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**FROM COHESION IN TEXT
TO COHERENCE IN COMPREHENSION**

Max Mike Louwerse




Ph.D. Thesis
University of Edinburgh
2000



DECLARATION

I hereby declare that I composed this thesis entirely by myself, that it describes my own research and that it has not been submitted, either in the same or different form, to this or any other University for a degree.



Max Mike Louwerson

Edinburgh

August 2000

- Can I have a moment?
- *What is it?*
- Mission accomplished. The matter's settled.
- *What matter?*
- Oh, forgive me. The most important matter of all. The major problem.
- *The major problem? What are you talking about?*
- The testimony.
- *But of course! Good heavens, how terrible! One devotes oneself full-time to the essential questions, one focuses all one's energies on them, and at a certain moment one simply forgets them, or deals with them in a trice.*

Harry Mulish
The Discovery of Heaven

If you cannot understand stories, what might work next as a general organizer? The linear sequence of time! You may not know why, or how, or whether, or what, but at least you can order all the items in a temporal series without worrying about their causal connections – this came before that, that before the other, the other before this-thing-here. He had triumphed.

Stephen Jay Gould
Questioning the Millennium

ABSTRACT

Text comprehension involves the construction of a coherent mental representation of the situations cohesively described by the text. We use the term 'coherence' for these representational relationships and 'cohesion' for the textual indications that coherent representations should be built. Cohesion can be indicated by lexical information (vocabulary-driven) or by grammatical information (grammar-driven). In either case, five types of coherence can result: REFERENTIAL, LOCATIONAL, CAUSAL, TEMPORAL and ADDITIVE strands, corresponding to identification of the who, where, why, when and what.

This thesis asks how textual cohesion supports representational coherence, by addressing two research questions:

1. To what extent is each of the types of cohesion independent of the others in its effects on the reader?
2. Does coherence develop (on-line) throughout the comprehension process, does it come about (off-line) in a final wrapping-up stage of the comprehension process or both?

To explore effects of vocabulary-driven cohesion on coherence, a connectionist model is used. Vocabulary-driven cohesion is represented as a large number of weighted relations between the elements of the situations described by the text. A series of computational experiments measure the effects of vocabulary-driven cohesion on summary and data. The results show that vocabulary-driven cohesion relations both interact and make independent contributions to coherence. They also show that the more specific a situation is, the more likely it is the situation is summarised.

The effects of grammar-driven cohesion are explored in two stages. First, a parameterisation of local grammar-driven cohesion and coherence relations is developed, using the categories TYPE (CAUSAL, TEMPORAL, ADDITIVE) and POLARITY (POSITIVE, NEGATIVE). It is assumed that these relations are processed by combinations of parameters. A series of reading time experiments test the role of these parameters in the comprehension process. Those cohesion relations that are less specific direct resources to cohesion-based information in the text and support an incremental-coherence hypothesis, whereas more specific relations direct resources to coherence-based information and support a delayed-coherence hypothesis.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Puzzling involves putting pieces of a jigsaw together in order to form a unified whole. One piece is connected to the next piece, the next to another and from the related pieces we form the jigsaw. In the result of the puzzling process the pieces of the jigsaw are hardly noticeable, as the interrelated pieces have become an interrelated representation. But how do the pieces of the jigsaw support the overall jigsaw in the puzzling process? To what extent are the relations between the pieces of the jigsaw independent of the others in its effects on the puzzler? Does the overall picture of the jigsaw appear throughout the puzzling process or in a wrapping-up stage in which the last few pieces are put together? These are some of the questions to be asked if we are to understand the process of puzzling.

The analogy of puzzling more or less illustrates the process from cohesion in text to coherence in comprehension. Text comprehension involves the construction of a coherent mental representation of the events described by the text (Gernsbacher, 1990; Kintsch, 1998). The events are described by clauses, which are interrelated in a number of ways. Those interclausal relationships that can be constructed on the basis of information in the text itself rather than from prior knowledge or inference, are the topic of this research. This thesis asks how textual cohesion supports representational coherence, by addressing two research questions:

1. To what extent is each of the types of textual cohesion independent of the others in its effects on the comprehender?
2. Does representational coherence develop (on-line) throughout the comprehension process and does it come about (off-line) in a final wrapping-up stage of the comprehension process or both?

In this introduction, we will first outline what we mean by text, cohesion and coherence. We will then make several classifications of cohesion and coherence that will play a central role in this research. The aim of this chapter is to introduce some key words in this thesis.

1.2 TEXT

As with the text comprehension process, our starting point is the text. Text is not just a concatenation of sentences. Clauses need to be interwoven into a bigger unified whole to become a text (Lat. *textus*, i.e., a weave). That is, adjacent clauses, and groups of adjacent clauses, need to be linked. These links are usually marked in the text by the sender of the message and cue the receiver on the intended structure of a unified whole. According to de Beaugrande & Dressler (1981: 3) seven standards need to be met before one can speak of a 'text':

1. *Cohesion*: The components of the linguistic surface structure (i.e., words) are mutually connected;
2. *Coherence*: Concepts and relations underlying the surface text are accessible and relevant;
3. *Intentionality*: The producer's intentions are to accomplish standard 1 and 2;
4. *Acceptability*: The receiver assumes that the producer accomplishes 1 and 2;
5. *Informativity*: The information presented is informative, but not *too* informative;
6. *Situationality*: The presentation of the information is neither too elaborate, nor too economical;
7. *Intertextuality*: The information is considered in a context, for instance a context of background knowledge or previous texts.

De Beaugrande & Dressler (1981: 11) argue that these standards function as constitutive principles (after Searle, 1969: 33) creating textual communication rather than regulating it. In this research, rather than seeing text as a set of rules language users follow, we see text as a set of strategies and principles language users normally follow in textual communication. In other words, we follow the more general approach of Grice (1975) and consider texts, like any other form of human communication, to be based on a principle of cooperation. The Cooperative Principle consists of the maxims Quantity, Quality, Relation and Manner (Grice, 1975: 45ff).

Cooperative Principle

Make your contribution such as is required, at the stage at which it occurs, by the accepted purpose or direction of the talk exchange in which you engaged.

- Maxim of Quantity** - make your contribution as informative as required for the current purposes of the exchange
- do not make your contribution more informative than is required.
- Maxim of Quality** - do not say what you believe to be false.
- do not say that for which you lack evidence.
- Maxim of Relation** - be relevant
- Maxim of Manner** - avoid obscurity of expression
- avoid ambiguity
- be brief and orderly

Grice's principles seem to offer what we are looking for in a definition of text. Firstly, Grice mentions that principles based on aesthetic, social or moral grounds may be needed (Grice, 1975: 46f). This is exactly what we may need in a definition of text, as there are many different text types (e.g. literature, news text, patient's information). Secondly, and more importantly, the four maxims can be directly related to the standards for textuality defined by de Beaugrande & Dressler. The Maxim of Quantity relates to standard Informativity, the Maxim of Quality to the standard Intertextuality, the Maxim of Relation to the standards Coherence, Intentionality and Acceptability, and the Maxim Manner to the standard Situationality. It may become clear that in both Standards and Maxims a distinction can be made between the linguistic information and the communicative event. Grice makes this distinction by stating "the category of manner, which I understand as relating not (like the previous categories [Quantity, Quality, Relation]) to WHAT is said but, rather to HOW what is said to be said" (Grice, 1975: 46). Similarly, in de Beaugrande & Dressler's standards of textuality the standards Cohesion and Situationality are directly related to the linguistic surface structure of the text. Standard Coherence, Informativity and Intertextuality seem to concern both the linguistic information and the communicative event, while standard Intentionality and Acceptability mainly concern the communicative event.

The above distinction in both maxims and standards between linguistic information and the communicative event, allows us to give two notions of text, one focussing on text-as-product, the other on text-as-process. According to the first, text can be characterised as linguistic construct, that is, text as a number of sentences forming a unified whole (see Van Dijk, 1972: 3; Rimmon-Kenan, 1983: 3). It primarily takes into account the linguistic (syntactic and semantic) organisation of the text. According to the second notion, text can be characterised as a communicative event, that is, text as a

medium in which people communicate ideas and beliefs (Van Dijk, 1997: 2). Here it is not the linguistic product, but rather the text during and after the comprehension process. This notion of text is clearly more dynamic than the static notion of text-as-product. For instance, in the notion of text-as-process the linguistic information is supplemented with variable inferential background knowledge. Hence, text-as-process and text-as-product are closely related, with the first depending on the latter.

This distinction between the two kinds of texts is certainly not new. Brown & Yule (1984: 24) speak of text-as-product and discourse-as-process, but use text and discourse interchangeably. Lenk (1998: 15) makes a similar distinction, but calls the product 'text' and the process 'discourse'. In this thesis, we will use the term 'text' as the product of written monological language. As we primarily deal with text comprehension rather than with text production, we will generally use the term 'comprehension' for text-as-process, despite the fact that we assume a close relationship between comprehension and production processes. Distinguishing text from discourse, we hence assume that text does not involve any negotiation of its meaning, something discourse (including dialogue) does.

1.3 COHESION AND COHERENCE

Defining text as a unified whole implies using the notions of cohesion and coherence. The two terms have often been used rather confusingly. Some researchers do not use these terms, but distinguish between different kinds of coherence (Van Dijk, 1972; Givón, 1993, 1995). Others use 'cohesion' for the surface structure of the text and coherence for the concepts and relations underlying this structure (de Beaugrande & Dressler, 1981). Yet others use the term 'coherence' for some general overall 'interrelatedness' in the text, while the term 'cohesion' is reserved for smaller units of language in the text (Halliday & Hasan, 1976, Martin, 1992; Shapiro & Hudson, 1997). Finally, others describe 'coherence' as the semantic coherence and 'cohesion' as grammatical manifestations of underlying semantic coherence (Van Dijk & Kintsch 1983).

Here, we use the term 'coherence' for the representational relationships and 'cohesion' for the textual indications that coherent representations should be built. Cohesion is consistency of elements in the text, coherence consistency of elements in

the representation. Contrary to others (e.g. Lenk, 1998: 16), we argue that cohesion is sufficient, but not necessary for coherence. That is, a text containing cohesion devices will generally be perceived as being more coherent than a text without them, but a text without cohesion devices can still be perceived as coherent.

The relation between cohesion and coherence can be shown in aphasic patients, who have difficulties with comprehension and production of cohesive texts (see Caplan, 1993). Huber & Gleber (1982) for instance investigated performance of aphasic (global, Wernicke's, Broca's and amnesic) patients, right hemisphere-damaged patients and normal subjects on a sentence-ordering and picture-ordering task. Subjects were asked to read nine stories, either in a pictorial version or in verbal versions. The verbal versions were characterised as either 'low linguistic cohesion' or 'high linguistic cohesion'. Subjects were asked to rearrange the unordered elements of the story into their correct order. No subject group showed a significant difference between high and low cohesion. However, a (non-significant) tendency was found for normal subjects with the smallest number of errors belonging to the high cohesion stories. This experiment shows that a highly cohesive text may facilitate comprehension only marginally. In fact, different degrees of cohesion do not have a significant effect even on those subjects who have coherence difficulties. In other words, even if a text is less cohesive, it is not automatically less coherent.

Contrary to our claim that cohesion is in the text and coherence is in the mind, Garnham & Oakhill (1997: 334; see also Spooren, Sanders & Van Wijk, 2000: 211), however, argue that 'interrelatedness' cannot lie in the text but can only lie between events in the world reflected by the text. As we have stated earlier, text-as-product and text-as-process do not exist independently. Similarly, cohesion and coherence are interrelated. Cohesion can indeed only be interpreted (as coherence), but similarly coherence usually comes about because of cohesive ties in the text.

In sum, when we analyse the linguistic information in the text, we speak of cohesion. When we interpret the textual information we speak of coherence. Cohesion is a sufficient but not a necessary condition for coherence. On the other hand coherence is neither sufficient nor necessary for cohesion, as it cannot affect cohesion in any way. Rather than regarding cohesion and coherence as mutually exclusive concepts, one should see them as related: cohesion affects coherence. The question to be addressed next is what types of cohesion and coherence can be distinguished.

1.3.1 Vocabulary-driven and grammar-driven

Givón (1995) and Kintsch (1995) argue that in text comprehension the comprehender uses both grammatical and lexical cues in the text and uses these cues for different, but related, processing modes. Thus, an important distinction can be made between vocabulary-driven and grammar-driven in both cohesion and coherence.

Givón follows a proposal by Kintsch (1995: 158) in which he suggests that two parallel processing channels are active during text comprehension: a weak, syntax-guided processes channel and a strong knowledge-based and domain-specific channel. Givón further explores Kintsch's proposal and distinguishes a rough-grained knowledge-driven comprehension process and a fine grained grammar-driven one. Thus, the language user applies two parallel processing channels:

- a. Knowledge-based inferences, supported by the lexical vocabulary of the clause.
- b. Grammar-cued inferences, supported by the syntactic structure, grammatical morphology and intonational cues of the clause. (Givón, 1995: 105)

Human language uses these two modes of discourse processing, the pre-grammatical and a grammatical mode. Evidence for these modes comes from child language, pidgin and aphasic speech, all mainly using a pre-grammatic mode producing relatively cohesive speech.

In agrammatic discourse, for instance, the evidence for the distinction between vocabulary-driven and grammar-driven cohesion is clearest (see also Givón, 1995: 78). Grammatical disorders can be divided into two clinically opposite categories: motor agrammatism and paragrammatism¹. Patients with motor agrammatic disorders (usually referred to as 'agrammatism') often do not use function words like connectives, articles or auxiliaries. Paragrammatic patients on the other hand produce speech with errors in the verb tense, in the pronoun case and gender and make incorrect use of prepositions. Agrammatic speech is characterised by vocabulary-driven cohesion. An example is given in (1):

¹ Motor agrammatic disorder is often a symptom of Broca's aphasia, the result of lesions of the anterior portion of the left-cerebral language zone (left frontal cortex). Paragrammatism on the other hand is often a symptom of Wernicke's aphasia, lesions of the posterior third of the first temporal gyrus (right behind Broca's area).

- (1) Ah ... Monday ... ah, Dad and Paul Haney [*referring to himself by his full name*] and Dad ... hospital. Two ... ah, doctors ..., and ah ... thirty minutes ... and yes ... ah ... hospital ... And, er Wednesday ... nine o'clock. And er Thursday, ten o'clock ... doctors. Two doctors ... and ah ... teeth. Yeah, ... fine. (Goodglass, 1976: 238)

This text contains several cohesion devices, mainly vocabulary-driven.² The text contains a notion of temporality, marked by *Monday*, *thirty minutes*, *Wednesday*, *nine o'clock*, *Thursday*, *ten o'clock*. Furthermore, references are made to the persons mentioned in the text: *Dad*, *Paul Haney*, *Dad*, *doctors*, *two doctors*. Although the text is not fully understandable, it will not surprise that the agrammatic patient, Paul Haney, tries to describe how he, together with his father, returned to the hospital for dental surgery.

Whereas the agrammatic text was characterised by a reduction of grammatical organisation, paragrammatic speech does contain grammar-driven cohesion devices, but the vocabulary-driven cohesion is less clear, as in the following text, in which a patient describes a series of pictures (2):

- (2) This is a boy, this is a boy. I forget the boy and a boy. This one ever which one is right and a boy. Then this one is right here, right here. And ... nice right in here. (Buckingham, 1981: 54)

This text mainly contains grammar-driven cohesion devices, like the demonstrative *this*, the definite and indefinite articles (and their reference to a known versus unknown entity) *the* and *a*, the conjunction *then*, the conjunction *and*, and the deictic *here*. Understanding the densely grammatically marked text (2) seems easier at first, but the vocabulary-driven telegraphic speech in example (1) turns out to make more sense, as the paragrammatic seemingly cohesive constructions turn out to be coherently unrelated to each other.

