLL-COLL

The simplest possibility is that both the subject and the object are related to the verb by means of a collective reading. An example follows:

(5.7) ‘the students ate the apples’

$\exists S, A, e\, [the.students(S) \wedge the.apples(A) \wedge eat(e) \wedge r_c(e, S) \wedge r'_c(e, A)]$

In this case two thematic relations are specified, $r_c(e,S)$ and $r'_c(e,A)$. The analysis of this case can be reduced to the one explained in Chapter 4, when only one NP is considered, where we saw that the properties assigned to the verb are transferred to the main sentence:

Theorem 5.1.3.1 *When an atomic verb combines with two NPs in a collective reading the result is an atomic sentence.*

Proof: The proof follows from Theorem 4.5.2.4. □

Theorem 5.1.3.2 *When a homogeneous verb combines with two NPs in a collective reading the result is an homogeneous sentence.*

Proof: The proof is a slight variation of that of Theorem 4.5.2.2. We will use the sentence ‘John drove a car’ as an example:

$$\begin{array}{|lll|}
\hline
\text{HOM}(drive) & ; & \\
\Rightarrow\ \forall d,d'(drive(d)\wedge drive(d')\wedge d'\sqsubset d\rightarrow drive(d')) & ; & \text{HOM definition}\\
\Rightarrow\ \forall d,d'(drive(d)\wedge \exists c(car(c)\wedge R(d,c)) & ; & \\
\qquad \wedge\ \exists j(john(j)\wedge R'(d,j))\wedge d'\sqsubset d & ; & \\
\qquad \rightarrow drive(d')) & ; & \\
\Rightarrow\ \forall d,d'(drive(d)\wedge \exists c(car(c)\wedge R(d,c)) & ; & \text{COLL}(R)\\
\qquad \wedge\ \exists j(john(j)\wedge R'(d,j))\wedge d'\sqsubset d & ; & \wedge\ \text{COLL}(R')\\
\qquad \rightarrow drive(d')\wedge R(d',c)\wedge R'(d',j) & ; & \\
\Rightarrow\ \forall d,d'(drive(d)\wedge \exists c(car(c)\wedge R(d,c)) & ; & \exists\ \text{introduction}\\
\qquad \wedge\ \exists j(john(j)\wedge R'(d,j))\wedge d'\sqsubset d & ; & \\
\qquad \rightarrow drive(d')\wedge \exists c'(car(c')\wedge R(d',c')) & ; & \\
\qquad \wedge\ \exists j'(john(j')\wedge R'(d',j')) & ; & \\
\Rightarrow\ \text{HOM}(for.john.to.drive.a.car) & ; & \\
\hline
\end{array}$$

□

COLL-GRAD

Another possibility is that one NP is related to the verb by means of a collective relation, whereas the other NP is related by means of a gradual relation. An example would be as follows:

(5.8) ‘the workers built the house’

$$\exists W,h,b\,[the.workers(W)\wedge the.house(h)\wedge build(b)\wedge r_c(b,W)\wedge r'_g(b,h)]$$

Here, although the workers stand in a collective reading with the construction and the verb *build* is homogeneous, the final sentence is not homogeneous. This can be checked by means of the typical tests:

(5.9) a. ‘the workers built the house in three months’

b. *‘the workers built the house for three months’

We can see therefore that it is the structure of the house (which is QUA) that is transferred to the event described by the sentence. In other words, a gradual reading “wins” over a collective reading. This will be expressed in the following theorem:

Theorem 5.1.3.3 *If an NP is related to the verb by means of a collective reading and the other NP is related by means of a gradual reading, the aspectual properties of the final sentence will be determined by the properties of the NP with a gradual reading.*

Proof: The predicate representing the whole sentence can be expressed as follows:

$$\text{(5.10)} \qquad \lambda e[\exists x(NP_2(x) \wedge R_g(e,x) \wedge [\exists y\, NP_1(y) \wedge V(e) \wedge R'_c(e,y)])]$$

This in turn can be seen as:

$$\text{(5.11)} \qquad \lambda e[\exists x(NP_2(x) \wedge R_g(e,x) \wedge Q(e))]$$

Where:

$$\text{(5.12)} \qquad Q = \lambda e[\exists y\, NP_1(y) \wedge V(e) \wedge R'_c(e,y)]$$

Now, (5.11) is of the same type as any expression involving only one NP, only that the "verb" is now a more complex predicate over events, which in this case is called Q. We can therefore apply Theorems 4.5.1.2 and 4.5.1.3. □

The proof in Theorem 5.1.3.3 is based on reducing the semantics of the whole sentence to an expression which can be processed with the theorems of Chapter 4. This expression is formed by grouping the argument with a collective reading together with the verb to create a more complex predicate. It would be possible to group instead the gradual reading, giving the following expression:

$$\text{(5.13)} \qquad \lambda e[\exists y(NP_1(y) \wedge R'_c(e,y) \wedge S(e))]$$

Where:

$$\text{(5.14)} \qquad S = \lambda e[\exists x\, NP_2(x) \wedge V(e) \wedge R_g(e,x)]$$

Now, (5.13) is similar to any expression where an NP is related to a verb (in this case a more complex event predicate S) with a collective reading, whereas Expression (5.14) is like any expression involving an NP and a verb related in a gradual reading. We can therefore use Theorems 4.5.1.2 and 4.5.1.3 to show that the properties of NP_2 are transferred to S (except CUM, as we have seen in page 124), and then Theorems 4.5.2.2 and 4.5.2.3 to show that they are further transferred to the whole sentence. By any of these two means we arrive to the same result, which is the one stated in Theorem 5.1.3.3.

It is easy to see that, as is the case of only one NP, even if the NP with a gradual reading is cumulative the whole sentence cannot be proven to be cumulative. We only need to follow the explanation in page 124 to (5.11).

COLL-DISTR

Another possibility is that one NP is related to the verb by means of a collective reading and the other NP is related by means of a distributive reading. Consider the following examples:

(5.15) a. ‘five workers built three houses’

b. ‘three people drove a car’

The most common reading of (5.15a) is one in which there are three houses and a group of workers such that every house was built by them. The semantics is as follows:

(5.16)
$$\begin{aligned} &\exists W, B, H\ [\mathit{five.workers}(W) \wedge \mathit{three.houses}(H) \wedge \mathit{build}^{*}(B) \\ &\qquad \wedge R_{r_c}(B, H) \wedge \mathrm{DISTR}(R) \\ &\qquad \wedge \forall b\,(b \in B \rightarrow r'_c(b, W))] \end{aligned}$$

However, as opposed to the combination COLL-GRAD, another reading is available, namely when a different group of workers is involved in the construction of each of the houses, that is:

(5.17)
$$\begin{aligned} &\exists B, H\ [\mathit{three.houses}(H) \wedge \mathit{build}^{*}(B) \\ &\qquad \wedge R_{r_c}(B, H) \wedge \mathrm{DISTR}(R) \\ &\qquad \wedge \forall b\,(b \in B \rightarrow \exists W\,[\mathit{five.workers}(W) \wedge r'_c(b, W)])] \end{aligned}$$

In this case the scope of the workers is more restricted. This reading is possible because distributivity, as I have mentioned in Chapter 4, is not a property of a thematic relation but a structuration of the objects and events. As we have already seen, both in graduality and collectivity there is only one event, but now in distributivity there is plurality of events. Thus, in any of the readings of the sentences in (5.15) we are talking of several individual events. This is expressed by means of the expression build^{*} in the above semantic representations. The second reading is perhaps more easily available in (5.15b), of which I show both readings here:

(5.18) a. $\exists P, D, c\,[three.people(P) \wedge a.car(c) \wedge drive^*(D)$
$\wedge R_{r_c}(D, P) \wedge \text{DISTR}(R)$
$\wedge \forall d\,(d \in D \rightarrow r'_c(d, c))]$

b. $\exists D, P\,[three.people(P) \wedge drive^*(D)$
$\wedge R_{r_c}(D, P) \wedge \text{DISTR}(R)$
$\wedge \forall d\,(d \in D \rightarrow \exists c\,[a.car(c) \wedge r'_c(d, c)])]$

In the second reading, every driving is of a different car; in the first reading, all the independent drivings are of the same car, presumably at three different times.