Although the two kinds of disordered speech cannot be compared in terms of cohesion devices, as more is disrupted in aphasic speech than just cohesion, we can see that text without grammar-driven cohesion can still be comprehended. Grammar-driven cohesion supports vocabulary-driven cohesion. At the same time, vocabulary-driven cohesion supports grammar-driven cohesion, as is the case in many prepositional

² The only grammar-driven cohesive device in the text is a cohesion relation marked by the conjunction *and*.

phrases (as in examples (3)(a) and (c)). Hence, like the distinction between cohesion and coherence, vocabulary-driven and grammar-driven cohesion are not mutually exclusive. In fact, often cohesion devices are both vocabulary-driven and grammar-driven simultaneously. Consider the following sentences:

(3)

- (a) Bill left *his office* and stepped *into the lounge where* Monica was waiting.
- (b) Bill left *his office*. *He entered the lounge*. Monica was waiting in the corner.
- (c) Bill left his office *opposite* the lounge. He walked *inside*. *There*, Monica was waiting.

In sentence (a) grammatical cues like *his*, *into* and *where* help to establish some kind of spatial coherence, which is vocabulary-driven by *his office* and *lounge*. In (b) the grammar-driven cohesion devices have been left out and are replaced by lexical markers. In (c) the focus lies on grammar-driven cohesion devices, like *opposite*, *inside*, *there*. The three sentences illustrate the supportive function of grammar-driven cohesion devices on vocabulary-driven cohesion and vice versa.

As we have seen grammatical-driven cohesion/coherence supports vocabulary-driven cohesion/coherence, and vice versa. In other words, grammatical-driven cohesion/coherence is neither sufficient nor necessary for vocabulary-driven cohesion/coherence, vocabulary-driven cohesion/coherence is neither sufficient nor necessary for grammar-driven cohesion-coherence. Grammar and lexicon clearly interact in both cohesion and coherence.

1.3.2 Global and local

So far, we have assumed that comprehenders use vocabulary-driven and grammar-driven cohesion in text in order to build a vocabulary-driven and grammar-driven coherent mental representation. Both cohesion and coherence are locally and globally structured. In the text the comprehender finds local cohesion relations between adjacent clauses, as well as global cohesion links between groups of clauses. Like the local and global structure in the text, a local and global structure in the coherent mental representation can be assumed (see Givón, 1995: 80). Van Dijk & Kintsch (1983) and

Kintsch (1998), among others, have made a similar distinction between (local) microstructures and (global) macrostructures and have argued that what is important in the coherent mental representation is the global organisation of the events described by the text.

The distinction between local and global cohesion/coherence is important, because both local and global cohesion cue comprehenders how to organise the comprehension process. It is therefore useful to look at the distinction in more detail.

Lenk (1998: 27) describes the difference between local and global cohesion as follows:³

Local coherence relations are those relations between segments in discourse that appear immediately adjacent to each other, whereas global coherence relations are the relations between segments in discourse that appear further apart, with other stretches of discourse in between.

With relatively vague notions as “segments in discourse” and “further apart”, it seems that Lenk emphasises the relative concept of local and global cohesion. The distinction between local and global coherence in the mental structure is described by Givón (1995: 63):

a. *Hierarchy:*

Episodic text representation has at least some depth of hierarchical organization, so that nodes (‘chunks’) are connected both ‘upward’ and ‘downward’ to other hierarchically adjacent nodes – clauses to governing chains, chains to governing paragraph, etc.

b. *Sequentiality:*

Episodic text representation displays at least some sequential chaining at each hierarchical level, so that nodes are connected to both preceding and following sequentially-adjacent nodes – a clause to a preceding and following clause, a chain to a preceding and following chain, etc.

Givón assumes text is mentally represented as a network of connected nodes. The difference between a global and local mental text structure is the difference between hierarchy and sequentiality.

³ Lenk (1998) uses coherence for linguistic ‘interrelatedness’, i.e., cohesion in our terms.

Cohesion can cue the comprehender for local or global coherence. Givón (1993: 313) for instance makes the distinction between pre-posed and post-posed adverbial clauses, and argues that post-posed adverbial clauses like (4) appear in paragraph medial contexts, whereas pre-posed adverbial clauses like (5) tend to appear at thematic breaks in the text.

(4) To illustrate this, consider the following passage.

(5) Then he considered the passage to illustrate it.

This means that local cohesion cues for continuity of coherence, whereas global cohesion cues for discontinuity. For instance, a paragraph describes a location, and the global cohesion cue in a new paragraph describes a new location.

However, the difference between local and global is often hard to make. Givón (1995: 82) gives examples like (6), where the (a)-sentence contains local cohesion and the (b)-sentence global cohesion:

(6)

(a) They left the *living room* and went *directly* into the *kitchen*.

(b) In *Los Angeles*, they found a big mess and fired the manager. In *Chicago* the following week, things were looking much better.

The distinction between local and global cohesion in these two random sentences is not entirely clear. Consider for instance local cohesion in (a). The sentence could contain global cohesion when we consider a play in which the setting of the first act is a living room. Guests arrive, discussions take place. At the end of the first act “they left the *living room* and went *directly* into the *kitchen*.” The local cohesion now seems to have become global cohesion.

Similarly, Givón considers the sentence pair (b) as globally cohesive. Now consider that sentence in a text about the developments of a multinational in the USA and Asia, like in (7).

(7) For years the company did very well in the *United States*. Recently, however, it was thrown into turmoil. In *Los Angeles*, they found a big mess and fired the manager. In *Chicago* the following week, things were looking much better.

In *Asia* however, the situation was different. The company's office in *Singapore* reported further profits in the first half of this year. In *Hong Kong* a similar situation occurred.

As has become clear, local and global cohesion are relative concepts and depend on the circumstances described in the text. That is, the scope of the cohesion determines whether sentences are locally or globally cohesive. For instance, the following text fragment from the novel *An awfully big adventure* by Beryl Bainbridge (1989: 13) shows increasing levels of global cohesion.

(8)

- (a) she reached the top floor
- (b) she rode the lift in Crane Hall, up through the showrooms of polished pianofortes where the blind men fingered scales, until she reached the top floor
- (c) she ran down the hill to Hanover Street and rode the lift in Crane Hall, up through the showrooms of polished pianofortes where the blind men fingered scales, until she reached the top floor
- (d) she ran down the hill to Hanover Street and rode the lift in Crane Hall, up through the showrooms of polished pianofortes where the blind men fingered scales, until she reached the top floor. She came home and shut herself in her bedroom off the scullery and spouted speeches.

Initially, sentence (b) seems to present global cohesion, but when compared with sentence (c) it seems locally cohesive. However, sentence (c) then seems to be less globally cohesive than initially assumed compared to sentence (d), which furthermore initiates a new paragraph to mark the global cohesion. Thus, the notions of local and global coherence are scalar, that is, a textual element is more or less locally or globally coherent.

Like the distinction between vocabulary- and grammar-driven cohesion shown in aphasic speech, the difference between local and global cohesion can be shown in

schizophrenic speech. Rochester & Martin (1979: 88) found that schizophrenic patients rely less on cohesion devices than normal subjects. But more importantly, thought disordered schizophrenic patients produce texts which hardly have any global cohesion. Consider for instance the following text, by a schizophrenic 19-year old male student:⁴

- (a) ... that's what I think hippyism is you know realizing you don't have to own the land to be part of this earth
- (b) and I, and I would rather own a piece of land
- (c) we own a farm
- (d) and I would rather own the land than to be able to pick flower's off somebody else's land (2.8 sec)
- (e) which isn't lawful taking flowers off other people's land
- (f) and we don't want to break the laws
- (g) do we (Interviewer: Do we?)
- (h) no (1 sec) no
- (i) I find, I find it's a lot easier swimming down stream than trying to swim against the stream
- (j) and I find it's a lot easier to blow in the wind than to fight the wind. (Rochester & Martin, 1979: 95)

This (part of) text contains many local cohesion devices, particularly lexical repetition: *land* links (a), (b), (d) and (e); *own* links (a), (b), (c) and (d); *law* links (e) and (f). Furthermore, collocations like *earth*, *land* and *farm* link (a), (b), (c), (d) and (e), while phrases like *swim against the stream*, *blow in the wind* and *fight the wind* are collocative. The text however lacks global cohesion, there is no continuity or consistency in the general ideas that are expressed. The speaker seems to jump from one idea to the other.

As with cohesion and coherence, and vocabulary-driven and grammar-driven cohesion/coherence, local and global cohesion/coherence interact. This interaction was examined by Kim (1993) in a series of psycholinguistic experiments. Kim looked at the effects of global and local themes on syntactic subject assignment. She defined the *local theme* as the most salient character in a picture and the *global theme* as the proposition the narrative is about, characterised by the title of the story or the person associated with the title. In several experiments subjects looked at a series of pictures, which together formed a story. After having read the title aloud, they were asked to tell a story corresponding to the events depicted on the pictures and matching the title of the story.

⁴ Other examples of locally cohesive, but globally incohesive discourse by other patients can be found in Rochester & Martin (1979: 93, 95, 97, 98).

One of the stories was for instance a miserable blind date. The title of the story was either “How John’s blind date ended in a total disaster” or “How Mary’s blind date ended in a total disaster”. Three hypotheses were tested:

1. Syntactic subject assignment is determined by the *global theme* of the story, i.e., subjects choose syntactic subjects according to the referent in the global theme;
2. Syntactic subject assignment is determined by the *local theme* of a picture, i.e., subjects choose syntactic subjects according to the salient person in a picture;
3. Syntactic subject assignment is determined by the *previous syntactic subject*, i.e., subjects choose syntactic subjects according to the syntactic subject they expressed in the previous clause.

In the stories produced by the subjects, Kim found clear evidence for an interaction of all three factors – previous subject, local theme and global theme – contributing to the selection of the syntactic subject in the production of the story, with local theme most consistent and powerful. More interestingly, Kim found that the three factors each have their particular functions. The global theme appeared to be strongest in the introduction, climax and conclusion of the story. Furthermore, it had a significant effect in psychological clauses, i.e. those clauses expressing a character’s psychological state or a speaker’s evaluation. The local theme, on the other hand, was significant in event clauses, i.e., those clauses describing the actual events expressed in the picture. The previous syntactic subject, finally, provided local coherence across the clauses. In the production of text language users thus apply both global and local themes to make the text globally and locally coherent.

In comprehension studies similar results are found. Wegner, Brookshire & Nicholas (1984) tested the comprehension of main ideas and details in globally cohesive and less cohesive text. Left hemisphere-damaged patients and non-aphasic subjects listened to globally cohesive and globally less cohesive texts. Cohesion was established by making reference to the topic in each of the sentences. In the globally less cohesive texts a change in topic occurred in every third and fourth sentence. Subjects were asked simple yes or no questions about the main idea in the text or about details in sentences. As can be expected the results showed that non-aphasic subjects performed better than aphasic subjects. Also, both groups performed better on comprehension of the main ideas than of the details. More importantly, whether the text was globally cohesive or not did not affect the comprehension score of detailed questions in the non-aphasic

group, but did in the aphasic group. In the latter group comprehension of details was worse for the globally cohesive paragraphs than the globally less cohesive paragraphs. One of most plausible explanations for these results is that while in normal subjects local and global cohesion interacted, aphasic subjects may have mapped globally cohesive information onto a developing global theme whenever this was possible, while forgetting the details once the global theme was established.

Finally, the classic evidence for the distinction and interaction between local and global cohesion/coherence comes from Bransford & Johnson's (1972). Bransford and Johnson carried out a series of experiments illustrating that when subjects were provided with the global theme of the text before they heard the text, comprehension ratings and recall improved considerably. For instance, subjects listened to the following passage, of which a fragment is quoted here.

The procedure is actually quite simple. First you arrange things into different groups, depending on their makeup. Of course, one pile may be sufficient depending on how much there is to do. If you have to go somewhere else due to the lack of facilities, that is the next step, otherwise you are pretty well set. [...] It is difficult to foresee any end to the necessity for this task in the immediate future, but then one never can tell. (Bransford & Johnson, 1972: 722)

Bransford & Johnson speak of the lack of a title as lack of appropriate contextual information. In our terminology, this passage is locally cohesive, but lacks a global cohesion. Bransford & Johnson found that when a title (global cohesion) is provided, comprehension ratings and recall scores increased.⁵

In sum, local (or global) cohesion is neither a sufficient nor a necessary condition for global (or local) cohesion/coherence. If a text is locally (or globally) cohesive, it may still lack global (or local) cohesion and if local (or global) cohesion is lacking, global cohesion (or local) may still be found in the text. However, local cohesion cues for global cohesion, for instance by linking the clauses of passages, which are themselves globally cohesive. Similarly, local coherence will facilitate global coherence and vice versa. Hence, neither the pairs cohesion and coherence, vocabulary-driven and grammar-driven, nor local and global are mutually exclusive. Whereas local cohesion cues for continuity, global cohesion cues for discontinuity of the information in the text.

1.3.3 Global and local, vocabulary- and grammar-driven: an overview

So far, we have distinguished between cohesion and coherence, the former being relatedness-in-the-text, the latter relatedness-in-the-mind. This distinction is parallel to the one between text-as-product and text-as-process made at the very beginning of this chapter: like the text-as-product, cohesion is static. One can point out cohesion devices in the text in a rather straightforward way. Coherence on the other hand is dynamic; it emerges over the comprehension process. This means that cohesion devices can facilitate establishing coherence, while coherence cannot affect cohesion. As pointed out earlier, it is important to note that we focus on the comprehension process rather than the production process. Obviously, in the production process cohesion is indeed influenced by coherence. For the comprehension process, it can be claimed that cohesion is a sufficient, though not necessary condition for coherence.

The second distinction we have made described grammar-driven and vocabulary-driven devices. This distinction can be found both in cohesion and coherence. It seems that in cohesion both grammar-driven and vocabulary-driven devices in the text can be pointed out rather easily. However, often the two occur simultaneously. In coherence, grammar-driven and vocabulary-driven coherence interact. Names of characters for instance support anaphora resolution, while anaphora guides the comprehender to refer to a particular person in the text.

Cohesion and coherence, both vocabulary-driven and grammar-driven, can be local or global. Examples of local cohesion are for instance conjunctions marking types of interclausal relationships, while the title of a text marks global cohesion. Again, in the comprehension process local and global coherence interact. Interclausal cohesion guides the comprehender in establishing larger chunks of information, while establishing local links are supported by global coherence.

With the above information, we can construct Figure 1. The figure shows how the different elements in cohesion are 'mirrored' in coherence. From the 'static' cohesion elements in the text coherence dynamically emerges by the interaction of these elements in the comprehension process.

⁵ Similar results were found in a replication of the Bransford & Johnson (1972) study, reported in Moravcsik & Kintsch (1993).

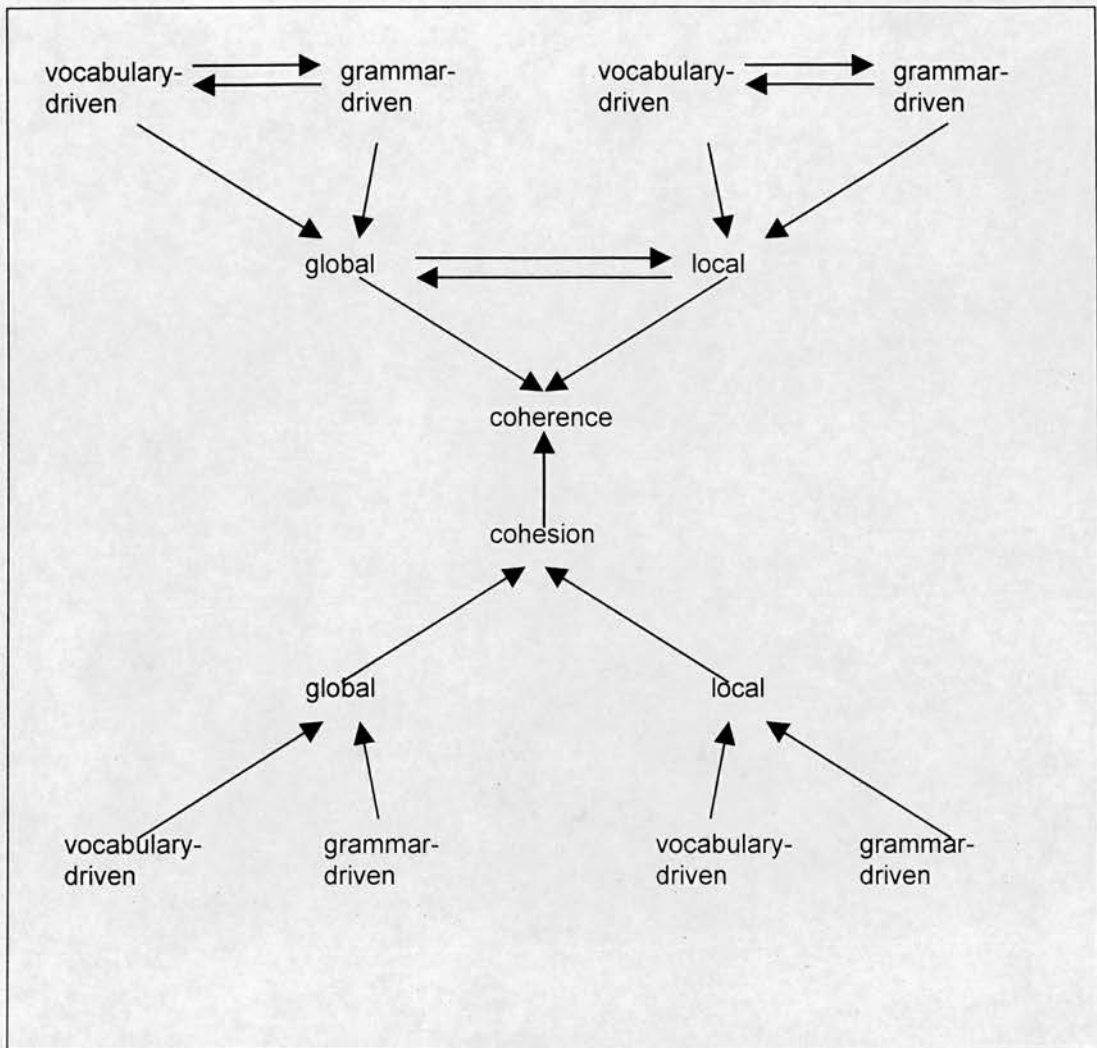


Figure 1 Overview of cohesion and coherence

1.3.4 Five cohesion and coherence strands

Following Givón (1995: 61), we can now extend our previous definition of cohesion as “the continuity or recurrence of some element(s) across a span (or spans) of text” and the coherence as the continuity or recurrence of some element(s) across a span (or spans) of events in the mental representation. The question to be answered next is what these elements are. In the following chapters of this thesis different types of cohesion and coherence relations will be discussed in detail. Here, the emphasis lies on the distinction between local versus global and vocabulary-driven versus grammar-driven. For now, we distinguish between five cohesion strands: REFERENTIAL, TEMPORAL, LOCATIONAL and CAUSAL and ADDITIVE

- a. REFERENTIAL *cohesion*: consistency in the who or what that is referred to, often signalled by anaphora. Events expressed by two clauses are referentially cohesive if they refer to the same persons, things or places.
- b. TEMPORAL *cohesion*: consistency in when the events occur and often signalled by the tense and aspect of the verb. Events expressed by two clauses are temporally cohesive if they share the same time frame.
- c. LOCATIONAL *cohesion*: consistency in where the events occur signalled by adverbial phrases or point of view. Events expressed by two clauses are locationally cohesive if they share the same place.
- d. CAUSAL *cohesion*: Events expressed by two sentences are causally cohesive if a CAUSAL relation can be established between the two events, often signalled by conjunctions like *because* and *so*.
- e. ADDITIVE *cohesion*: unspecified consistency in events that concerns the addition of information, often signalled by conjunctions like *and* or *moreover*. Information from a previous clause is amplified in the following clause, or new information is added to the old information.

We use the word 'strands' for REFERENTIAL, TEMPORAL, LOCATIONAL and CAUSAL relations to distinguish them from the vocabulary-driven and grammar-driven relations⁶. All five strands can occur in the text as grammar-driven or vocabulary-driven and local or global. We will first give examples of the five cohesion strands being vocabulary-driven or grammar-driven. In the next section we will then provide a complete overview of the terms we have distinguished in this chapter. Consider the following examples:

- (9) REFERENTIAL *cohesion*
 - (a) Bill looked over the allegations. The man was worried.
 - (b) Bill looked over the allegations. He was worried.
 - (c) Bill looked over the allegations. And was worried.

- (10) *LOCATIONAL cohesion*
- (a) Bill worked in his office. The room was bright.
 - (b) Bill worked in his office, where it was bright.
 - (c) Bill worked in his office. Bright light fell in.
- (11) *CAUSAL cohesion*
- (a) Bill was in trouble. The cause of it was that he had kissed Monica.
 - (b) Bill was in trouble, because he had kissed Monica.
 - (c) Bill was in trouble. He had kissed Monica.
- (12) *TEMPORAL cohesion*
- (a) Bill made himself a cup of coffee. A few minutes later he read the newspaper.
 - (b) Bill made himself a cup of coffee. Then he read the newspaper.
 - (c) Bill made himself a cup of coffee. He read the newspaper.
- (13) *ADDITIVE cohesion*
- (a) Bill gave Monica a ring. In addition, he offered her a job.
 - (b) Bill gave Monica a ring and he offered her a job.
 - (c) Bill gave Monica a ring. He offered her a job.

The (a)-sentences are vocabulary-driven and the (b)-sentences grammar-driven. The (c)-sentences are more or less similar in meaning but a vocabulary-driven and grammar-driven cohesive cue is lacking. Without grammar-driven cohesion relations, this suggests the text being vocabulary-driven. But in that case, one could argue that any text always contains vocabulary-driven cohesion, as it always contains lexical information. Clearly, such a statement would be too broad. Nevertheless, comprehenders will usually consider these sentences coherent. These ‘implicit’ cases, in which no cohesion devices can be pointed out but coherence can still be established, show again that cohesion is a sufficient but not necessary condition for coherence.

⁶ Gernsbacher (1990) calls strands ‘sources of coherence’, Zwaan & Radvansky (1998) call them ‘indexes’.

1.3.5 Global, local, vocabulary- and grammar-driven cohesion: an illustration

We can now give complete examples of these five (REFERENTIAL, TEMPORAL, LOCATIONAL, CAUSAL and ADDITIVE) cohesion strands, which are either global or local, and vocabulary-driven or grammar-driven cohesive. For this purpose, we derive the examples from the novel *An awfully big adventure* by Beryl Bainbridge (1989). Obviously, the context of the sentences given here can only partly be given. For further contextual information, see Bainbridge (1989).

REFERENTIAL cohesion

REFERENTIAL cohesion concerns vocabulary-driven and/or grammar-driven reference to a previous or forthcoming person or object in the text. REFERENTIAL cohesion provides the most important cohesion strand, and has accordingly received much attention from a variety of disciplines (see Givón, 1995: 105; see also Chapter 4). The most common grammar-driven REFERENTIAL cohesion device is anaphoric reference, in the form of personal pronouns (GrammD-Loc a, b)⁷ or possessive pronouns (GrammD-Glob a). But it can also take demonstratives or even determiners. For vocabulary-driven cohesion, there is a range of different devices: adjectives or adverbs may refer to an earlier mentioned object or person. More commonly, vocabulary-driven REFERENTIAL cohesion is established by the use of repetition or synonyms (VocD-Loc a, b; VocD-Glob a,b). Global REFERENTIAL cohesion is often found in the form of a vocabulary-driven re-introduction of an earlier character in the text: a character that has not played a role in a previous section (paragraph, chapter) will be re-introduced by name. Sometimes this global re-introduction can also be achieved by using anaphoric reference, if the anaphor is not ambiguous (GrammD-Glob b). In most cases of global REFERENTIAL cohesion it means that a passage focussing on one character stops, and a new passage discussing an old or introducing a new character starts.

⁷ VocD = vocabulary-driven, Gramm-D = grammar-driven, Loc = more local, Glob = more global. (GrammD-Loc a, b) thus refers to the *a* and *b* examples of the local grammar-driven cohesion category. Page numbers refer to Bainbridge (1989).

REFERENTIAL	More local	More global
<p>Vocabulary Driven</p>	<p>a. While she was speaking, <i>a thin man wearing a duffel coat</i>, followed by a stout man in mackintosh and galoshes, came round the bend of the stairs. They would have left her high and dry if the doorman hadn't called out, 'Mr Potter, sir. A young lady to see you.'</p> <p>b. The municipal railings had been taken away for the war effort and through the gaps in the makeshift fence of galvanised iron he saw <i>a tramp</i> in an army greatcoat sitting on a green bench. <i>The tramp</i> looked up and glared maliciously back ... (p.49)</p>	<p>a. ... To her way of thinking it was yet another indication of the girl's cleverness, a further example, should one be needed, of her ferocious, if morbid imagination. <i>Uncle Vernon</i> paid off the cab right away. (p.18)</p> <p>b. Stella lounged against a cocktail cabinet whose glass frontage was engraved with the outline of a naked woman. I'm not going to be cowed, she thought. Not by nipples. <i>The stage manager</i> perched himself on the brass rail of the fire-guard and stared transfixed on his galoshes. (p. 24)</p>
<p>Grammar Driven</p>	<p>a. At first it had been Uncle Vernon's ambition, not Stella's. <i>He</i> thought <i>he</i> understood <i>her</i>. (p.13)</p> <p>b. For her part, Lily had tried to wheedle Stella into letting Uncle Vernon accompany her to the theatre. <i>She</i> implied it was no more than <i>his</i> due. (p.20)</p>	<p>a. Emotions weren't like washing. There was not call to peg them out for all the world to view. Mostly, <i>her</i> behaviour smacked of manipulation, of opportunism. <i>He'd</i> known people like <i>her</i> in the army ... (p.19)</p> <p>b. At this hour the square was empty. The flower-sellers had long since gone home, leaving the orange boxes piled up beside the urinals. Between the jagged buildings the lights of ships jumped like sparks above the river. <i>They</i> stood in silence, looking down into the darkness as though waiting for a curtain to rise.</p>

TEMPORAL *cohesion*

TEMPORAL cohesion has received relatively limited attention in cohesion and coherence studies, compared to REFERENTIAL, LOCATIONAL and CAUSAL cohesion. Often it is rather difficult to track the many TEMPORAL cues in a text, mainly because both vocabulary-driven and grammar-driven devices are often found simultaneously. The main reason for this is that many TEMPORAL grammar-driven devices are available, the most common ones being tense and aspect (GrammD-Glob a), which mark the order of events. These often go together with adverbial phrases and conjunctions. TEMPORAL vocabulary-driven cohesion is often cued by times or dates (VocD-Loc a, b; VocD-Glob a, b). It can also occur more subtly, when the events need to be reordered on the basis of background knowledge of these events. Strictly speaking, this form of TEMPORAL cohesion is vocabulary-driven, despite the fact that no clear single cues are available.

While TEMPORAL local cohesion usually links events within a stereotypical time frame, TEMPORAL global cohesion starts a new time-frame (VocD-Glob a, b). In other words, the global TEMPORAL cohesion cues for a discontinuity in the established time frame. As we have seen before, this introduction of a new time frame is often marked by a pre-posed adverbial phrase (VocD-Glob a). As a new time frame usually means a new location, TEMPORAL cohesion is often intermixed with LOCATIONAL cohesion (GrammD-Glob b).

TEMPORAL	More local	More global
Vocabulary Driven	<p>a. He wrote her a shopping list and gave her a ten-shilling note. <i>Half an hour later</i>, when he came up in the dark hall, jingling the loose coppers in his pocket, he found her huddled on the stairs. (p.14)</p> <p>b. The journey into town took less than <i>ten minutes</i>; it was <i>a quarter past three</i> by the Oyster Bar clock when Stella arrived in Houghton Street.</p>	<p>a. ... The audition was fixed for the third Monday in September. <i>Ten days before</i>, over breakfast, she told Uncle Vernon she was having second thoughts (p.14).</p> <p>b. ‘So’, Uncle Vernon said, ‘what’s new?’ But his tone was good-humoured. <i>The three o’clock aeroplane</i>, the one that climbed from Speke and circled the city on five-minute trips, had just bumped overhead (p.17).</p>
Grammar Driven	<p>a. It was such a dark day that the neon sign above the lintel of the door had been flashing on and off since breakfast; the puddles winked crimson. Later, <i>after</i> he had visited the house, Meredith said that only brothels went in for red lights. (p.17)</p> <p>b. <i>Before</i> the rehearsal began Desmond Fairchild ordered the new girl, Stella, to fetch him a packet of cigarettes from the porter’s desk. (p.53)</p>	<p>a. Then Bunny, battling his way against the flow of children, appeared in the hall and halted for a moment, the belt of his mackintosh undone, looking up at the windows of the rehearsal room. Meredith waved; he didn’t think Bunny saw him. They <i>had</i> met in the railway carriage ... (p.57)</p> <p>b. It was left to George to explain that Meredith was away in London with the set designer, choosing costumes for the opening production. <i>Until then</i>, in the hope that Meredith would stumble across her, Stella had wasted the best part of three days hunched on the stairs ... (p.35)</p>

LOCATIONAL *cohesion*

LOCATIONAL cohesion devices have many similarities with TEMPORAL cohesion devices. First of all, as with TEMPORAL cohesion, LOCATIONAL vocabulary-driven and grammar-driven devices often occur simultaneously. Adverbial phrases often go together with spatial descriptions or place names (VocD-Loc a). The interaction between vocabulary-driven and grammar-driven cohesion can also be seen in the use of prepositions (VocD-Glob a). As prepositions may be seen as grammatical or lexical-semantic, and as they go together with nouns indicating a location, the boundary between the two is not always clear. Furthermore, as in TEMPORAL cohesion, LOCATIONAL global cohesion is often marked by pre-posed adverbial phrases, usually vocabulary-driven, sometimes grammar-driven (VocD-Loc b, VocD-Glob a). Global cohesion is often marked by a spatial reorientation, which is usually accompanied by a new time frame (VocD-Glob a, b). Global LOCATIONAL cohesion cues that the spotlight on one location is put on another.

LOCATIONAL	More local	More global
<p>Vocabulary Driven</p>	<p>a. Still, she went along with the idea and for two years, on a Friday after school, she ran down the hill to <i>Hanover Street</i> and rode <i>the lift in Crane Hall, up through the showrooms</i> of polished pianofortes <i>where</i> the blind men fingered scales, until she reached <i>the top floor ...</i> (p.13)</p> <p>b. Entering the <i>railway hotel</i> he ordered a cup of coffee and sat in <i>the main lounge</i> with his back to <i>the stairs</i>. (p.50)</p>	<p>a. 'I could,' Rosie told him, 'but I won't. The orphanage has rung twice already. God forgive us, but it'll be good for business.'</p> <p><i>Directly below, where the branches of the lime trees bounced in the wind, sending the lamplight skeetering in the across the cobblestones,</i> the man in the muffler stood ... (p.11)</p> <p>b. Love, she told herself, would be her staircase to the stars and, moved as she was by the grand ring to the sentiment, tears squeezed into her eyes.</p> <p><i>At the top of the hill, on the corner by the Commercial hotel,</i> she telephoned mother, using the three pennies pinched from the saucer in Fuller's Café. (p.32)</p>
<p>Grammar Driven</p>	<p>a. Excusing herself, Stella went to the <i>ladies' room where</i> she made a show of washing her hands. (p.30)</p> <p>b. 'Sorry to go on about it, squire,' he said. 'I just find it impossible to get into character <i>here</i>.' (p.59)</p>	<p>[no instances found in novel]</p> <p>a. She was made redundant at her job in London. Things were not going well with the company and she was fed up with the work. She found another job in Manchester.</p> <p><i>There</i> she started a new life. Her colleagues welcomed her heartily...</p> <p>b. The future of the company did not look very bright. Offices in several parts of Europe were closed.</p> <p><i>Elsewhere</i> in the world losses were not as disastrous. In China for instance, the financial year looked very good</p>

CAUSAL *cohesion*

Although causality forms a very important cohesion factor – some claim the most important cohesion factor because it underlies our thinking (Van den Broek, 1994) – it is also the least manifest form of cohesion. The most common form of CAUSAL cohesion is an implicit form of vocabulary-driven cohesion (VocD-Loc a, b; VocD-Glob a). These instances can usually only be spotted if events are put in a stereotypical script or frame, in which we know from experience that one event is usually caused by the other. More explicit vocabulary-driven cohesion devices are very limited. CAUSAL grammar-driven cohesion is cued by conjunctions (GrammD-Loc a, b; GrammD-Glob a, b). CAUSAL cohesion often co-occurs with TEMPORAL cohesion (in fact, CAUSAL cohesion implies TEMPORAL cohesion), LOCATIONAL cohesion and REFERENTIAL cohesion. Global CAUSAL cohesion will accordingly show shifts in time (GrammD-Glob a, b) and place (VocD-Glob a). It is often argued that global CAUSAL cohesion forms the backbone of narratives (Van den Broek, 1994), as it outlines the narrative structure of the text.