Due to the fact that now the object under a collective reading can have either a wide or a narrow scope we cannot apply a theorem like 5.1.3.3, but still the proof is very similar. We will use two theorems:

Theorem 5.1.3.4 *If one of the objects has a distributive reading and the other has a collective reading, if the object with the distributive reading is quantised then the whole sentence will be quantised.*

Proof: We will try to reduce a complex expression representing a sentence with a distributive reading so that we can apply a modified version of Theorem 4.5.1.2 which we have seen in Chapter 4, page 122. We will do this because, as we have seen already, the properties attached to distributivity are very similar to those of graduality. Consider the two possible readings of Sentence (5.15b), which are represented in (5.18). We will rewrite them in an alternative way which is easier to work with:

(5.19) $for.three.people.to.drive.a.car$

a. $\lambda D\,\exists P\,[three.people(P) \wedge drive^*(D) \wedge R_{r_c}(D, P) \wedge \text{DISTR}(R)$
$\wedge \exists c\,[a.car(c) \wedge \forall d\,(d \in D \rightarrow r'_c(d, c))]]$

b. $\lambda D\,\exists P\,[three.people(P) \wedge drive^*(D) \wedge R_{r_c}(D, P) \wedge \text{DISTR}(R)$
$\wedge \forall d\,(d \in D \rightarrow \exists c\,[a.car(c) \wedge r'_c(d, c)])]$

The second lines of the representations above specify the existence of the car and the differences in scope. In both cases this second line can be reduced to a one-place predicate:

(5.20) a. $M = \lambda D \exists c\,[a.car(c) \wedge \forall d\,(d \in D \rightarrow r'_c(d, c))]$

b. $N = \lambda D \forall d\,(d \in D \rightarrow \exists c\,[a.car(c) \wedge r'_c(d, c)])$

As for the first lines of (5.19), they can be represented by another predicate:

(5.21) $O = \lambda D\, \exists P\, [three.people(P) \wedge drive^{*}(D) \wedge R_{r_c}(D, P) \wedge \text{DISTR}(R)]$

Thus, both expressions are reduced to a more general one:

(5.22) $for.three.people.to.drive.a.car$
$\lambda D\, [O(D) \wedge \mathcal{X}(D)]$
Where: $\mathcal{X} = \lambda D\, (M(D) \vee N(D))$

Now, according to Theorem 4.5.1.2 and the fact that $three.people$ is quantised, we know that O is quantised. That is:

$$\forall D, D'\, O(D) \wedge D' \sqsubset D \rightarrow \neg O(D')$$

It is obvious therefore that $for.three.people.to.drive.a.car$ is quantised:

$$\forall D, D'\, [O(D) \wedge \mathcal{X}(D) \wedge D' \sqsubset D \rightarrow \neg(O(D') \wedge \mathcal{X}(D'))]$$

□

As for the transference of homogeneity, we can reuse Theorem 4.5.1.3 provided that we can prove that $\mathcal{X}$ is homogeneous. The theorem follows.

Theorem 5.1.3.5 *If one of the objects has a distributive reading and the other has a collective reading, if the object with the distributive reading is homogeneous and the verb is homogeneous then the whole sentence will be homogeneous.*

Proof: Similar to the proof of Theorem 5.1.3.4 and with the help of Theorem 4.5.1.3, we will have that HOM(O). We will have to prove that HOM$(\mathcal{X})$. This is easy, since the appearance of $\forall$ in the way it does in the expression guarantees that it has MAP-O$_R$.

The following proof can be therefore applied:

$$\boxed{\begin{array}{lll} O(Y) \wedge \mathcal{X}(Y) \wedge Y' \sqsubset Y & ; & \text{Assumption} \\ \Rightarrow \quad O(Y') \wedge \mathcal{X}(Y) \wedge Y' \sqsubset Y & ; & \text{Theorem 4.5.1.3} \\ \Rightarrow \quad O(Y') \wedge \mathcal{X}(Y') & ; & \text{HOM}(\mathcal{X}) \end{array}}$$

□

Finally, note that, as opposed to the analysis of distributivity performed in Chapter 4, now the property of cumulativity cannot be transferred from the NP to the sentence. The reason for this is the possible scope of the argument which stands in a collective reading. More specifically, M is not cumulative in a predicate like $there.is.a.car.which.people.drove$ because the cars which are driven by D and by D' may be different for two different interpretations of the predicate:

(5.23)
$$\begin{aligned} &\exists c, c' \, [\forall d(d \in D \rightarrow a.car(c) \wedge r'_c(d, c)) \wedge \\ &\qquad \forall d'(d' \in D' \rightarrow a.car(c') \wedge r'_c(d', c'))] \\ &\not\rightarrow \\ &\exists c'' \;\; [\forall d''(d'' \in D \sqcup D' \rightarrow a.car(c'') \wedge r'_c(d'', c''))] \end{aligned}$$

Here, as it has been shown with the predicate $push.a.cart$ in page 108, we cannot guaranty that $a.car(c'')$ even if $c'' = c \sqcup c'$, since $a.car$ is not cumulative.

DISTR-GRAD

One more possibility is that one NP is related to the verb with a distributive reading and the other NP is related by means of a gradual reading. As happened in the previous section, a sentence with such types of relations may have one of two readings, depending on the scope of the NP which has the gradual reading. This can be seen in the following sentence:

(5.24) ‘three people read a book’

a.
$$\begin{aligned} &\exists E, P \, [three.people(P) \wedge read^*(E) \\ &\qquad \wedge R_{r_c}(E, P) \wedge \text{DISTR}(R) \\ &\qquad \wedge \forall e \, (e \in E \rightarrow \exists b \, [a.book(b) \wedge r'_g(e, b)])] \end{aligned}$$

b.
$$\begin{aligned} &\exists P, E, b \, [three.people(P) \wedge a.book(b) \wedge read^*(E) \\ &\qquad \wedge R_{r_c}(E, P) \wedge \text{DISTR}(R) \\ &\qquad \wedge \forall e \, (e \in E \rightarrow r'_g(e, b))] \end{aligned}$$

As we can see in these representations, it may be that each person read a different book, or that the same book was read by each person.

We can handle the aspectual interactions in exactly the same way as in the previous section. This is so because the semantics can also be expressed in terms of a conjunction of two predicates: $O(X)$ and, say, $\mathcal{Y}(X)$. The only difference between $\mathcal{Y}$ and $\mathcal{X}$ is that now the inner object is related by means of a gradual relation instead of a collective one, but this difference does not affect the proofs of the last section. Therefore here, as in the combination DISTR-COLL, the properties of the NP affected by the distributive reading (except possibly CUM) are transferred to the sentence.