CAUSAL	More local	More global
Vocabulary Driven	a. The very mention of his name <i>caused</i> her to tremble, and in his company she had the curious sensation that her feet and her nose had enlarged out of proportion. (p.84)	<i>[no instances found in novel]</i> a. The introduction of the Euro will therefore have an impact on the financial and economical situation throughout the world. Its <i>impact</i> for the average household in Britain cannot be fully overseen at the moment.
Grammar driven	a. The bomber released its load <i>because</i> it was having difficulty reaching the coast. (p.59) b. <i>Though</i> they both wore the uniform of a Private it was plain who was of superior rank. (p.58)	<i>[no instances found in novel]</i> a. The Gulf War may have had some impact on the Iraqi leader, but Iraq is still further developing its biological weapon industry. <i>So</i> the political situation in the Middle East is not very stable. b. And it is particularly in Scotland that the drugs problem seems to get worse. <i>Because of this</i> , the government has announced new education plans to clamp down on drug use.

ADDITIVE cohesion

Like CAUSAL cohesion, ADDITIVE cohesion has very limited vocabulary-driven cohesion devices. The available vocabulary-driven devices almost look like grammar-driven cohesion devices (VocD-Loc a, GrammD-Glob a). Its grammar-driven cohesion is – like CAUSAL cohesion – more common by means of a conjunction (GrammD-Loc a, b; GrammD-Glob a). Furthermore, ADDITIVE cohesion often occurs together with REFERENTIAL and TEMPORAL cohesion (see Givón, 1995: 92). ADDITIVE cohesion without other strands usually occurs locally, but only very occasionally it can be found globally. The reason for this is that with the introduction of a new global text unit, comprehenders need to have some orientation, which is usually provided by the other more specific strands.

ADDITIVE	More local	More global
Vocabulary Driven	a. Bunny told Stella that <i>in addition to</i> understudying Michael, he wanted her to manage Tinkerbell. (p.101)	[No instances found in novel] a. Clinton sent military troupes to the Middle East as peace keepers. <i>On top of this</i> , he announced humanitarian help for the devastated country.
Grammar Driven	a. She came home and shut herself in her bedroom and spouted speeches. She sat at the tea table <i>and</i> dropped her cup to the saucer... (p.13) b. For the life of her she couldn't fathom where funerals came into it. <i>Besides</i> , not everyone wore shoes with laces. (p.69)	[No instances found in novel] a. Recently, Labour introduced tuition fees. One could argue that this is not a revolutionary decision. Education becomes more and more expensive. <i>Besides</i> , students in many countries in Europe have always paid tuition fees.

The above examples have clarified the notions of global and local, and vocabulary-driven and grammar-driven cohesion. At least they have shown how thin the borderline is between the categories.

1.4 CONCLUSION AND RESEARCH QUESTIONS

We have defined cohesion as continuity and consistency in the text and coherence as continuity and consistency in the mind. While coherence supports cohesion in text production, cohesion supports coherence in text production and comprehension. However, this thesis will only be concerned with text comprehension. We made a distinction between grammar-driven and vocabulary-driven cohesion devices. Grammar-driven cohesion can occur together with vocabulary-driven cohesion, and we have argued that both interact in the emergence of coherence. For both vocabulary-driven and grammar-driven cohesion and coherence five strands can be defined: REFERENTIAL, TEMPORAL, LOCATIONAL, CAUSAL and ADDITIVE. These strands operate both at a local and a global level. Local cohesion links adjacent text units, while global

cohesion links larger stretches of text units. There is psycholinguistic evidence that local and global cohesion cue local and global coherence. In fact, local cohesion cues for the continuity of a strand, whereas global cohesion cues for discontinuity. This was shown in a series of quotes from a novel, in which most of the global cohesion relations marked a paragraph boundary. With the introduction of local and global, grammar-driven and vocabulary-driven REFERENTIAL, TEMPORAL, LOCATIONAL, CAUSAL and ADDITIVE cohesion and coherence, we now have the key notions that will be used in this research.

In the beginning of this introduction, we stated that this thesis asks how textual cohesion supports representational coherence. With the above classifications, we can divide this main question into two parts:

- a. What is the effect of vocabulary-driven REFERENTIAL, TEMPORAL, LOCATIONAL, CAUSAL and ADDITIVE cohesion on coherence?
- b. What is the effect of grammar-driven REFERENTIAL, TEMPORAL, LOCATIONAL, CAUSAL and ADDITIVE cohesion on coherence?

We also stated that in order to answer the main question, we have formulated two research questions:

To what extent is each of the types of cohesion independent of the others in its effects on the comprehender?

Does coherence develop (on-line) throughout the comprehension process and does it come about (off-line) in a final wrapping-up stage of the comprehension process or both?

The answer to these questions consists of five steps.

1. If we are to understand the comprehension processes resulting in a coherent representation, we need to have a model of the processes and mechanisms of comprehension. Several models of text comprehension have been developed throughout the years. Well-known are Kintsch's (1998) Construction Integration Model, Van den Broek, Young, Tzeng & Linderholm's (1999) Landscape Model, Zwaan & Radvansky's (1998) Event Indexing Model and Gernsbacher's (1990) Structure Building Framework. A comparison of these models can give us a

blueprint of comprehension processes. Such a blueprint can serve as a working hypothesis throughout the research.

2. Most theories of text comprehension assume the aim of text comprehension is the construction of coherent mental structures. To describe these structures we need a representational system. Most commonly, propositions are used to describe what such a representational system looks like and what it represents. However, propositions fail to accommodate the rich structure that appears to be associated with textual understanding. Therefore, we need a representational system that uses more expressive logic. Situations (Parsons, 1990) offer such a tool. They can point out the interdependency of cohesion strands, and can show how specific a cohesion relation is.
3. Several psycholinguistic studies have shown that REFERENTIAL, TEMPORAL, LOCATIONAL, CAUSAL and ADDITIVE cohesion facilitate the comprehension process. Consistency in each of these strands lowers processing times and improves recall in comparison with cases of no consistencies or discontinuities. An investigation of the interdependency of cohesion relations has not received much attention. Computational models are ideal for such an investigation as they can investigate the effects of cohesion relations by considering a large set of variables.
4. The question of interdependency of cohesion and coherence relations is common in theories of grammar-driven cohesion and coherence. Several taxonomies of grammar-driven relations have been proposed (Halliday & Hasan, 1976; Martin, 1992; Mann & Thompson, 1987; Hobbs, 1985; Knott, 1996; Sanders, Spooren & Noordman, 1992). Sanders et al. (1992) have argued that it is not grammar-driven relations that are not processed, but sets of properties of these relations. The question then is what such a taxonomy looks like.
5. The psycholinguistic literature also shows us where integration of textual information takes place in the comprehension process, when comprehenders for instance encounter a grammar-driven cohesion relation. But the answers differ. Some claim that integration takes place throughout the reading process (Traxler, Bybee & Pickering, 1997a), whereas others (Millis & Just, 1994) claim that integration takes place at the very end of the reading process, i.e. at the end of a clause. This is the second research question we will investigate: does coherence develop (on-line)

throughout the comprehension process and does it come about (off-line) in a final wrapping-up stage of the comprehension process or both?

In sum, the following questions can be formulated in order to answer the two research questions:

1. How does text comprehension come about? What levels and processes can be distinguished?
2. What representational system is best to be used in describing the rich structure textual understanding is associated with?
3. To what extent does interdependency of cohesion strands affect text comprehension?
4. What basic categories of grammar-driven cohesion/coherence relations should be distinguished?
5. Does coherence develop (on-line) throughout the comprehension process, does it come about (off-line) in a final wrapping-up stage of the comprehension process or both?

An answer to the first question is given in Chapter 2 in which we discuss and compare several models of text comprehension in order to define some mechanisms and processes in text comprehension. The second question will be answered in Chapter 3 where we discuss mental representation, point out the problems with propositions as a representational language and propose a representational system of situations. The third question is particularly answered in Chapter 4 where we explore effects of vocabulary-driven cohesion on coherence in a connectionist model is used. The effects of grammar-driven cohesion are explored in two stages. First, in Chapter 5, we propose a parameterisation of grammar-driven cohesion and coherence relations to answer the fourth question. Secondly, in Chapter 6 we answer the fifth research question in a series of experiments.

CHAPTER 2

THEORIES OF TEXT COMPREHENSION

2.1 INTRODUCTION

In the first chapter we gave an overview of cohesion and coherence. We distinguished between vocabulary-driven and grammar-driven cohesion and coherence relations both at a global and a local level, defined REFERENTIAL, LOCATIONAL, CAUSAL, TEMPORAL and ADDITIVE strands and argued that cohesion affects coherence. We ended the first chapter stating that main question of this thesis – how textual cohesion supports representational coherence – needs to be answered in several steps. One of these steps concerns the answer to the questions how text comprehension comes about and what levels and processes can be distinguished. The aim of this chapter is to answer these questions.

Understanding how we comprehend cohesion and coherence relations requires an understanding of cognitive processes involved in text comprehension. This chapter provides an overview of leading theories of text comprehension, in order to cast light on the mental processes involved in constructing cognitive representations of the situations expressed in the text, and hence in how we process cohesion and coherence relations. Many cognitive processes are involved in text comprehension. We access words from the mental lexicon, activate concepts, search for information, compare structures already active, and build structures by adding, deleting and rearranging information (Graesser, Gernsbacher & Goldman, 1997: 293). Text comprehension can therefore be defined as “the dynamic process of constructing coherent representations and inferences at multiple levels of text and context, within the bottle-neck of a limited-capacity working memory” (Graesser & Britton, 1996: 350). In this chapter, we will unravel Graesser & Britton’s (1996) definition by looking at its various aspects from the perspective of four leading theories in text comprehension, thus clarifying several unanswered questions in the four theories. We then compare these models with two theories of memory, and conclude this chapter by proposing a working model of text

comprehension that merges the theories discussed. It sets the research in the context of the field of text comprehension and introduces some key notions that will be shown to be important for later chapters.

2.2 FOUR MODELS OF TEXT COMPREHENSION

The four models of text comprehension we discuss here are Kintsch's (1998) Construction Integration Model, Van den Broek, Young, Tzeng & Linderholm's (1999) Landscape Model, Zwaan & Radvansky's (1998) Event Indexing Model and Gernsbacher's (1990) Structure Building Framework. The discussion aims at outlining the descriptive rather than the explanatory character of these models.

2.2.1 Construction Integration Model (CI Model)

The first model to be discussed is Kintsch's Construction Integration Model (Kintsch, 1988, 1992, 1994, 1998). The model is an adapted extension (Kintsch, 1994: 729) of two underlying models which have largely influenced two decades of studies in text comprehension, the Kintsch and Van Dijk (1978) model and the Van Dijk & Kintsch (1983) model. To appreciate the CI Model, and in fact the other three models to be discussed below, a brief overview of the Kintsch & Van Dijk model and Van Dijk & Kintsch model is worthwhile.

According to Kintsch & Van Dijk's processing model, the aim of text comprehension is the formation of structures at two main levels, a microstructural and a macrostructural level. The microstructure is the local structure of the text, the sentence- and sequence structure supplemented with information from background knowledge. The macrostructure is the global structure of the text, a hierarchically ordered net of propositions. The distinction between micro- and macrostructure is identical to the distinction between local and global cohesion/coherence we made in Chapter 1. In the comprehension process meaningful text units are transformed into propositions, the formal structure of the events expressed in the clauses of the text. These are ordered in a coherent text base, the microstructure of the text. If a proposition shares one or more arguments with the proposition in the text base, it is included in the textbase. In

addition, inferential processes are eventually initiated to organise the textbase. As checking whether propositions share arguments and making inferences take a lot from a limited memory, we cannot check the complete text base, but need to process chunks of texts in cyclical packages of n number of propositions. When a chunk of n propositions is processed, it is matched with the arguments of a p number of propositions carried over from the short-term memory buffer. In this way, a network of related propositions is constructed. From the microstructure an edited version is derived, the macrostructure. This is the global structure of the text. Three macrorules are active in the formation of the macrostructure: deletion (incoherent subsequent propositions are deleted); generalisation (a sequence of propositions is replaced by a superset); and construction (a sequence of propositions is replaced by a single proposition).

The model by Kintsch & Van Dijk (1978) is modified in Van Dijk & Kintsch (1983). In addition to the micro- and macrostructure distinction, Van Dijk & Kintsch (1983) distinguish between textbase and situation model, which shifts the emphasis from the text to the interaction of text and comprehension. The textbase is the structure that contains a series of propositions directly derived from the text. However, in the comprehension process we supplement textual information with personal background knowledge and experiences. The complete structure of propositions derived from the text and propositions from personal memory forms the situation model. The distinction between the textbase and the situation model is orthogonal to the micro- and macrostructure distinction, with both the text base and the situation model having a micro- and a macrostructure (Kintsch, 1998: 166). In sum, the textbase - situation model distinction is one between the stage in the comprehension process, the microstructure - macrostructure one between a local and a global level of propositional structures.

Kintsch's (1998) CI Model is derived from the previous two models, but the model provides more information on how the macrostructure of the text formed and how information stored in the long-term memory (LTM) interacts with textual information from the macrostructure. It distinguishes two stages in comprehension, a construction and an integration stage. In the construction stage a mental representation of propositions (a text base) is created by weak production rules. Kintsch (1998: 96) only defines abstract rules for interconnecting propositions in a network: one proposition is directly linked to another if the propositions share arguments, it is

indirectly linked if the propositions are related by inference, or one proposition may be subordinate to another. In the comprehension process, propositions are first derived from the surface structure of the text. These propositions are entered in a short-term buffer and form a propositional net. Once associatively related propositions are retrieved from LTM, the two sets of propositions form the elaborated propositional net. This network contains many irrelevant and redundant propositions. Because of these weak rules, the representation contains redundant and disorganised information. It then undergoes a process of integration in which the redundant information is filtered out, resulting in a well-structured mental representation. Just like the operations after the construction of the textbase in the Kintsch & Van Dijk model, the integration stage – the actual filtering of information already established – is the centre of attention in the CI Model. An activation process spreads around the network of propositions, boosting strong links between propositions and dampening weak links in order to get a well-structured mental representation. The representation resulting from the Integration process is then stored in the LTM. The overall result of these processes is three levels of representation: a linguistic representation (a surface representation of the text itself), a propositional representation (propositions formed on the basis of linguistic information in the text) and a situational representation (an LTM mental representation of the text and background knowledge, consisting of a network of interrelated propositions of various strengths).

The CI Model assumes that working memory – the central processor – has a limited capacity. In fact, that is the reason why the CI Model assumes that text comprehension develops in cycles. Due to the limited capacity of working memory, at different points in time only smaller chunks of information can be processed and integrated into a developing structure that is stored in LTM. But a contradiction arises here. While on the one hand working memory (WM) is limited (Miller's (1956) magical number seven), comprehenders are able to process text while retrieving lots of information from LTM. How do comprehenders access LTM so quickly during reading and how do they store the incoming information from our perception and the information retrieved from LTM in a buffer that only has a limited capacity? Ericsson and Kintsch (1995) introduce a Long-Term Working Memory (LT-WM), to account for the fact that LTM cannot meet the criteria of speed and reliability in speed and storage,

while WM that has the speed and storage cannot hold so much information. In their view it is possible to expand the fixed capacity of the general short-term working memory (ST-WM) in expert activities like text comprehension by using parts of the long-term memory as working memory. Memory nodes in the capacity limited STM serve as retrieval cues for parts of the LTM (e.g. Kintsch, 1998: 219). The connections between these retrieval cues in LT-WM and LTM are called retrieval structures. During reading a memory representation of the text is constructed and stored in LTM. Via the retrieval structures the relevant parts of this representation remain accessible to the cues in STM. Evidence for a LT-WM comes, for instance, from studies showing that subjects' reading can be disturbed for over 30 seconds without any impairment of comprehension: Glanzer, Fisher and Dorfman (1984) asked subjects to read a text. After every sentence the subject was disturbed by various activities for a variable length of time. No effects on comprehension were found. According to Kintsch (1998) this effect cannot be explained by the traditional theories of WM, as the limited capacity would delete all temporarily stored information when new information enters working memory. Apparently the comprehender has a continuous use of retrieval structures explaining the direct role of LTM in text comprehension by means of a LT-WM.

The stages in the CI Model and the relation to the various memory stores are illustrated in Figure 1.

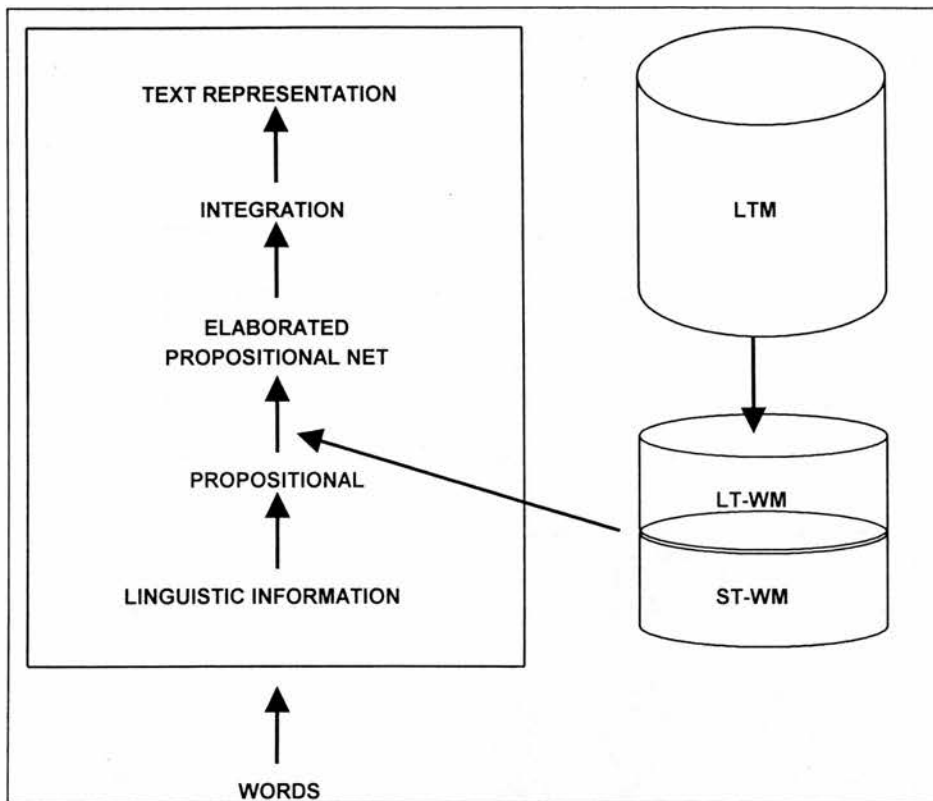


Figure 1 Stages in the Construction Integration Model. After Kintsch (1992).

The processes in the CI Model can be illustrated with the following example.

- (1)
 - (a) My neighbour was a 25 year-old student of music
 - (b) She played saxophone
 - (c) I didn't like it
 - (d) although she practised every day

Assuming that the words of this text are converted into some linguistic representation by a process of parsing, we can suppose that the linguistic representation can be used by the comprehender to form an abstract conglomerate of meaningful units. According to Kintsch (1974, 1988, 1998) and Van Dijk & Kintsch (1983) the product of this process is a propositional net of the following kind:

- (a) P1 BE (NEIGHBOUR, 25-YEAR-OLD-STUDENT-OF-MUSIC)
- (b) P2 PLAY (NEIGHBOUR, SAXOPHONE)
- (c) P3 LIKE-NOT (I, P2)
- (d) P4 ALTHOUGH (P3, P5)
- (e) P5 PRACTICE (NEIGHBOUR, EVERY-DAY)

This propositional net is supplemented with information from LTM. In this example, previous experiences with the comprehender's neighbours (e.g. information about playing an instrument, about the protagonist, etc.) are added to the text based propositional net, resulting in an elaborated propositional net. A lot of this information retrieved from the text and LTM is not necessary to understand the text. For instance, the fact that the neighbour is 25 years of age is irrelevant information, as is, for instance, the comprehender's memory of his neighbour across the street. This (for the coherent representation irrelevant) information is filtered out in the integration process, resulting in a text representation that is stored in LTM. When the text refers again to the saxophone-playing neighbour, parts of the text representation stored in LTM are retrieved in LT-WM by retrieval structures.

Recently, Kintsch (1998) has found a possible alternative to a propositional representation in the form of Latent Semantic Analysis (LSA). LSA records which words occur in the same textual context. By looking at co-occurrences of a word it constructs a vector of numbers. Each number indicates the strength of a concept to another concept. In other words, the more a word correlates with another word, the more these words appear in the same contexts. From an LSA-perspective a proposition is a vector of numbers, each number being the correlation of the proposition being related to another proposition. The advantage of LSA over propositions is that no subjective, arbitrary hand coding is necessary. In LSA concepts and propositions are automatically generated from a high-dimensional space. However, despite its enormous advantages in text generation and semantic analyses, a representational system is still desirable to be able to describe cohesion and coherence relations in text.

Evaluation

The CI Model as well as the Kintsch & Van Dijk (1978) model have the advantage over the original version in Kintsch & Van Dijk (1978) that both propositional representations and situational representations are available. The lack of the situational representation is a serious drawback in the original version of the model. On the other hand, the (1978) model is, like the (1998) CI Model, more explicit. The CI Model uses both a propositional representation next to a situational representation and spells out in detail how textual information and reader's knowledge are combined in a cognitive representation. Particularly the integration stage in which irrelevant information is filtered out is very effective. It allows for a rough-grained preliminary analysis and is only at a later stage concerned with a precise filtering process.

The CI Model has been very influential in psycholinguistics. There are two main reasons for this. First of all, the CI Model is based on the influential Kintsch & Van Dijk (1978) and Van Dijk & Kintsch (1983) studies. These introduced concepts like 'propositions' and 'situational models' in psycholinguistics. Secondly, the CI Model has been computationally implemented and has hence produced new concepts and hypotheses. There nevertheless are some problematic issues in the CI Model that are important for further discussion:

1. *Medium of representation.* The building blocks of the CI Model are propositions. As we will see in the next chapter, propositions have proven to be extremely useful in explaining discourse processes. The question however is whether propositions are 'psychologically real', as Kintsch (1998: 69) claims, and whether they capture the essential information of a textual or a mental representation.
2. *Role of memory.* An important aspect of the CI Model is the limited capacity of STM, which has led to the introduction of ST-WM and LT-WM, the latter a memory store that mediates between STM and LTM. Furthermore, the limited memory capacity has led to the idea that information is processed in cycles. The result of the use of cycles is that information not selected to be stored in LTM will be filtered out and will thus not be included in a subsequent cycle. This has important consequences for a model of text comprehension and even more so for computational models, as we will see in Chapter 4.

3. *Types of cohesion and coherence strands.* Kintsch states “One often hears the complaint that with that many degrees of freedom, any structure could predict any data set. This is an ill-founded complaint, however. It is the structure of the model that yields the good predictions, not the free parameters” (Kintsch, 1998: 266). Although this may be true, the question remains which processes are involved in the text comprehension process. For a theory of text comprehension it would be essential to know which cohesion and coherence links are made and which cognitive processes are involved in making these links.
4. *Definition of processes.* The CI Model distinguishes between two stages: construction and integration. The constructing processes establish the links between propositions and the integration processes integrate these links into a coherent representation. Whether there are any other processes active during constructing and integrating and whether the two main processes are interactive remains open.

2.2.2 Landscape Model

The Landscape Model (Van den Broek, Risdien, Fletcher & Thurlow, 1996; Van den Broek, Young, Tzeng & Linderholm, 1999) tends to integrate the two ‘static’ stages of the CI Model, construction and integration, into one dynamic model.

Van den Broek et al. (1999) distinguish three generations of cognitive research in reading. The aim of the first generation research was to determine what comprehenders understand (e.g. Kintsch & Van Dijk, 1978). The focus of the second generation of research was how the comprehender understands text (e.g. Kintsch, 1988). In a third generation of research both on-line and off-line aspects of text comprehension are combined. The focus in this generation lies on comprehension processes and memory representation and the relation between the two. Kintsch & Van Dijk (1978) are mainly concerned about what readers remember, Kintsch (1988) tries to explain how they remember it, while Kintsch (1998) tries to integrate the two areas in what Van den Broek et al. (1999) call the third generation of text comprehension.

The Landscape Model is also a third generation approach to text comprehension. The model is intended to capture the dynamic processes of online comprehension, as well as the way these processes construct the mental representation

of the text. Reading is modelled as a dynamic landscape of fluctuating activation of information expressed in the text. According to the Landscape Model, readers maintain coherence as they proceed through the text within the bottleneck of attentional resources. Two types of cohesion and coherence play a role in the activation: anaphoric clarity and causal explanation. If the same concepts (events, persons, and objects) are shared between sentences or if sentences are causally related – what we have called REFERENTIAL and CAUSAL cohesion – they are activated. As in the CI Model activation takes place in reading cycles. Four sources of activation can be distinguished: the text currently being processed, the text from the previous reading cycle, the text from even earlier reading cycles and background knowledge. With each cycle new concepts and relations are activated, whereas others lose their activation due to working memory limitations.

Like the CI Model, the Landscape Model primarily is a computational theory. Simulations with the model have provided evidence for the importance of anaphoric clarity and causal explanation and suggest patterns of recall (for the computational aspects of the Landscape Model, see Chapter 4). To illustrate the processes in the Landscape Model, we return to the text we used earlier.

(2)

- (a) My neighbour was a 25 year-old student of music
- (b) She played saxophone
- (c) I didn't like it
- (d) although she practised every day

The model starts with a representation of the text in constituent concepts, the lexical items of a statement, which are more or less equivalent to propositions:

- (a) neighbour / was / 25-years-old-student-in-music
- (b) she (neighbour) / played / saxophone
- (c) I / like-not / it (playing saxophone)
- (d) although / she (neighbour) / practised / every-day

When reading the first clause, the comprehender brings the constituent concepts of (a) in the reading cycle, as well as background knowledge (e.g. previous experiences with neighbours, students, music, etc.). In the second reading cycle, redundant information is filtered. Clause (b) is now imported with links to the anaphorically related constituent concept to *neighbour* from the previous clause and the causal explanation link between the two clauses (it is very likely she plays saxophone because she was a student of music). To this structure background knowledge is attached. In the following reading cycle, the information carried over from clauses (a) and (b) are processed (the anaphoric link of saxophone playing between (b) and (c)), information from clause (c) and background knowledge. In processing clause (d), the anaphoric links between (a), (b) and (d) are processed, as well as the anaphoric link between saxophone playing in (b) and (c). There is also a causal explanation of (c) and (d). All these links construct a memory representation of the text with the nodes as constituent concepts and the anaphoric and causal relations between the concepts as their connections.

Evaluation

The Landscape Model is very similar to the CI Model. Both assume that text comprehension takes place in cycles and that information loses activation due to limited working memory resources. Information from previous cycles is used in current cycles and only relevant information is carried over to subsequent cycles. The largest similarity between the two models is their primarily computational nature. Although both models are based on behavioural evidence, they are clearly developed to simulate text comprehension processes computationally. The consequence is that the cohesion and coherence relations defined are those that can be implemented. It is very likely that more coherence relations can be defined, but cannot be implemented in the computer model. In other words, there is a trade-off between what is computationally feasible and what may be assumed theoretically. In the CI Model free parameters are used, in the Landscape Model two types of cohesion/coherence relations are implemented. Using more cohesion/coherence relations would enhance theoretical explanatory power, though it reduces the computational prospects. The advantage of the Landscape Model over the CI Model is the definition of cohesion and coherence strands. The 'free parameters' of the Landscape Model are reduced to the weights of the links, with the

links themselves being defined by two coherence strands: anaphoric clarity and causal explanation.

Like the CI Model some of the issues in the Landscape Model remain open for discussion:

1. *Medium of representation.* Instead of propositions, Van den Broek et al. use “constituent concepts” as textual input (Van den Broek, 1996: 170). Whereas the concept of proposition refers to some theory of predicates and arguments, it remains unclear what constituent concepts are, what psychological background they have and whether they capture the textual information.
2. *Role of memory.* Like the CI Model, the Landscape Model assumes that reading proceeds in cycles due to limited STM capacity. Information filtered out in early cycles can thus not be included in later cycles. As with the CI Model, the question remains whether there is sufficient evidence for the claim that comprehenders process information in cycles.
3. *Types of cohesion and coherence strands.* In the Landscape Model, two cohesion and coherence strands are defined: anaphoric clarity and causal explanation. Although Van den Broek et al. provide evidence for these processes, it remains unclear whether, and if so which, other types of cohesion and coherence can be distinguished.
4. *Definition of processes.* The Landscape Model explains the different models readers construct in the reading process. However, contrary to the CI Model, the Landscape Model does not spell out the processes involved in text comprehension, except for a reactivation process for each of the constructed models. On the basis of reference and causality, links are made, but where these processes take place in the processing model is unclear.

2.2.3 Event Indexing Model (EI Model)

The Landscape Model’s multidimensional view of coherence (anaphoric and causal) as used in the Landscape Model is expanded in the Event Indexing Model (Zwaan, Langston & Graesser, 1995; Zwaan & Radvansky, 1998; Zwaan, Radvansky & Whitten, in press). According to the EI Model, the reader builds several situation models during

the comprehension process. The EI Model definition of a situation model is similar to the CI Model version: a mental representation of a described situation in a real or imaginary world. However, while the situational representation in the CI Model is based on a propositional representation (the text base), the EI Model does not assume a propositional level.

Contrary to models that describe one aspect of a situation model, the EI Model integrates different aspects of cohesion and coherence in order to describe and explain a multidimensional situation model. The EI Model makes use of recent proposals in memory and text comprehension and describes both on-line comprehension and the resulting representation. It assumes that the reader decomposes each incoming event in the text, denoted by the verb in a clause, into at least five dimensions or indexes: entity, time, space, causality and intentionality. According to the EI Model, consistency in who, when, where and why facilitates the construction of a model.

During the comprehension process the reader constructs three models, a current model, an integrated model and a complete model. The reader constructs the current model at Time t_i while reading a clause or sentence. The current models created at Time t_1 to t_{n-1} are incorporated into a global model, the integrated model. Once all the textual input has been processed, a complete model is created. The complete model is stored in the LTM, but may be adjusted when the reader reflects on the text. Throughout the text comprehension process the reader retrieves information from LTM. To allow for this, the EI Model incorporates the idea of LT-WM, as introduced in Ericsson & Kintsch (1995) and discussed before.