DISTR-DISTR

The NPs may also relate to the verb by means of a double distributive reading. Consider the distributive interpretation of the following sentence:

(5.25) ‘three lawyers hired five cleaners’

We can find an interpretation where for every lawyer there is a set of five cleaners such that each of them has been hired independently. Whereas this is the most normal interpretation, an interpretation with a reversed scope is also possible, namely, that there are five cleaners such that for every cleaner there is a set of three lawyers such that each one of the lawyers hires each one of the cleaners. The respective interpretations are:

(5.26) a.

$$\begin{aligned} & \exists L, H\ [three.lawyers(L) \wedge hire^{*}(H) \\ & \qquad \wedge R_{r_c}(H, L) \wedge \text{DISTR}(R) \\ & \qquad \wedge \forall h\ (h \in H \rightarrow \exists C\ [five.cleaners(C) \wedge R'_{r'_c}(h, C) \wedge \text{DISTR}(R')])] \end{aligned}$$

b.

$$\begin{aligned} & \exists C, H\ [five.cleaners(C) \wedge hire^{*}(H) \\ & \qquad \wedge R'_{r'_c}(H, L) \wedge \text{DISTR}(R') \\ & \qquad \wedge \forall h\ (h \in H \rightarrow \exists L\ [three.lawyers(L) \wedge R_{r_c}(h, L) \wedge \text{DISTR}(R)])] \end{aligned}$$

Apart from these readings there is another possibility in which the lawyers and the cleaners are all the same, that is, there are three lawyers and five cleaners such that every lawyer hired each one of the cleaners. This can be expressed in any of these two equivalent forms:

(5.27) a.

$$\begin{aligned} & \exists L, C, H\ [three.lawyers(L) \wedge five.cleaners(C) \wedge hire^{*}(H) \\ & \qquad \wedge R_{r_c}(H, L) \wedge \text{DISTR}(R) \\ & \qquad \wedge \forall h\ (h \in H \rightarrow R'_{r'_c}(h, C) \wedge \text{DISTR}(R'))] \end{aligned}$$

b.

$$\begin{aligned} & \exists L, C, H\ [five.cleaners(C) \wedge five.cleaners(C) \wedge hire^{*}(H) \\ & \qquad \wedge R'_{r'_c}(H, L) \wedge \text{DISTR}(R') \\ & \qquad \wedge \forall h\ (h \in H \rightarrow R_{r_c}(h, L) \wedge \text{DISTR}(R))] \end{aligned}$$

There is finally a cumulative reading. This reading is more difficult to represent, but basically it accounts for the case that there are three lawyers and five cleaners and the hiring events involve all the lawyers and all the cleaners. However, not every lawyer hires all the cleaners or not every cleaner is hired by all the lawyers.

Sentences with a double distributive reading cannot be analysed like the ones of the other types. In order to see this, consider a possible analysis of the following sentence under the reading provided:

(5.28) ‘three people lifted pianos’

$$\begin{aligned}&\exists P, L\,[three.people(P) \wedge lift^*(L)\\ &\qquad \wedge R_{r_c}(L, P) \wedge \mathrm{DISTR}(R)\\ &\qquad \wedge \forall l\,(l \in L \rightarrow \exists Q\,[pianos(Q) \wedge R'_{r'_c}(l, P) \wedge \mathrm{DISTR}(R')]))]\end{aligned}$$

In the expression above, however, L is seen as a set whose elements are sets in themselves if we were using sets. Since we are using lattices the interpretation is different: L is the join of either three events (one for every person) or of an indefinite number of events (one for each actual lifting of a piano by one of the persons), depending on the level of granularity. In other words, we can say that L is actually the join of only three events such that, if we look with a finer granularity, each one of these events is seen again as being composed of other events. That is, under a gross granularity the inner distribution is not considered at all.

Independently of whether we use a set interpretation or a lattice interpretation, (5.28) does not express the correct semantics. Since in (5.28) the only structure which matters is that of the outer NP *three.people*, if we applied the theorems of the previous sections we would arrive at the conclusion that (5.28) is quantised. However, this is not the case, as the following sentences prove:

(5.29) a. ‘three people lifted pianos for two hours’

b. ‘for two hours, three people lifted pianos’

(5.30) a. *‘three people lifted pianos in two hours’

b. *‘in two hours, three people lifted pianos’

In these examples we have attached the adverbial at the end of the sentence — option (a) — and at the beginning of the sentence — option (b). This is so because, depending on where we attach the adverbial, the scope of the adverbial may be different, and sometimes it is not clear which is the chosen reading. The sentences in (5.29), for example, may have two interpretations:

Narrow scope: every one of the people lifted pianos for hours.

Wide scope: the set of lifting actions has been happening for hours; this is the reading preferred in (5.29b).

Still, the results lead all to the same conclusion: all of the sentences in (5.29) and (5.30) lead us to assume that (5.28) is not quantised but homogeneous. We must therefore provide a different explanation. A possibility is to consider that L is the join of *all* the lifting events, that is, we use a fine level of granularity. In (5.28) the number of lifting events is indeterminate, and therefore the whole sentence is homogeneous. It seems therefore that Verkuyl's (1993) PLUS-principle holds for double distributive sentences, and that it holds regardless of the actual scope chosen.

While this is very easy to say, the proof is not so easy. The problem lies in that now the thematic relation which links the plural event with the outer NP must also take the inner NP into account. For example, a semantics of (5.26a) would be as follows:

(5.31) $$\exists L, H\, (three.lawyers(L) \wedge hire^{*}(H) \wedge R_{r_c, r'_c, five.cleaners}(H, L) \wedge \text{DISTR}'(R))$$

Here, $R_{r_c, r'_c, P}(H, L)$ must specify the predicate P of the inner argument ($five.cleaners$ in our example) so that its properties are taken into account. The formal specification of $R_{r_c, r'_c, P}(H, L) \wedge \text{DISTR}'(R)$ is:

(5.32) $$\begin{array}{l} \forall r, r', P, H, L\, [R_{r, r', P}(H, L) \wedge \text{DISTR}'(R) \\ \qquad\qquad \Leftrightarrow \\ \qquad\qquad \forall h\, [h \in H \\ \qquad\qquad\quad \rightarrow \\ \qquad\qquad\quad \exists X, !x, !l (P(X) \wedge x \in X \wedge l \in L \wedge r(h, l) \wedge r'(h, x))]] \end{array}$$

That is, $R_{r_c, r'_c, P}(H, L) \wedge \text{DISTR}'(R)$ is an abbreviation of the property that for every atomic subevent of H, say h, there is an object X which falls under the predicate P, a unique object x which is an atomic subobject of X and a unique object l which is an atomic subobject of L such that l and x are related to h by means of the relations r_c and r'_c, respectively.