Four classes of processes operate on these three models: construction, updating, retrieval and foregrounding. The construction process builds the current model of the situation expressed in the clause currently read. In the updating process the current model is incorporated into the integrated model of the situations expressed in previous clauses. The retrieval process brings back parts of the integrated or complete model into working memory (ST-WM, LT-WM). The process of foregrounding maintains the retrieval cues between ST-WM buffers and parts of the integrated model in LT-WM (Zwaan & Radvansky, 1998: 180). An overview of the EI Model is presented in Figure 2.

is updated by clause (d) and by the indexes of causality, reference and time, which are shared with the previous clauses. The total integrated model will now be stored in LTM as a complete model.

Evaluation

The EI Model has several advantages over the CI Model and the Landscape Model. It defines building blocks of the mental representation more clearly than the previous two models. Instead of propositions, events expressed by the clauses of the text are used. Furthermore, the EI Model describes the sources of coherence in text comprehension along different dimensions. Text comprehension and memory research has investigated these dimensions, without controlling for the others. The EI Model moves away from this research by looking at a multidimensional view of text comprehension in which all five dimensions (time, space, causality, intentionality, and protagonist) play a role. The issues pointed out in the previous two models are also important for the EI Model:

1. *Medium of representation.* Events form the building blocks for the situation models in the EI Model, which are denoted by verbs. It is not clear what the difference is between propositions or constituent concepts as used in the CI Model and the Landscape Model and events in the EI Model. It is likely that 'events' are better concepts as a format to capture a mental representation, because they are more flexible. However, exactly how events are defined in the EI Model is not clear.
2. *Role of memory.* Like the CI Model and the Landscape Model the EI Model assumes text comprehension is completed in cycles. As pointed out earlier, it remains questionable whether this indeed is the case.
3. *Types of cohesion and coherence strands.* The EI Model claims that previous studies have not taken into consideration the multidimensionality of situation models by controlling for other 'indexes' than the one relation under investigation (e.g. Gernsbacher & Hargreaves (1988): REFERENTIAL; Anderson, Garrod & Sanford (1983): TEMPORAL; Black, Turner & Bower (1974): LOCATIONAL; Deaton & Gernsbacher (in press): CAUSAL). However, the model uses exactly these studies to obtain evidence for the different dimensions (Zwaan & Radvansky, 1998).
4. *Processes defined.* The CI Model defines four processes: constructing, updating, foregrounding and retrieving. Constructing and updating refer to the development

of a current or integrated model. The processes of foregrounding and retrieval on the other hand refer to the activation of memory: foregrounding maintains retrieval cues in LT-WM, retrieving refers to bringing back the integrated or complete model back into ST-WM or LT-WM. The relation between these processes is not entirely clear. It seems that constructing and updating, and foregrounding and retrieving are consecutive processes. Whether these processes could occur in parallel is unclear.

2.2.4 Structure Building Framework

Like the other models, Gernsbacher's (1990, 1997) Structure Building Framework assumes that the aim of comprehension is the construction of a coherent representation of the information. However, it does not describe the stages in achieving this aim, but focuses on the different processes involved once the meaning has been extracted from the information.

The Structure Building Framework states that language comprehension at least involves the processes of Laying a Foundation, Mapping and Shifting. Comprehenders begin the comprehension process by laying a foundation for the development of the mental representation. Once the foundation is laid, information is mapped onto this structure when the incoming information is coherent with the previous information (process of Mapping). If the incoming information is less coherent, the comprehender initiates to a new substructure (process of Shifting). Gernsbacher distinguishes four sources of coherence: *referential* coherence, in which there is consistency in the who and what of the incoming information and the previous information; *temporal* coherence and *locational* coherence, in which there is consistency in when and where the events occur, and *causal* coherence, in which there is consistency in why the events occur.

The building blocks of the Structure Building Framework are 'memory cells'. Incoming stimuli activate the cells and this initial activation forms the basis of the mental structure. When the comprehender maps information onto the developing structure, (partly) overlapping memory cells are activated. Instead, when the comprehender shifts to a new substructure new memory cells are activated. Once memory cells are activated the comprehender can modulate activation by Suppression and Enhancement. Gernsbacher (1990: 238) argues that the initial activation uses

electrical transmission of neural information, whereas the process of Enhancement resembles chemical transmission of neurotransmitters.

Evidence for the Structure Building Framework comes from a large number of experiments (for an overview, see Gernsbacher, 1990, 1997). For instance, an effect resulting from Laying a Foundation is the Advantage of First Mention. After reading a sentence containing two characters, it is easier to remember the character mentioned first than the character mentioned second (Gernsbacher, 1989). Evidence for the processes of Mapping and Shifting comes from a series of experiments showing that Mapping takes less processing time than Shifting. For instance, the reading times for sentences with the definite article *the* were faster than those for sentences with an indefinite article (*a, an, some*), demonstrating that the article *the* maps information onto the same mental structure, whereas the indefinite article cues for a shifting process (Gernsbacher & Robertson, in press). The Structure Building Framework states that once information is activated, information is either suppressed or enhanced. Gernsbacher (1989) demonstrates this by a series of experiments with anaphoric reference in which subjects read sentences that introduced two characters in the first clause. The subsequent clause referred to one of the two characters. Activation of the characters was measured by a verification task, showing that explicit anaphors enhance the antecedent and suppresses the activation of the other character.

Again, we illustrate the model by the example used before.

(4)

- (a) My neighbour was a 25 year-old student of music
- (b) She played saxophone
- (c) I didn't like it
- (d) although she practised every day

When comprehenders read clause (a), they lay a foundation, a to-be-developed structure containing (at least) *a neighbour* and an *I*. The second clause (b) either maps information onto the developing structure or initiates another substructure. In this case, the anaphor *she* refers to *my neighbour* and the clause is mapped onto the same mental representation. If there were more than one female character in (a), activation of one of the antecedents

would be enhanced, whereas activation of the other would be suppressed. Clause (c) maps onto the developing structure, as *it* refers to a concept introduced in (b). Clause (d) is less coherent (because of the negative causal conjunction *although*) as the expected causal relation ceases to extend and introduces a new substructure in a Shifting process.

Evaluation

The Structure Building Framework differs from the previous three models in one important way. Rather than describing the various stages in the construction of mental structures that culminate from cognitive processes, the Structure Building Framework describes the actual processes. Evidence for the model comes from a wealth of studies.

- The strength of the model is clearly its generality: it assumes that language processing draws on simple general cognitive processes. The disadvantage of this is that many questions remain unanswered:

1. *Medium of representation.* In what medium are mental structures and substructures represented (Gernsbacher, 1990: 227, Haberlandt, 1991: 86)? This question has been left unanswered in the Structure Building Framework. Although Gernsbacher shows that both linguistic and non-linguistic input is processed similarly, the question whether the representation is linguistic, propositional or situational has been left more or less unanswered: mental structures whose building blocks are memory cells.
2. *Role of memory.* Where does the comprehender's background knowledge come in? Building blocks of the Structure Building Framework are memory cells. The role of memory in text comprehension remains unclear in the model. Gernsbacher (1990: 73, 238) abandons the idea that the working memory has a limited storage capacity and that information is processed in cycles. Although the Structure Building Framework is clear about (the rejection of) the memory-limitations hypothesis, the role of LTM, and thereby the role of the comprehender's background knowledge, remains unexplained.
3. *Types of cohesion and coherence strands.* Like the EI Model, the Structure Building Framework assumes four sources of coherence, all facilitating the process of mapping: *referential, temporal, location* and *causal* coherence, in the same definitions as we use them. What the relation is between these sources of coherence remains unclear.

4. *Definition of processes.* Is the process of laying a foundation a distinct independent process or is it related to, or even dependent on, the other processes, like Mapping and Shifting? Are the processes of Mapping and Shifting distinct independent processes or are they closely related, or even dependent on one another (Haberlandt, 1991: 85)? Gernsbacher states that laying a foundation can be part of the Shifting process in which new substructures are initiated (Gernsbacher, 1990: 63). The process of laying a foundation however is described as a separate process (ibid.: 222). Similarly, it is unclear how Mapping and Shifting are related. For instance, it is likely that Shifting occurs only when Mapping fails. Shifting should then be considered as a sub-process. Suppression and Enhancement occur when memory cells are activated. It is not entirely clear whether this means that Enhancement occurs in Mapping and Suppression in Shifting only, or whether the two processes operate in laying a foundation, Mapping and Shifting. It is not clear what the relation between these processes and mechanisms is. Two possible relationships can be proposed (see also Haberlandt, 1991: 85):
- a. Mapping is based on Enhancement, Shifting on Suppression. When information coheres with previous information, the information is enhanced. When this is not the case, activation of memory cells is shifted to new substructures, resulting in a Suppression of the previous information.
 - b. Suppression and Enhancement both play a role both in the Mapping process and in the Shifting process. This would mean that information can be mapped or shifted to a certain extent. Information that can easily be mapped/shifted is enhanced, other information is suppressed.

It could also be argued that Suppression and Enhancement are not two processes, as Gernsbacher (1990) claims, but one process either enhancing more/suppressing less or enhances less/suppresses more. This means that Suppression and Enhancement are not binary processes, but form one process that enhances /suppresses to a certain degree.

2.3 A COMPARISON

So far, we discussed the CI Model, the Landscape Model, the EI Model and the Structure Building Framework. But there are many other models that could have been

discussed. For instance, after having introduced Grice's Cooperative Principle in Chapter 1, it could be argued that we have excluded an important theory of text comprehension, Relevance Theory (Sperber & Wilson, 1986). This theory pretends to be a unified theory of communication and cognition, and may therefore be expected ideal for the aim of this chapter. It is based on Grice's Co-operative Principle, but it does not assume that cooperation is essential for communication. It argues that the four conversational maxims can be reduced to one single principle, the principle of relevance. Contrary to Grice's maxim of relevance, Relevance Theory claims that Relevance is not a principle that speakers obey, but that it is a fundamental to communication because it is fundamental to cognition. The theory is based on the idea that comprehenders can interpret an utterance in many different ways. The interpretation the comprehender chooses is the most relevant one. There are several serious problems with Relevance Theory, which form the reason we will not further discuss the theory in this research.

- a. It has generally not been accepted in psycholinguistics;
- b. It is particularly concerned with discourse rather than text;
- c. It believes that relevance determines the success of a coherent mental representation and does not include a central role for cohesion cues.

On the other hand, the four models we selected resemble each other by dealing less with discourse than with text, they are all influential in today's psycholinguistics and assign an important role in the comprehension process to cohesion. Despite these similarities, the CI Model, the Landscape Model, the EI Model and the Structure Building Framework differ considerably from each other. In Table 1 a comparison is given of the four models. The overview is based on the information reported in the studies we used in the discussion of the models. This means that issues that have not been reported have not been included. Hence, the Table 1 does not speculate on whether these unreported issues could be included.

	CI Model	Landscape Model	EI Model	Structure Framework	Building
Cognitive / Linguistic evidence	mainly linguistic	Linguistic	linguistic	cognitive (incl. linguistic)	
Representation	propositions	Constituent concepts	events	mental structures	
Levels of representation	3 surface structure, propositional level, situation model	2? encountering information, landscape of activations	3 current model, integrated model, completed model	?	
Processes defined	2 construction, integration	1? reactivation	3 foregrounding, updating, retrieving	5 laying a foundation, mapping, shifting, suppressing, enhancing	
Parallel processes defined	no	no	no	yes mapping and shifting, suppression and enhancement	
Multiple memory stores	yes LTM, ST-WM, LT-WM	yes STM, LTM	yes LTM, ST-WM, LT-WM	no?	
Cycles	yes	yes	yes	no	
Computationally implemented	yes	yes	no	no	
Types of cohesion/coherence strands	unlimited? (directly, subordinated)	2 anaphoric clarity, explanation	5 referential, causal, temporal, spatial, intentional	4 referential, causal, temporal, spatial	

Table 1 Overview of the four models of text comprehension



The differences between the models outlined in Table 1 bring up several questions that require an answer and which are related to the research questions presented in Chapter 1.

Medium of representation

Each of the four models seems to use a different concept for representing the building blocks of the mental representation. The CI Model uses propositions, the Landscape Model uses constituent concepts, the EI Model events. The Structure Building Framework avoids the question of the medium of the representation and states that the building blocks of its mental structures are memory cells. However, for the purpose of this thesis the question whether these proposals for building blocks of comprehension are valid is less important than the question about the best working hypothesis for a formal textual and mental representation. This question will extensively be answered in the following chapter. Related to the question of the medium of representation is that of the levels of representation. The CI Model defines three levels of representation: a surface, propositional and situational level. The latter two levels, on which the CI Model focuses, more or less coincide with the construction and integration stage of that model. In the Landscape Model the levels of representation are less clear. It is likely that they are similar to those EI Model, as in the Landscape Model too the construction of situation models plays a central role. In the EI Model at least three levels are distinguished: a current, integrated and complete model. That the question of building blocks and levels of representation are related can also be seen in the Structure Building Framework. The model leaves the question of the medium of representation open and (consequently) the levels of representation remain undefined.

Role of memory

What is the role of memory in text comprehension? All four models incorporate the notion of STM and LTM in some way. The CI Model, Landscape Model and EI Model assume that due to memory limitations text is processed in cycles. The CI Model and the EI Model further assume that in STM a division can be made between LT-WM and ST-WM in order to keep retrieval structures to the LTM memory active. The Structure

Building Framework assumes that processing does not take place in cycles and in this the model fundamentally differs from the other three.

The evidence often given for limited memory resources in text comprehension is that comprehenders quickly forget the exact form of recently comprehended information. The CI Model, the Landscape Model and the EI Model argue that incoming information (propositions, constituent concepts, events) is kept in a short-term memory buffer. After the limit of this buffer is reached, the information is transferred to LTM. When a new element is added to the buffer, integration of the information – in terms of the CI Model – takes place. The problem with this account is that the information in the STM buffer needs to be related to the representation of already comprehended text and to background knowledge. The CI Model and the EI Model solve this problem by introducing LT-WM that mediates between the STM buffer and LTM. In the CI Model and the Landscape Model it is assumed that selected information is carried over from one reading cycle to another. How much information is carried over remains unclear. Van den Broek et al. (1996: 171), following Van Dijk & Kintsch (1978), and Kintsch (1998: 102) argue that it is a small number (generally 1) of statements or propositions that is carried over. The problem with reading cycles is that this number must vary, assuming that some propositions and some links between these propositions are more complicated than others. Gernsbacher (1990) points out another problem. Boundary experiments (Gernsbacher, 1985) show that the comprehender's ability to remember information is affected by the structure of that information.

When comprehenders cross structural boundaries, recently comprehended information becomes less accessible – regardless of how much information has been held or how long that information has been held in a hypothetical short-term memory. [...] Perhaps the system is so 'smart' that when anticipating a time or space limitation it expunges at a structurally appropriate point. But this leaves us without an *a priori* specification of how long or how much information can be held, and no causal link. (Gernsbacher, 1990: 73)

Instead, Gernsbacher argues for a Shifting Hypothesis. When the comprehender is cued to shift to a new substructure, the information from the previous substructure is less accessible. This means that the higher the probability of shifting, the lesser the accessibility of comprehended information. The cues to shift to new substructures are,

what Gernsbacher (1990: 77) calls, 'Adverbial Leads', TEMPORAL or LOCATIONAL discontinuities. These discontinuities are what we have called global cohesion: they cue the comprehender that the focus of the previous passage shifts to a new character, location, time, or cause. These shifts are usually marked by a new paragraph.

In sum, whereas for the CI Model, the Landscape Model and the EI Model information is processed in predefined package sizes, the Structure Building Framework assumes that the size depends on the textual information. If comprehenders are cued to shift, integration into the mental structure takes place before the shift. When the new substructure is started comprehended information from the old substructure is less accessible.

Types of cohesion and coherence strands

In Chapter 1 we introduced four cohesion and coherence strands: REFERENTIAL, LOCATIONAL, CAUSAL, TEMPORAL and ADDITIVE strands. This categorisation was based upon cohesion devices in the text. How do these five strands relate to those defined in the four models? As we have seen, the type of relations between the propositions in the CI Model is not entirely clear. Kintsch defines abstract rules for interconnecting the propositions in a network: directly, indirectly and subordinately. These rules point out the structure but not the content of these relations. Hypothetically, they could be any of the REFERENTIAL, LOCATIONAL, CAUSAL, TEMPORAL and ADDITIVE strands, we have defined. The Landscape Model is more explicit about the relations and defines anaphoric clarity and causal strands, equivalent to the REFERENTIAL and CAUSAL strands. The EI Model defines five strands (or dimensions): entity, time, space, causality and intentionality. The first four are equivalent to the four strands we have defined. The fifth one, keeping track of the goals and plans seems to be related to the CAUSAL strand, as goals, actions and outcomes are generally structured causally. The Mapping process in the Structure Building Framework resembles the indexing in the EI Model in that the sources of coherence (the indexes) are identical: *referential, temporal, spatial* and *causal* strands between the text components facilitate text comprehension.

We will discuss the cognitive evidence for these strands in Chapter 4. It suffices here to conclude that there are large similarities between the various cohesion and coherence strands that are defined in the four text comprehension models.

Definition of processes

With similarities between the cohesion and coherence strands, one would also expect similarities in the processes defined for the models that bring these strands about. What are the cognitive processes involved in the construction of a mental representation? The CI Model mainly distinguishes between construction and integration, the first to construct an elaborated propositional network, the second to integrate this network into a filtered mental representation. The Landscape Model leaves the processes undefined. However, the integration stage of the CI Model can also be assumed in the Landscape Model, where cohesion strands cause fluctuation of activation in each cycle. Furthermore, the sources of activation in the Landscape Model largely resemble the different models – current, integrated and complete – in the EI Model. The Landscape Model's stage of text immediately being processed is similar to the EI Model's construction of the current model; the Landscape Model's stage of text in the previous reading cycle and earlier cycles resembles the EI Model's updating into an integrated model. The formation of the completed model in the EI Model would then resemble all information plus background knowledge in the Landscape Model.

Making similar comparisons in the Structure Building Framework proves to be problematic. According to this model, the cognitive processes involved in text comprehension are Laying a Foundation, Mapping, Shifting, Enhancement and Suppression. Mapping and Shifting on the one hand, and Suppression and Enhancement on the other, are parallel processes: comprehenders either Map or Shift when activating information, they either Enhance or Suppress once information is activated.

How do the processes defined in the Structure Building Framework relate to those defined in the CI Model, the Landscape Model and the EI Model? The answer lies in the levels of representation that each of the models assumes. In the CI Model, Landscape Model and the EI Model at least two levels of representation are assumed, one in which the textual information is processed and one in which the processed information is integrated in larger mental structure that includes earlier comprehended information and background knowledge. In other words, it seems that one level is more text-based (CI Model: Construction Stage; Landscape Model: encountering textual information; EI Model: constructing current model), the other one is more

comprehension based (CI Model: Integration Stage; Landscape Model: landscape of activations; EI Model: updating integrated model). In the Structure Building Framework such a distinction in levels cannot be made. The processes defined in the Structure Building Framework all concern parallel processes developing the mental structures and may therefore be assumed to occur in the comprehension-based level.

If we follow this line of reasoning and assume at least two levels of representation, one being more text-based, the other being more comprehension-based, how does this translate into terms of cohesion and coherence? It means that comprehenders organise vocabulary-driven and grammar-driven cohesion strands in the text, and integrate this textual information into a larger mental structure in order to construct a coherent mental representation. We hypothesise that two kinds of processes are used in the more text-based stage and more comprehension-based stage, which we will call 'cohesion-based' processes and 'coherence-based' processes.

2.4 COHESION-BASED AND COHERENCE-BASED PROCESSES

What evidence can be given for the distinction between cohesion-based processes and coherence-based processes? In this section we will give an overview of three accounts which make a similar distinction. In the Multiple Entry Modular Memory System a distinction is made between perceptual processes and reflective processes, the former being related to information in the external world, the latter to information in the internal world. This distinction can also be found in other accounts of the comprehension process, for instance in Caplan & Waters' (1999) Separate Language Interpretation Resources Hypothesis or in Sanford & Garrod's (1998) Scenario Mapping and Focus Theory. The Multiple Entry Modular Memory System also illustrates how the four models of text comprehension can be brought together into one unified theory.

2.4.1 Multiple Entry Modular Memory Model (MEM)

A theory that addresses several of the above questions is the Multiple Entry Modular Memory System (MEM). The MEM proposed by Johnson (1983) and expanded in Johnson & Hirst (1991, 1992) and Johnson (1992) consists of a small set of cognitive processes configured into memory subsystems. Incoming information is processed by multiple cognitive processes, thus creating multiple memory entries in multiple interacting, but distinguishable, subsystems. Each of these subsystems is specialised in a number of functions. A particular event may thus be processed by all or several subsystems, creating memory traces or 'entries' in these systems.

The MEM distinguishes between two memory systems, a perceptual and a reflective system. The perceptual system depends on stimuli from the external world. Processes like seeing and hearing are processed in this system. In the reflective system on the other hand internal processes come about. Processes like planning and imagining run in this system. Johnson & Hirst (1991: 198) give three arguments for this distinction. First, in language acquisition reflective processes develop later than perceptual processes. Secondly, reflective processes are more likely to be disrupted by stress, depression, aging, and use of alcohol and other drugs, than perceptual processes. And thirdly, in different kinds of amnesia, reflective processes may be relatively intact while perceptual processes are disrupted, or vice versa. Neuropsychological data clearly distinguish between perceptual and reflective processes. In patients with brain damage reflective processes may be normal, whereas the perceptual processes are disrupted (like in patients with Huntington's disease) or the reverse in which perceptual processes are more or less intact, whereas the reflective processes are disrupted (like in patients with Alzheimer's Disease). Similar evidence comes from Schacter (1985: 355) showing that amnesic patients exhibit normal performance on skill-learning tasks, suggesting that conscious recollection is neither useful nor necessary for performance of these tasks.

Within both the perceptual and the reflective memory system two subsystems can be defined. The difference between these two subsystems lies in their accessibility. Subsystems may be consciously or subconsciously accessible. In the former case the processes are deliberate and under strategic, conscious control, in the latter they are automatic and not under a person's control. For instance, when reading this text, the

reader may be conscious of parts of the reading process, e.g. when detecting an error, but will generally process the text without being conscious of every eye movement, the black and white patterns on paper, etc. Similarly, one can remember things more or less automatically (e.g. while reading this text), or consciously (while being asked to recall the words of this last sentence). Within each of the subsystems Johnson and Hirst (1992) distinguish four parallel processes.

1. In the automatic perceptual processes (P1) *extracting*, *tracking*, *locating* and *resolving* are distinguished. In *extracting*, invariants from perceptual arrays are deduced. In *tracking*, the different traces of the perceptual stimuli are followed. *Locating* designates the position of the stimuli. The processes of *resolving* break the perceptual stimuli up in separate, constituent elements to analyse further.
2. The perceptual processes (P2) are identical to P1 processes, but are deliberate, strategic and under the comprehender's control. In *structuring* a pattern of organisation across the stimuli is abstracted. In *examining* the comprehender perceptually investigates the different aspects of the stimuli. In *placing*, the stimuli are allocated to a particular position or function. *Identifying* fixes the identity of the stimuli.
3. The automatic reflective system can be divided in the following processes: *noting* indicates the relations between the stimuli. *Shifting* changes the attention from one arrangement of the stimuli to another. In *reactivating* information dropped out of consciousness is brought back to an active state. *Refreshing* prolongs activation of the information so that it remains active for other processes.
4. The parallel processes for the deliberate reflective system (R2) again are parallel to those in R1. *Discovering* reveals the relation between the stimuli. *Initiating* introduces new aspects of the stimuli. *Retrieving* restores the activation by recalling it. *Rehearsing* drills the pattern of stimuli so that they remain active.

Memory processes also occur in other combinations. For instance, activation of the processes at the edges of the cubes (see Figure 3) describe the following phenomena (Johnson and Hirst, 1992: 252):

1. *resolving*, *identifying*, *refreshing* and *rehearsing* function to identify and maintain active the objects of perception and thought;

2. *extracting, structuring, noting* and *discovering* function to create relations along and time and/or events;
3. *tracking, examining, shifting* and *initiating* function to provide ways of introducing changes in activation pattern to the system;
4. *locating, placing, reactivating* and *retrieving* function to provide mechanisms for going back to earlier objects of perception and thought.

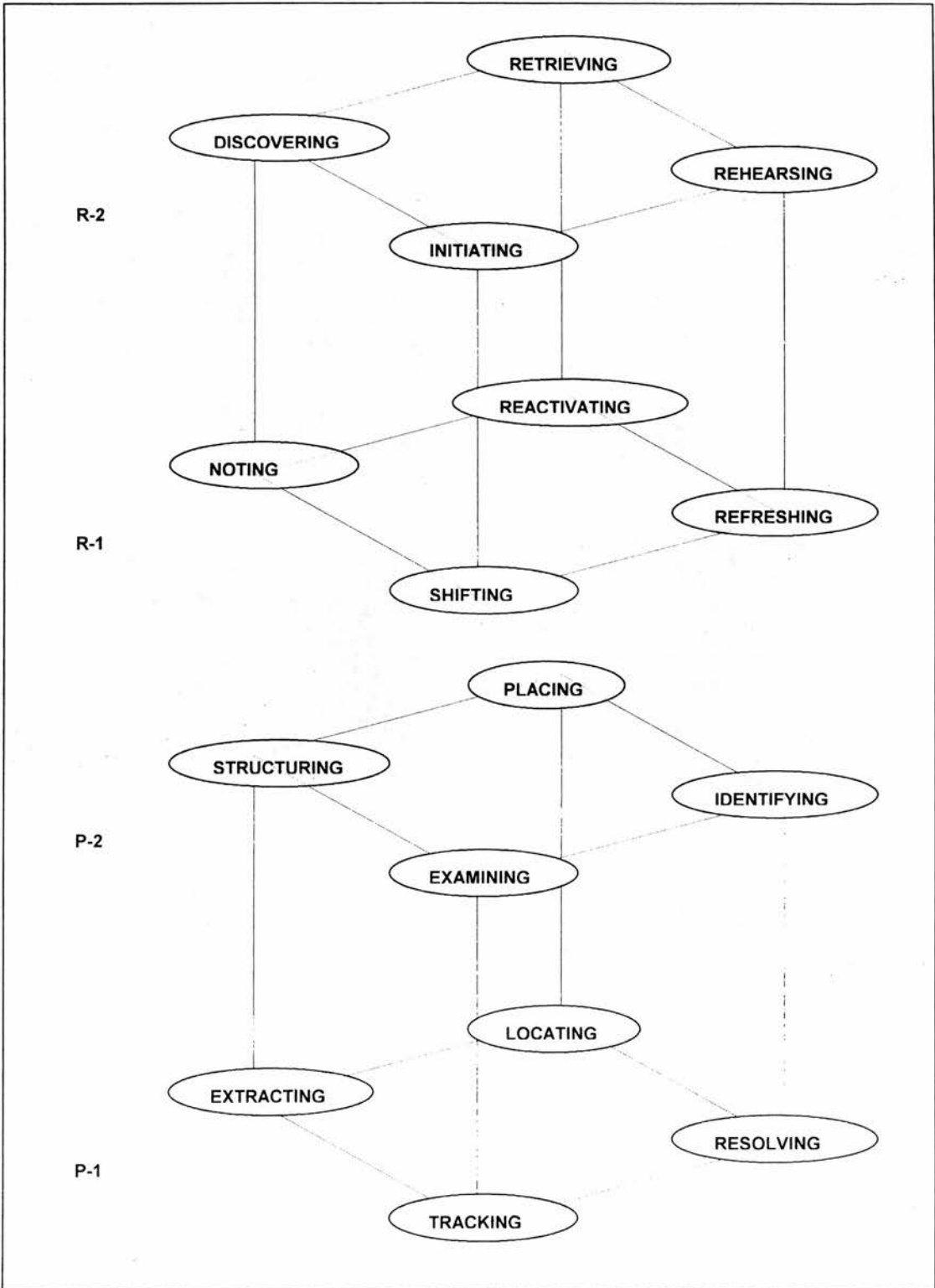


Figure 3 Multiple Entry Modular Memory System. Adapted from Johnson & Hirst (1992)

The main problem with MEM lies in its detail. The model assumes sixteen different memory sub-processes. The question is whether entities are not being multiplied beyond necessity. Indeed, models in which different memory subsystems underlie cognition are often criticised as ones that propose a new system as soon as it encounters a new fact (Roediger, 1990). Schacter (1985: 352) draws another conclusion: "To postulate that performance on different types of memory tasks is mediated by 'different forms of memory' does not explain the nature of the underlying processes, but it can provide a useful description of the data and hence point the way toward an explanation." And MEM does describe a range of cognitive processes and impairments. For instance, whereas in normal (unintentional and strategic) learning all processes in R1 and R2 are active, unintentional (or simple intentional) learning can be described as a deactivation of the R2 processes. The experience of free association or stream of consciousness is the result of activation of the processes of initiating, shifting, refreshing and rehearsing, while the other R1 and R2 processes are not activated. Compulsive disorders activate reactivating, retrieving, refreshing and rehearsing, while the other processes are not activated. Creativity can be explained by an activation of noting, discovering, shifting and initiating. When all components except refreshing and rehearsing are intact, a STM deficit could arise. On the other hand, a LTM deficit, like core anterograde amnesia, can be observed when all but reactivating and retrieving are intact. Similarly, selective disruption of P2 processes may cause visual agnosias (Johnson & Hirst, 1992: 271).

Describing general cognitive processes, MEM also describes text comprehension processes. Johnson & Hirst (1992: 264) argue that P1 processes divide the speech signal into units, language signals into words, P2 processes extract syntax and meaning, while R1 processes generate associations between the information units. Finally, R2 processes develop more complex text representations.

Although the literature introducing the Multiple Entry Modular Memory System does not discuss any theories of text comprehension, the model enables us to show the relations between the four models of text comprehension. First of all, MEM also makes the distinction between cohesion-based (P-processes) and coherence-based processes (R-processes). P-processes depend on stimuli from the external world and would hence fall in the CI Model's Construction stage, the Landscape Model's stage of encountering

textual information and the EI Model's stage of constructing of the current model. R-processes, which are independent of sensory information, seem to cover the CI Model's integration stage, the Landscape Model's fluctuation of activation and the EI Model's updating of the integrated model.

But in MEM the relation between the CI Model, Landscape Model and the EI Model on the one hand and the Structure Building Framework on the other, can also be pointed out. In MEM the processes of extracting, structuring, noting and discovering – though at different processing levels – all indicate the organisation of units by matching similarities. On the other hand, tracking, examining, shifting and initiating focus on the differences between these units. Rather than trying to match similarities, these processes distinguish the units. These two sets of processes seem to resemble the Mapping and Shifting process in the Structure Building Framework. In Mapping the comprehender maps incoming information that matches with comprehended information onto the same developing structure. In Shifting the information that differs from the comprehended information is brought into a new substructure. This would mean that Mapping and Shifting take place at (at least) two levels: a cohesion-based and a coherence-based level. As we have seen, the Structure Building Framework also defines the processes of Enhancement and Suppression. As we have pointed before, these two processes may be seen as one process that either enhances more/suppresses less or enhances less/suppresses more. The Suppression and Enhancement process(es) either dampens the activation of less relevant information or boosts activation of relevant information. If we now assume that this occurs at different levels of cognition, we can see that Suppression and Enhancement resemble the resolving, identifying, refreshing and rehearsing processes in the MEM. According to MEM these processes prolong the activation of memory cells if the units are relevant.