Whereas the relation R as it is described above has the property of uniqueness of objects, it will not have the property of mapping to events, since it is possible that a subevent of the complex hiring event be related to the whole set of lawyers (remember that we use the *restricted* version of MAP-O, which I call MAP-O$_R$). More formally, the following is true:

(5.33) $$\exists H' [H' \sqsubset H \wedge \neg(\exists L'\, (L' \sqsubset L \wedge R_{r_c, r'_c, P}(H', L'))]$$

Such a subevent of H is easy to find. Let H be the whole set of 15 hirings, where h_{ij} represents the hiring event involving the lawyer i and the cleaner j:

(5.34)
$$H = \{ \begin{array}{l} h_{11} \sqcup h_{12} \sqcup h_{13} \sqcup h_{14} \sqcup h_{15} \sqcup \\ h_{21} \sqcup h_{22} \sqcup h_{23} \sqcup h_{24} \sqcup h_{25} \sqcup \\ h_{31} \sqcup h_{32} \sqcup h_{33} \sqcup h_{34} \sqcup h_{35} \end{array} \}$$

A possible H' would be any in which all the lawyers are involved, but not all the cleaners. For example:

(5.35)
$$H' = \{ \begin{array}{l} h_{11} \sqcup h_{12} \sqcup h_{13} \sqcup h_{14} \sqcup \\ h_{21} \sqcup h_{22} \sqcup h_{23} \sqcup h_{24} \sqcup \\ h_{31} \sqcup h_{32} \sqcup h_{33} \sqcup h_{34} \end{array} \}$$

Here $H' \sqsubset H$ but there is no portion L' of the lawyers L such that $R_{rc,r'_c,five.cleaners}(H', L')$, simply because all the lawyers are involved and therefore $L' = L$.

Since $R_{rc,r'_c,P}(H', L')$ does not have MAP-O$_R$ we cannot apply the theorem involving distributivity. Therefore the transference of the structure of the object under the outer NP cannot be proved to be accomplished. Instead, it is the joint structure of both objects which matter, since for every possible combination of both objects there is a hiring event which relates them. If the number of combinations is not determined, the number of hirings is not determined either. From this it may be possible to prove the combined transference of the NP properties following Verkuyl's PLUS-principle. We will not attempt to do it in this thesis, however. This is a topic for further research.

GRAD-GRAD

The remaining combination possible is that both the subject and the object are related to the verb by means of a gradual relation. This possibility, however, is very unlikely to happen. In fact, I haven't found any example having this combination. A possible candidate would be the following:

(5.36) ‘water filled the tank’

Under a double gradual reading, for every subevent of the filling event, a portion of the water would be used to fill a portion of the tank. This interpretation is however unlikely to be the one which applies to (5.36). According to Dowty (1991:593), the incremental theme (that is, the NP which is incrementally affected by the action, in other words, the NP with a gradual reading) is $the.tank$. This can be seen by comparing the following two sentences:

(5.37) a. ‘the crowd entered the auditorium halfway / partly’

b. ‘the water filled the tank halfway / partly’

From (5.37a) we can conclude that some percentage of the crowd has entered, but from (5.37b) the only conclusion we can draw is that some percentage of the tank is occupied, and nothing is supposed with respect to the percentage of the water used. Example (5.37a) is not double gradual either because we cannot conclude that the auditorium is partly occupied.

The relation between $water$ and the rest of the sentence will therefore be one of collectivity, not graduality. This can be seen by considering the typical tests for telicity / atelicity:

(5.38) a. ‘water filled the tank in one hour’

b. *‘water filled the tank for an hour’

That is, it is the quantisation property of the predicate $the.tank$ what is transferred to the main sentence.

5.2 An existential definition of homogeneity?

In this section I would like to briefly introduce, discuss and refute a new definition of homogeneity which specifically addresses the ‘minimal parts’ problem. The definition of homogeneity we are using in this thesis is that, given an object which falls under a predicate, all the possible subobjects must also fall under that same predicate. Here I repeat the definition:

(Def. 4.3.2.1) $\forall P\,[\mathrm{HOM}(P) \iff \forall x, y[P(x) \wedge y \sqsubset x \rightarrow P(y)]]$

What if we specify instead that *only some* of the subobjects fall under the predicate? The new definition may run as follows:

(5.39) $$\forall P\,[\mathrm{HOM}_2(P) \iff \forall x\,[P(x) \rightarrow \exists y\,(P(y) \wedge y \sqsubset x)]]$$

This new definition corresponds to Hinrichs’s (1985) intuition about the atelicity of activities which, as we have seen in page 38, applies to sentences like ‘pills dissolved’.

This new definition is more general than Def 4.3.2.1. Is it, however, too general? In other words, can a non-atomic quantised predicate also be homogeneous in this new sense? This is not the case, since according to Def. 4.3.0.3 for quantisation there cannot be any y such that $y \sqsubset x \wedge P(y)$. What about the aspectual interactions? Under a collective reading the interaction is fine:

(5.40) *drive.a.car*

$\mathrm{HOM}_2(V) \Longrightarrow \mathrm{HOM}_2(\lambda e\, \exists x\, (V(e) \wedge O(x) \wedge \mathrm{COLL}(e,x)))$

	$\mathrm{HOM}_2(V)$	; Assumption
$\Leftrightarrow$	$\forall e\, [V(e) \rightarrow \exists e'(V(e') \wedge e' \sqsubset e)]$	; HOM_2 definition
$\Rightarrow$	$\forall e\, [\exists x(\mathrm{COLL}(e,x) \wedge O(x)) \wedge V(e)$	;
	$\rightarrow \exists x'(\mathrm{COLL}(e,x') \wedge O(x')) \wedge \exists e'(V(e') \wedge e' \sqsubset e)]$	;
$\Rightarrow$	$\forall e\, [\exists x(\mathrm{COLL}(e,x) \wedge O(x)) \wedge V(e)$	;
	$\rightarrow \exists e'(\exists x'(\mathrm{COLL}(e',x') \wedge O(x')) \wedge V(e') \wedge e' \sqsubset e)]$	; COLL(R)

The trouble comes when attempting to define the aspectual interactions under a homogeneous or distributive reading:

(5.41) *drink.beer*

$\mathrm{HOM}_2(V) \wedge \mathrm{HOM}_2(O) \Longrightarrow \mathrm{HOM}_2(\lambda e\, \exists x\, (V(e) \wedge O(x) \wedge \mathrm{GRAD}(e,x)))$

1.	$\mathrm{HOM}_2(V) \wedge \mathrm{HOM}_2(O)$	; Assumption
2.	$\forall e\, [V(e) \rightarrow \exists e'(V(e') \wedge e' \sqsubset e)]$	; HOM_2 definition
3.	$\forall e\, [\exists x(\mathrm{GRAD}(e,x) \wedge O(x)) \wedge V(e)$	;
	$\rightarrow \exists x'(\mathrm{GRAD}(e,x') \wedge O(x')) \wedge \exists e'(V(e') \wedge e' \sqsubset e)]$	;
4.	$\forall e\, [\exists x(\mathrm{GRAD}(e,x) \wedge O(x)) \wedge V(e)$	;
	$\rightarrow \exists e', x', x''(\mathrm{GRAD}(e',x'') \wedge O(x')$	; MAP-O_R(R)
	$\wedge\, x'' \sqsubset x \wedge V(e') \wedge e' \sqsubset e)]$	; MAP-O_R(R)
5.	$\forall e\, [\exists x(\mathrm{GRAD}(e,x) \wedge O(x)) \wedge V(e)$	;
	$\rightarrow \exists e', x''(\mathrm{GRAD}(e',x'') \wedge O(x'')$	; Wrong!
	$\wedge\, x'' \sqsubset x \wedge V(e') \wedge e' \sqsubset e)]$	;

The trouble we find at Step 5 is that there is no way to guarantee that x' and x'' are the same if the NP has the property HOM_2. The reason for this is that, since HOM_2 introduces an existential quantifier, we cannot guarantee that *all* the subparts of x fall under the same predicate, and therefore x'' might not fall under the predicate O. Therefore, it might be the case that $\neg O(x'')$. This problem disappears if we allow for an NP to be HOM, that is, if we keep the original definition of homogeneity for the domain of objects. This may be fine for predicates like *beer*, *water*, and so on, but still we would have to explain the case of heterogeneous masses like *fruit.cake*, *pebble* and so on. In other words, the 'minimal parts' problem would still need to be explained unless, of course, one considers that a lattice represents not the real world but our

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 5.1. The aspectual interactions in a gradual reading.

verb	property	NP	property	VP	property
push	HOM	a cart	QUA	push a cart	HOM
drive	HOM	a car	QUA	drive a car	HOM
notice	atomic	a car	QUA	notice a car	atomic

Table 5.2. The aspectual interactions in a collective reading.

linguistic interpretation of it, which is one of the major points I am trying to put forth with this thesis.

5.3 A characterisation of boundedness and unboundedness

In Chapter 4 and also Section 5.1, I have proceeded to an analysis of the possible interactions between verb and arguments, based on a set of properties assigned to the predicates. We have seen that some predicate properties may or may not be transferred to the whole sentence; the possible types of transfer properties are summarised in the examples of Tables 5.1, 5.2, and 5.3. Now, how does all this relate to the ‘classical’ classification between atelic and telic predicates? In this section we will analyse the possible connection.

With respect to this, it has been pointed out that there is a difference between telicity / atelicity and boundedness / unboundedness (Depraetere 1995; Egg 1995). Basically,

verb	property	NP	property	VP	property
drive	HOM	two cars	QUA	drive two cars	QUA
drive	HOM	cars	HOM,CUM	drive cars	HOM,CUM

Table 5.3. The aspectual interactions in a distributive reading.

	Sentence	+:telic ⇔:atelic	+:bounded ⇔:unbounded
1.	John left at eight o'clock	+	+
2.	John read a book	+	+
3.	John was opening the parcel	+	⇔
4.	Ten firecrackers were exploding	+	⇔
5.	John lived in London for a year	⇔	+
6.	I've been playing in the mud	⇔	+
7.	John leaves at eight o'clock	⇔	⇔
8.	John reads books	⇔	⇔

Table 5.4. Telicity / atelicity *versus* boundednes / unboundedness.

a predicate is telic if there is a goal implied in it which leads to a different state, where this different state is not the trivial state of "just having P'ed." For example, Depraetere classifies *enter.the.room* as telic on the grounds that after entering the room we are in the state of being inside the room, but *run.a.mile* as atelic because the only state we arrive at after running a mile is the trivial one of having run a mile. As opposed to this, a predicate is bounded if the event is temporally well defined, i.e., it has clear boundaries in the temporal domain. According to such a definition, *peter.ran.a.mile* is bounded, whereas *peter.was.running.a.mile* is unbounded because the boundaries of the event are not defined. A few examples of sentences are included in Table 5.4, extracted from the data considered by Depraetere (1995). In Table 5.4 we can see that the use of the progressive or the perfective may affect (un)boundedness, whereas the use of plurals may affect both (a)telicity and (un)boundedness.

The approach followed in this thesis is closer to the distinction boundedness / unboundedness than to telicity / atelicity, since what is being described here is whether the temporal structure has clear boundaries or not. Therefore, whenever I was talking of the distinction between telicity and atelicity I was referring rather to that between boundedness and unboundedness.

Both Krifka and Verkuyl also use the distinction boundedness / unboundedness, but they use different names. Krifka defines atelicity (that is, unboundedness according to what it has been said here) as lacking a set terminal point (Krifka 1989b), and telicity (or rather, boundedness) as having a set terminal point. According to Krifka, a terminal point is 'a function TP which maps events to the last point in their run time' (1989b:5).

This is formalised by Krifka as:[1]

Def. 5.3.0.6 (Terminal Point)

$$\forall e,t[\mathrm{TP}(e)=t \iff t\in T_a \wedge t \sqsubseteq \tau(e) \wedge \forall t'[t' \sqsubseteq \tau(e) \rightarrow t' \leq t]]$$

In order to understand def. 5.3.0.6 we need to take a quick look at Krifka's use of temporal points. Under Krifka's system, the lattice of times can be generated by a set of atomic temporal points T_a. These atoms are linearly ordered, where $\leq$ is the linear relation. A (non-atomic) interval will be composed of subintervals, which will ultimately be composed of temporal points, forming a complete join-semilattice T with the bottom element removed, whose *part-of* relation is $\sqsubseteq$. We can extend $\leq$ to the intervals by checking that all the temporal points in two intervals are related by $\leq$:

$$\forall t,t'[t \leq t' \iff \forall t'',t'''[t'' \in T_a \wedge t''' \in T_a \wedge t'' \sqsubseteq t \wedge t''' \sqsubseteq t' \rightarrow t'' \leq t''']]$$

There is also a homomorphism from the domain of events to that of times, the **temporal trace** τ which preserves the lattice structure, that is:

$$\forall e,e'[\tau(e)\in T \wedge \tau(e')\in T \wedge \tau(e\sqcup e') = \tau(e)\sqcup\tau(e')]$$

Now, def. 5.3.0.6 states that for every possible interval t' which is part of the temporal trace of an event e, this interval happens before ($\leq$) the terminal point.

A predicate will have a set terminal point STP if all its subevents have the same terminal point:

Def. 5.3.0.7 (Set Terminal Point)

$$\forall P[\mathrm{STP}(P) \iff \forall e(P(e) \rightarrow \forall e'[P(e') \wedge e' \sqsubseteq e \rightarrow \mathrm{TP}(e)=\mathrm{TP}(e')])]$$

According to this, a quantised predicate will obviously have a set terminal point, since it does not allow for any of the events under its extension to have any subevent falling under the same predicate. As opposed to this, a cumulative predicate which refers to

---

[1] I must mention here that Krifka's expression is slightly different; he specifies that:

$$\forall e,t[TP(e)=t \iff t\in T_a \wedge t \sqsubseteq \tau(e) \wedge \forall t'[\boxed{t' \sqsubseteq t} \wedge t' \sqsubseteq \tau(e) \rightarrow t' \leq t]]$$

I have framed the condition which is added by Krifka. This condition will only be met if $t' = t$, since $t \in T_a$, that is, t is atomic. Clearly, this is not what we want to express.

more than one event (strictly cumulative predicate or SCUM) will *typically* lack a set terminal point. I stress the word *typically*, since one may find a SCUM predicate which has a set terminal point. One such example is:

(5.42) $for.john.to.run.until.3.pm.on.1/8/1996$

Since here the end point is clearly determined and only one person can perform the event, namely John, all the events which can be described by (5.42) have the same TP, and furthermore the join of such events will always be an event of John's running until 3 pm on 1/8/1996. Thus, the predicate in (5.42) will be SCUM with a set-terminal point. Note that, under my theory, this sentence would not be HOM: there are some subevents of the event described in (5.42) which do not end at 3 pm and therefore they will not be described by the same predicate.

Verkuyl (1993) also talks of the bounded/unbounded distinction, again with a different terminology. He uses the concept of terminativity for boundedness and durativity for unboundedness. All his theory is developed around these concepts, and he shows how the NPs and the verb can be analysed in completely different domains, and still they interact to give a final reading to the sentence. I am not going to comment on his theory however, since this has been discussed extensively in Chapter 3.

The dichotomy QUA/HOM which we have been studying in this thesis is representative of the distinction bounded/unbounded, but the full correspondence is still to be proven. In the remainder of this section I will introduce some of the problematic sentences, and whenever possible a hint at how to explain them. The comments here are very tentative, since more complete research in this area is needed. Still, it is worth considering the sentences here included and the comments on them as suggestions on how to cope with the linguistic interpretation of the world.

One such example is the predicate expressed in (5.42), which I will repeat here in the shape of a full sentence:

(5.43) 'On 1/8/1996, John ran until 3 pm'

This sentence, as I have said above, has a STP and should therefore be bounded. As I have said already, the sentence is not HOM; but it is also true that it is not QUA either. There may be subevents which can be described with the predicate (5.42). This predicate therefore fails to be classified as either HOM or QUA. This predicate is actually quite problematic in other grounds. More specifically, it does not follow all of Dowty's tests for accomplishments (see Table 1.3 page 7), and this is remarkably true for the in- and the for- adverbial tests:

(5.44) a. *'On 1/8/1996, John ran until 3 pm for ten minutes'

b. *'On 1/8/1996, John ran until 3 pm in ten minutes'

There are other sentences which, however, are less problematic in terms of Dowty's tests but which are still difficult to explain under the theory developed in this thesis. Here are some of them:[2]

(5.45) a. 'John ate at most five apples'

b. 'John wrote something'

c. 'John ate more than three apples'

d. 'Mary drank at least three glasses of wine'

All of these sentences are used to express telic predicates (as we can see if we apply Dowty's tests, and more specifically the in/for test), but none of them is quantised according to our definition of QUA. For example, any subevent of John eating at most five apples will be an eating of even less apples, and therefore it will be an eating of at most five apples as well. In a similar way, some events of John eating more than three apples have subevents of John eating more than three apples (for example, if John actually ate five apples). Sentence (5.45b) is even more difficult, since the NP *something* is highly undeterminate, and practically any object falls under its extension. In all these sentences the object being considered is vaguely specified, but still in our minds it is bounded. Thus, if one says 'John wrote something', we all know that John wrote a piece of writing which is clearly bounded. Thus, even when *something* is not literally a quantised predicate, the concept we have in our minds is quantised, so that one can say (5.46a) but not (5.46b):

(5.46) a. 'John wrote something in ten minutes'

b. *'John wrote something for ten minutes'

5.4 Final conclusions

This thesis is by no means the result of finished research. My intention has been to show the possibility of analysing aspectual composition by means of a formal approach, but there are still many desirable aspects and consequences to be developed. For example,

---

[2] Most of these sentences are from a personal communication from Naumann. He uses similar examples in (Naumann 1995a:312ff).

no attempt has been made to provide an analysis of the structure of the NP. We have commented on the NP properties one needs in order to account for the aspectual interactions, namely quantisation and homogeneity, but nothing has been said on how these properties may depend on the components of the NP. For example, we have not looked at the link between bare plurals and homogeneity, nor the use of measures in masses to specify quantisation. Instead, we have focused only on the interaction between the verb and arguments, but still we have not considered in detail other types of arguments apart from syntactic subjects and objects. Very little has been said of partitives, and nothing of locatives. Nothing has been said on the interaction with temporal adverbials either.

Still, there is a major achievement made in this thesis. Since a formal approach has been used, the result is a robust theory. The mechanism which models the aspectual interactions is very simple and it relies on a very restricted set of properties of predicates (homogeneity and quantisation) and of thematic relations (graduality, distributivity, and collectivity).

But more important consequences can be drawn. One of them is that aspectual composition is based on the properties of the thematic relations linking events and objects, and therefore it is related to a section of language which is very deeply rooted in the inner mechanism of language itself. It has been argued in the literature, for example, that our ability to determine the thematic roles which are involved in an action appeared in our ancestors even before language itself (Bickerton 1990:187). Exploring the mechanisms involved in the thematic relations, therefore, would help in determining how we subconsciously process the world, and aspectual interaction is one of the consequences of the use of thematic relations. The problem one finds in working with thematic relations and aspectual properties is, of course, that the choice of the aspectual property assigned to a thematic relation in a specific sentence will depend on such intractable problems as pragmatics and world knowledge.

In Chapter 1 we commented on the relation between the real world and what we say of it. In that chapter it was said that, in the same way that we cannot process all the information we receive of the world, we cannot express all the information we know of a situation. As a consequence, we focus only on those bits of information which are relevant at the moment. We always keep a concept in focus and gradually shift this focus so that eventually we have managed to express the whole picture of the situation we want to describe. In the area of aspectual composition there is a special focus on the components of the event which are relevant: their temporal structuration. This can be seen in a sentence like the following:

(5.47) ‘for hours, fifty people drove a car’

This sentence is grammatical in a context where each one of the fifty persons drove a car simultaneously (say, in a car race). This means that there are fifty independent driving events, and therefore the sentence has a distributive interpretation. As we have seen in Chapter 4, in a distributive interpretation the aspectual properties of the argument $fifty.people$ are transferred to the sentence. And since $fifty.people$ is quantised, the predicate $fifty.people.drove.a.car$ is predicted to be quantised. But as we can see in (5.47), the sentence can combine with a for adverbial, and therefore it is not quantised; it seems that my theory cannot explain the behaviour of this sentence. The problem here is that, although the sentence is distributive in the sense that a conjunction of events is created, since all of them occur at the same time, *temporally* the interpretation is of collectivity. As a consequence, what we have is a double collective reading, and therefore the aspectual properties assigned to the verb are the ones which are transferred to the final sentence, giving as a result a homogeneous sentence, as predicted.

A central concept in this thesis is that the plural (or mass) structure of the entities referred to in a sentence depends on context; the very same sentence may imply a structured entity in one context, whereas in a different context the structure of the object is not considered. The examples we have used are:

(1.17) a. ‘he pushed two carts’
b. ‘he noticed two errors’
c. ‘he noticed errors’
d. ‘he lost money’

Sentence (1.17a), for example, can have a distributive reading so that two independent pushing events are described. But it can also have a collective reading, by means of which only one event is introduced. This difference in the event structure is what eventually will lead to a different type of aspectual interaction, so that under a distributive reading the sentence is telic, but under a collective reading it is atelic.

As a final word, I would like to give a personal interpretation of Wittgenstein’s metaphor of a language as an ancient city:

> Our language can be seen as an ancient city: a maze of little streets and squares, of old and new houses, and of houses with additions from various periods; and this surrounded by a multitude of new boroughs with straight regular streets and uniform houses. (1958:8e)

The straight regular streets would correspond with syntax, whereas the maze of little irregular streets would correspond with semantics. Aspect would lie right in the centre of the city.

Bibliography

Alarcos Llorach, Emilio, 1970. *Sobre la Estructura del Verbo Español*, chapter II, pp.50–94. Madrid: Gredos.

Bach, Emmon, 1986. The algebra of events. *Linguistics and philosophy* 9: 5–16.

Barwise, Jon, 1987. Noun phrases, generalized quantifiers and anaphora. In P. Gärdenfors (ed.) *Generalized Quantifiers: linguistic and logical approaches*, pp.1–30. Dordrecht: Reidel.

—— & Robin Cooper, 1981. Generalised quantifiers and natural language. *Linguistics and Philosophy* 4: 159–219.

Bennett, M. & B. Partee, 1972. Toward the logic of tense and aspect in english. Technical report, Sytem Development Corporation, Santa Monica, Calif. Available from the Indiana University Linguistics Club.

Bennett, Winfield S., Tanya Herlick, Katherine Hoyt, Joseph Liro & Ana Santisteban, 1990. Toward a computational model of aspect and verb semantics. *Machine Translation* 4: 217–250.

Bickerton, Derek, 1990. *Language and Species*. Chicago: Univ. of Chicago Press.

Binnick, Robert I., 1991. *Time and the Verb: A Guide to Tense and Aspect*. Oxford University Press.

Bruce, Vicky & Patrick R. Green, 1990. *Visual Perception: Physiology, psychology and ecology*. Hove and London: Lawrence Erbaum, 2 edition.

Bunt, Harry C., 1979. Ensembles and the formal semantic properties of mass terms. In Francis Jeffry Pelletier (ed.) *Mass Terms: Some Philosophical Problems*, volume 6 of *Texts and Studies in Linguistics and Philosophy*, pp.249–277. Dordrecht: Reidel.

Caenepeel, Mimo, 1989. *Aspect, Temporal Ordering and Perspective in Narrative Fiction*. Unpublished PhD thesis, University of Edinburgh, Edinburgh.

Carlson, Gregory Norman, 1977. *Reference to kinds in English*. Unpublished PhD thesis, University of Massachusetts.

Carlson, Lauri, 1981. Aspect and quantification. In Philip Tedeschi & Annie Zaenen (eds.) *Tense and Aspect*, volume 14 of *Syntax and Semantics*, pp.31–64. New York: Academic Press.

Chafe, Wallace L., 1974. Language and consciousness. *Language* 50: 111–133.

Clark, Herbert H. & Catherine R. Marshall, 1981. Definite reference and mutual knowledge. In Joshi *et al.* 1981, chapter 1, pp.10–63.

Comrie, Bernard, 1976. *Aspect: an Introduction to the Study of Verbal Aspect and Related Problems*. Cambridge: Cambridge Univ. Press.

Davidson, Donald, 1980. The logical form of action sentences. In *Essays on Actions and Events*, pp.105–122. Clarendon Press, 3 edition. Originally in Rescher, Nicholas (ed.) (1967) *The Logic of Decision and Action*, Univ. of Pittsburg Press.

Davies, E.R., 1990. *Machine Vision: Theory, algorithms, practicalities*. London: Academic Press.

Depraetere, Ilse, 1995. On the necessity of distinguishing between (un)boundedness and (a)telicity. *Linguistics and Philosophy* 18: 1–19.

Dowty, David R., 1979. *Word Meaning and Montague Grammar: the semantics of verbs and times in generative semantics and in Montague's PTQ*. Dordrecht: Reydel.

——, 1991. Thematic proto-roles and argument selection. *Language* 67(3): 547–619.

Eberle, Kurt, 1990. Eventualities in a natural language understanding system. In Karl Hans Bläsius, Ulrich Hedstück & Claus-Rainer Rollinger (eds.) *Sorts and Types in Artificial Intelligence*, pp.209–239. Berlin: Springer-Verlag. Proceedings of a workshop held at Eringerfeld (FRG) on 1989.

——, forthcoming. The influence of plural NPs on Aktionsart in DRT. In Fritz Ham & Erhard Hinrichs (eds.) *Plural Quantification*. Dordrecht: Kluwer.

Egg, Markus, 1995. The intergressive as a new category of verbal aktionsart. *Journal of Semantics* 12: 311–356.

Fenwick, Susan Lee Grady, 1980. *Verbal Aspect: its form and function in contemporary Spanish*. London: University Microfilms International. PhD thesis held at The University of Iowa.

Fillmore, Charles J., 1968. The case for Case. In Emmon Bach & Robert T. Harms (eds.) *Universals in Linguistic Theory*, pp.1–88. New York: Holt, Rinehart and Winston.

Gamut, L.T.F., 1991. *Introduction to Logic*, volume 1 of *Logic, Language and Meaning*. Chicago: University of Chicago Press.

Gillon, Brendan S., 1987. The readings of plural noun phrases in English. *Linguistics and Philosophy* 10: 199–219.

Grice, H. Paul, 1975. Logic and conversation. In Peter Cole & Jerry L. Morgan (eds.) *Speech Acts*, volume 3 of *Syntax and Semantics*, pp.41–58. New York: Academic Press.

Grosz, Barbara J., 1981. Focusing and description in natural language dialogues. In Joshi *et al.* 1981, chapter 3, pp.84–105.

Hinrichs, Erhard W., 1985. *A Compositional Semantics for Aktionsarten and NP Reference in English*. Ann Arbor (Michigan): University Microfilms International. PhD thesis held at Ohio State University.

Jackendoff, Ray, 1991. Parts and boundaries. *Cognition* 41: 9–45.

Joshi, Aravind K., Bonnie L. Webber & Ivan A. Sag (eds.), 1981. *Elements of Discourse Understanding*. Cambridge: Cambridge University Press.

Kamp & Reyle, 1993. *From Discourse to Logic*. Dordrecht: Reydel.

Kamp, Hans, 1981. A theory of truth and semantic representation. In Janssen Groenendijk & Stokhof (eds.) *Formal Methods in the Study of Language*, pp.277–322. Amsterdam: Mathematical Centre Tracts.

Kenny, Anthony, 1963a. *Action, Emotion and Will*. London: Routledge.

——, 1963b. *States, Performances, Activities*, chapter 8, pp.171–186. In Kenny 1963a.

Krifka, Manfred, 1989a. *Nominalreferenz und Zeitkonstitution. Zur Semantik von Massentermen, Pluraltermen und Aspektklassen*. Munich: Wilhelm Fink. Publication of his PhD held at Universität München, 1986.

——, 1989b. Thematic relations as links between nominal reference and temporal constitution. In Manfred Krifka (ed.) *Algebraic Semantics for Aspectual Phenomena*, Saarbrücken. Univesität des Saarlandes. The version I used is a draft. Also in Sag / Sabalcsi (eds.) 1992. *Lexical Matters*, Chicago University Press.

——, 1995. Telicity in movement. In Pascal Amsili, Mario Borillo & Laure View (eds.) *Time, Space and Movement: Meaning and knowledge in the sensible world*, Workshop Notes of the 5th International Workshop TSM'95, pp.63–75, Château de Bonas, France.

Landman, Fred, 1989. Groups (I and II). *Linguistics and Philosophy* 12: 723–744, 559–605.

——, 1991. *Structures for Semantics*. Dordrecht: Kluwer.

Lasersohn, Peter, 1995. *Plurality, Conjunction and Events*. Dordrecht: Kluwer.

Link, Godehard, 1983. The logical analysis of plurals and mass terms: a lattice-theoretical approach. In Rainer Bauerle, Christoph Schwarze & Arnim von Stechov (eds.) *Meaning, Use and Interpretation of Language*, pp.250–209. Berlin: de Gruyter.

——, 1987. Algebraic semantics for event structure. In Groenendijk, Stokhof & Veltman (eds.) *Proceedings of the 6th Amsterdam Colloquium*. Amsterdam: ITLI.

Lyons, John, 1977. *Semantics*, volume 2. Cambridge: Cambridge University Press.

Moens, Marc, 1987. *Tense, Aspect and Temporal Reference*. Unpublished PhD thesis, University of Edinburgh.

—— & Mark Steedman, 1988. Temporal ontology and temporal reference. *Computational Linguistics* 14(2): 15–28.

Mollá Aliod, Diego, 1994. On the influences of noun phrases in the determination of the sentence aspectual class. In *Proceedings of the Departmental Conference 1994*, pp.126–135. Department of Linguistics, University of Edinburgh. Available via Internet http://www.ling.ed.ac.uk/anonftp/pub/working-papers/proc94/dmollaaliod.ps.Z.

——, 1996a. Aspectual composition and our (linguistic) interpretation of the world. In Diego Mollá Aliod & John Cleary (eds.) *Proceedings of the 1996 Joint Linguistics and Applied Linguistics Departments Conference*, Edinburgh. University of Edinburgh, Dept. of Linguistics. Available at URL http://www.ling.ed.ac.uk/~pgc/Proc96/diego.abs.

——, 1996b. On the aspectual interactions between verbs and noun phrases. In Karl A. Bernhardt (ed.) *Papers in Linguistics from the University of Manchester*, volume 1, pp.129–143, Manchester. University of Manchester, Dept. of Linguistics.

Mourelatos, Alexander P.D., 1981. Events, processes and states. In Philip Tedeschi & Annie Zaenen (eds.) *Tense and Aspect*, volume 14 of *Syntax and Semantics*, pp.191–212. New York: Academic Press.

Muskens, R., 1994. A compositional Discourse Representation Theory. In *Proceedings of the 9th Amsterdam Colloquium*, pp.467–486. University of Amsterdam.

Naumann, Ralf, 1995a. *Aspectual Composition and Dynamic Logic*. Habilitationsschrift, Heinrich Heine Universität, Düsseldorf.

——, 1995b. Aspectual composition and dynamic logic. In Paul Aekker & Martin Stokhof (eds.) *Proceedings of the 10th. Amsterdam Colloquium*, volume 3, pp.567–586, Amsterdam. University of Amsterdam, ILLC.

Ornstein, Robert, 1991. *The Evolution of Consciousness*. Ney York: Prentice Hall.

Parsons, Terence, 1985. Underlying events in the logical analysis of English. In Ernest Lepore & Brian P. McLaughlin (eds.) *Actions and Events: Perspectives on the philosophy of Donald Davidson*, pp.235–267. Oxford: Blackwell.

——, 1990. *Events in the Semantics of English: A study in subatomic semantics*. Cambridge (MA): MIT.

Partee, Barbara H., 1984. Nominal and temporal anaphora. *Linguistics and Philosophy* 7: 243–286.

——, Alice ter Meulen & Robert E. Wall, 1990. *Mathematical Methods in Linguistics*. Dordrecht: Kluwer.

Pelletier, Francis Jeffry, 1979. Non-singular reference: some preliminaries. In Francis Jeffry Pelletier (ed.) *Mass Terms: some philosophical problems*, volume 6 of *Texts and Studies in Linguistics and Philosophy*, pp.1–14. Dordrecht: Reidel.

Perlmutter, David M., 1978. Impersonal passives and the Unaccusative Hypothesis. *Berkeley Linguistic Society* 4: 157–189.

Quirk, Randolph, Sidney Greenbaum, Geoffrey Leech & Jan Svartvik, 1985. The semantics of the verb phrase. In *A Comprehensive Grammar of the English Language*, chapter 4. London: Longman.

Real Academia Española, 1973. *Esbozo de una Nueva Gramática de la Lengua Española*. Madrid: Espasa-Calpe.

Rojo, Guillermo, 1974. La temporalidad verbal en español. *Verba* 1: 68–149.

Sanfilippo, Antonio, 1991. Thematic and aspectual information in verb semantics. In Manfred Krifka (ed.) *Algebraic Semantics for Aspectual Phenomena*. Saarbrücken: Universität des Saarlandes. Draft.

Scha, Remko J.H., 1984. Distributive, collective and cumulative quantification. In Jeroen Groenendijk, Theo M.V. Janssen & Martin Stokhof (eds.) *Truth, Interpretation and Information*, volume 2 of *Groningen-Amsterdam Studies in Semantics*, pp.131–158. Dordrecht: Foris.

Sidner, Candace Lee, 1979. Towards a computational theory of definite anaphora comprehension in English discourse. Technical Report AI-TR 537, MIT. (revised PhD thesis).

Smith, Carlota S., 1983. A theory of aspectual choice. *Language* 59: 479–501.

——, 1991. *The Parameter of Aspect*. Studies in Linguistics and Philosophy, Vol.43. Dordrecht: Kluwer Academic Press.

Sperber, Dan & Deirdre Wilson, 1995. *Relevance: Communication and cognition*. London: Blackwell, 2nd. edition.

Taylor, Barry, 1977. Tense and continuity. *Linguistics and Philosophy* 1: 199–220.

van Benthem, Johan & Alice ter Meulen (eds.), 1985. *Generalised Quantifiers in Natural Language*. Dordrecht: Foris.

van Voorst, Jan, 1988. *Event Structure*. Amsterdam: John Benjamins Publishing.

Vendler, Zeno, 1967. Verbs and times. In *Linguistics in Philosophy*, pp.97–121. Ithaca (NY): Cornell University Press.

Verkuyl, Henk J., 1972. *On the Compositional Nature of the Aspects*. Dordrecht: Reidel.

——, 1986. Nondurative closure of events. In Jeroen Groenendijk, Dick de Jough & Martin Stockhof (eds.) *Studies in Discourse Representation Theory and the Theory of Generalized Quantifiers*, pp.87–113. Dordrecht: Foris.

——, 1989. Aspectual classes and aspectual composition. *Linguistics and Philosophy* 12: 39–94.

——, 1993. *A Theory of Aspectuality: The interaction between temporal and atemporal structure*. Cambridge: Cambridge University Press.

——, 1994. Distributivity and collectivity: a couple at odds. In Makoto Kanazawa & Christopher J. Pi nón (eds.) *Dynamics, Polarity, and Quantification*, pp.29–80. Stanford (CA): CSLI.

——, 1995a. Aspectuality. From the 7th. European Summer School in Logic, Language and Information.

——, 1995b. Aspectualizers and event structure. In Pascal Amsili, Mario Borillo & Laurie Vieu (eds.) *Time, Space and Movement: Meaning and knowledge in the sensible world*, pp.31–48, Château de Bonas. Workshop Notes of the 5th International Workshop TSM'95.

——, 1995c. Events as dividuals: Aspectual composition and event semantics. Draft.

White, Michael, 1993. Delimitedness and trajectory-of-motion events. In *Sixth Conference of the European Chapter of the Association for Computational Linguistics*.

Wilson, Deirdre & Dan Sperber, 1988. Representation and relevance. In Ruth M. Kempson (ed.) *Mental Representations: the interface between language and reality*. Cambridge University Press.

Wittgenstein, Ludwig, 1958. *Philosophical Investigations*. Oxford: Basil Blackwell, 2 edition.