Finally, the Structure Building Framework does not discuss the use contextual information and background information. In MEM processes that integrate this information are called locating, placing, reactivating and retrieving. In the CI Model, Landscape Model and the EI Model the retrieval of background knowledge only occurs at the coherence-based stage in the comprehension process. However, it seems necessary that background knowledge like syntax and semantics is incorporated at a very early stage. This means that, like the other processes, incorporating background

knowledge and contextual knowledge occur at different levels, at least a cohesion-based and coherence-based level.

2.4.2 Separate Language Interpretation Resources Hypothesis (SLIR)

Caplan & Waters (1999) make a similar distinction as the cohesion and coherence based processes one with, what they call, 'interpretative processing' and 'post-interpretative processing'. Interpretative processes extract meaning from a linguistic signal (word, sentence): recognising words, parsing the sentence in syntactic features and assigning thematic roles. Post-interpretative processes use the extracted meaning in other cognitive tasks: reasoning, planning actions, etc. Many psycholinguists have claimed that the processes involved in interpretative processing are distinct from those in post-interpretative processing (e.g. Fodor, 1983; Frazier, 1990). The distinction can be extended to working memory. Caplan & Waters (1999) report a large range of studies showing that there is an effect of working memory capacity on post-interpretative processing, but no effect on interpretative processing. They argue that high- and low-capacity subjects perform with the same accuracy and speed on complex clauses (object-relativised sentences, garden path sentences). Furthermore, there is no evidence linking short-term memory impairment with syntactic processing in sentence comprehension (Caplan & Waters, 1990). Similarly, patients with Dementia of the Alzheimer Type did not have particular difficulty with difficult syntactic structures. In a sentence- and picture-matching test they did perform more poorly than a control group. However, the patients were affected by the number of propositions in the sentence and not by the syntactic complexity (Rochon, Waters & Caplan, 1994). Poor performance can thus be ascribed to aspects of post-interpretative processing.

The distinction between interpretative and post-interpretative processes seems to resemble the distinction between cohesion-based and coherence-based processes. It means that working memory limitations only affect coherence-based processes, i.e. the integration stage (CI Model), the activation stage (Landscape Model) and updating and subsequent stages (EI Model).

2.4.3 Scenario-Mapping and Focus Theory (SMF)

The distinction between cohesion-based and coherence-based processes can also be found in Sanford & Garrod's (1981, 1998) Scenario Mapping and Focus Theory (SMF). Sanford & Garrod argue that the principal task in language comprehension is to relate the incoming information to background knowledge at the earliest possible stage. Interpretation can only take place after this relation has been made. According to the SMF Model comprehenders analyse text against a fourfold partitioning of memory. These four partitions form the background data structure against to which incoming information is related. First, there is the distinction between static partitions and dynamic partitions. Static partitions consist of general knowledge and memory for the interpreted text. These partitions are more or less permanent, although they can be updated. In contrast to these permanent partitions, dynamic partitions are flexible. They consist of representations of the recent text input. Orthogonal to the distinction between static and dynamic partitions is the text-based and knowledge-based distinction. The dynamic (or focus) partitions contain an implicit focus for knowledge-based representations and an explicit focus for text-based representations. The implicit focus contains situations (or scenarios), a frame that serves for the organisation of the interpretation of a clause. A scenario of a clause contains scenario-role slots, which need to be filled in by the discourse entities in the text. These entities are part of the explicit focus (see Table 2). The static partitions correspond to the episodic and semantic LTM memory, while the dynamic memory is more or less the STM.

	Dynamic	Static
Knowledge-based	Implicit focus (situations)	World knowledge and scenarios
Text-based	Explicit focus (discourse entities)	Memory for text

Table 2 Fourfold memory partitioning in the SMF Model (after Sanford & Garrod, 1998: 162)

According to the SMF Model, in reading a sentence like "Bill kisses Monica" the comprehender singles out a verb schema for "kiss" (e.g. x kisses y) and fills in the scenario-slots of the verb schema with the discourse entities "Bill" and "Monica" (e.g. *Bill* kisses *Monica*). Comprehenders will thus use the earliest possible opportunity to

activate situation-specific knowledge. The slots of the activated frame are then filled in by the discourse entities. The situations are knowledge-based, whereas the discourse entities are text-based.

In the SMF account too the distinction between cohesion-based and coherence-based is found in text-based and knowledge-based memory partitions. In the coherence-based partitions situations are tracked. Entities in the cohesion-based partitions are mapped onto these cohesion-based partitions. The cohesion-based 'memory for discourse' and the coherence-based 'world-knowledge and scenarios' resemble the construction and integration stage (CI Model), the statement and landscape activations (Landscape Model) and the current and integrated model (EI Model). According to the SMF Model, the coherent mental representation is a set of connections between the cohesion-based implicit (situations) and coherence-based explicit (discourse entities) focus. These links between memory partitions are defined as separate mental structures or models in the other models.

2.5 A BLUEPRINT OF TEXT COMPREHENSION

We have presented the CI Model, the Landscape Model, the EI Model, the Structure Building Framework and have compared them with each other, and with other models, like the Multiple Entry Modular Memory System, the Separate Language Interpretation Resources Hypothesis and the Scenario Mapping and Focus Theory. If we bring all these accounts together, we can draw Figure 4.

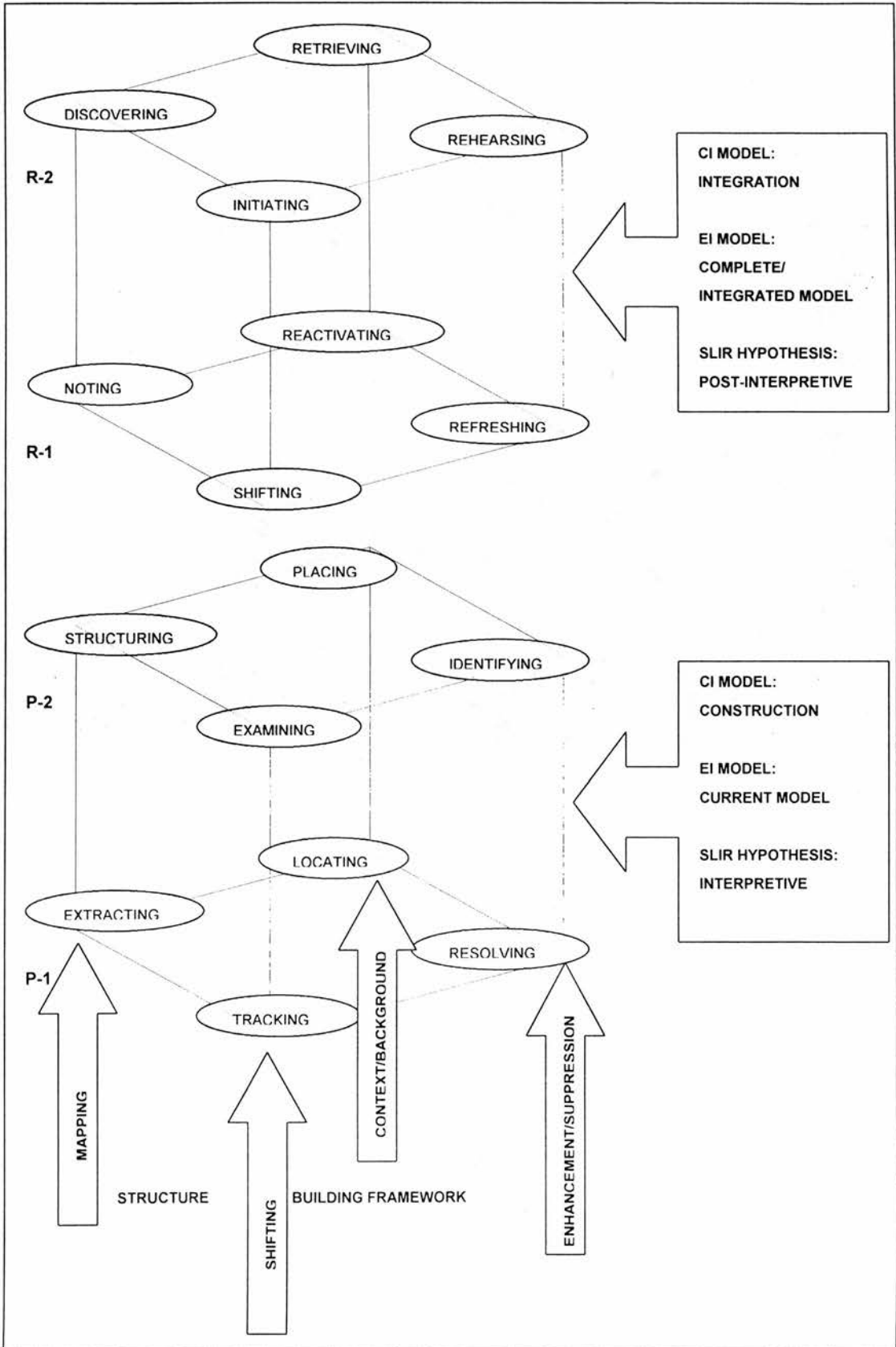


Figure 4 Overview of the models presented in Chapter 2

In the beginning of this chapter we stated that the aim of this second chapter was to outline how text comprehension comes about and what levels and processes can be distinguished. Having discussed four leading models of text comprehension, having compared them with each other and with some other account of cognition of comprehension, we can now give a tentative answer to these questions. In this research we assume that text comprehension involves general cognitive processes, in which at least a distinction can be made between cohesion-based and coherence-based processes. The cohesion-based processes direct the memory resources towards information in the text, coherence-based processes direct memory resources towards the developing mental structure and background knowledge. We assume that both for cohesion-based and the coherence-based processes similar processes are active, which we assume to be mapping and shifting. In mapping the comprehender maps incoming information onto a developing text structure (cohesion-based) or mental structure (coherence-based). In shifting the comprehender shifts to a new substructure. We assume that the process of mapping is the default process. Following Grice's Cooperative Principle, comprehenders will try to map information. If textual information cues the comprehenders not to map, they will shift. The layout of the text (new paragraph, end of sentence), as well as linguistic information (global cohesion relations), cues comprehender when to shift. Before they shift, they integrate information into the mental structure. After they shifted the old sub-structure is less accessible.

Information is mapped onto the developing structure, when the incoming information shows a continuity of the REFERENTIAL, LOCATIONAL, CAUSAL, TEMPORAL and ADDITIVE strands. When a discontinuity of any of these strands occurs, information is shifted to a new substructure. When the comprehender maps incoming information, and more cohesion and coherence strands are shared, the activation is enhanced. The more cohesion and coherence strands are shared between the incoming information and the developing structure, the more activation is enhanced and the more accessible the information is. This means that a cohesion strand is active both independently and interdependently in the comprehension process. It cues for the mapping of information onto a developing structure of one strand, but also supports the mapping of information of other strands. Because of the relations to other strands, interdependent relations are more specific than independent relations.

It is likely that when comprehenders encounter cohesion strands in the text that are less specific, their resources are directed toward cohesion-based information. More information from the text is needed to decide which coherence relation is applicable and hence to establish coherence. On the other hand, if cohesion strands in the text are more specific, comprehenders can process the text more easily, mapping information on the developing structure toward the end of a comprehension process. The beginning and the end are determined by global cohesion cues.

2.6 CONCLUSION AND HYPOTHESES

In this chapter four leading models of text comprehension have been discussed: the Construction Integration Model, the Landscape Model, the Event Indexing model and the Structure Building Framework. In each of these models similar issues have been pointed out, which have been brought together in an overview. We have argued that in the levels of representation three of these models use (CI Model, Landscape Model and the EI Model) a distinction can be made between (textual) cohesion-based and (knowledge) coherence-based processes. This distinction can also be found in several other accounts, like the Multiple Entry Modular Memory system, the Separate Language Interpretation Resources hypothesis and the Scenario Mapping and Focus Theory. The first of these accounts, MEM, also shows the relation between the four text comprehension models: the processes described by the CI Model, the Landscape Model and the EI Model are more or less orthogonal to the processes described by the Structure Building Framework.

The comparison of the models brought us to the introduction of a blueprint of text comprehension. We argued for two types of processes – cohesion-based and coherence-based – corresponding to the two levels. Comprehenders map or shift incoming information. They do that on the basis of the five cohesion and coherence strands: REFERENTIAL, LOCATIONAL, CAUSAL, TEMPORAL, and ADDITIVE. When more than one strand is shared activation is enhanced.

Johnson & Hirst (1992: 252) define cognition “as consisting of a small set of ‘themes’ (e.g. identifying, relating, introducing change, going back) represented at multiple levels or various levels of complexity in an overall cognitive system.” The

similarities with the definition of text comprehension offered by Graesser & Britton's (1996: 350) definition given at the beginning of this chapter is obvious. They defined text comprehension as "the dynamic process of constructing coherent representations and inferences at multiple levels of text and context, within the bottle-neck of a limited-capacity working memory" and was the result of five metaphors Graesser & Britton distinguished (1996: 342):

1. Understanding is the assembly of a multileveled representation
2. Understanding is the construction of a coherent representation
3. Understanding is a complex dynamical system
4. Understanding is the process of managing working memory
5. Understanding is inference generation

Following all four models of text comprehension we have discussed in this chapter, we have argued that the aim of text comprehension is the construction of a coherent mental representation (metaphor 2). Following three of the models – the CI Model, the Landscape Model and the EI Model – we assume that the comprehension process takes place at least at two levels, a cohesion-based and a coherence-based level (metaphor 1). Managing cohesion-based and coherence-based processes takes place in working memory. We follow Gernsbacher's Shifting Hypothesis and believe that cohesion-based information cues the comprehender when to transfer information to higher memory stores like LTM (metaphor 4). But as we have argued in Chapter 1, cohesion is not enough for coherence. We need to activate situation-specific information from background knowledge to make inferences. This seems particularly needed when cohesion relations are not present in the text (metaphor 5). Various processes are active at each level. Following the Structure Building Framework we assume the main processes Mapping and Shifting, and Suppression and Enhancement (metaphor 3).

In the first chapter we formulated two research questions:

1. To what extent is each of the types of cohesion independent of the others in its effects on the comprehender?
2. Does coherence develop (on-line) throughout the comprehension process and does it come about (off-line) in a final wrapping-up stage of the comprehension process or both?

Following the discussion in this chapter and according to the subsequent model, we can now formulate the following hypothesis:

Specification Hypothesis

Cohesion strands that are less specific than others direct the comprehenders' resources toward cohesion-based information, while those strands that are more specific direct the comprehenders' resources toward coherence-based information.

Before this hypothesis can be tested we need to take one of the other steps defined in Chapter 1: answering the question is what the medium is of representing textual information and the medium of representing the mental structures? This question will be answered in the next chapter.

CHAPTER 3

THE EVENTUALITY OF PROPOSITIONS: REDEFINING A CONCEPT

3.1 INTRODUCTION

One of the steps in answering the main question how textual cohesion supports representational coherence was to answer the question what representational system is best to be used in describing the rich structure textual understanding is associated with. In the previous chapter we saw that propositions were the medium of representation in the CI Model, an abstract representation of meaningful units in the text. The Landscape model uses similar components in the form of constituent concepts, i.e., abstract representations of the sentence. The EI Model, on the other hand, does not assume such an abstract propositional level: its building blocks were the events expressed in the clauses of the text. The Structure Building Framework left the question of the medium of the representations more or less unanswered. It assumes mental structures whose building blocks were memory cells. We concluded the previous chapter with a comparison of text comprehension and memory models and proposed a blueprint of comprehension, arguing that in understanding text we direct memory resources toward cohesion-based and coherence-based processes to build a coherent mental representation. To be able to describe cohesion and coherence we need a representational system. The aim of this chapter is to propose a representational system that provides the necessary descriptive language.

With regard to this representational system we can ask a functional question and a structural question. The functional question is what the representational system looks like, more or less regardless of what it represents. From this viewpoint the representational system is merely a formalisation tool. The structural question asks what the system represents. Although the emphasis of this chapter lies on the functional question, we start with addressing the structural question.

3.2 SYMBOL GROUNDING

What does a representational system represent? There are two fundamental problems in describing a language of thought in which meaning is described (see Kamp & Reyle, 1993: 10). The first problem is that the only access we have to a language of thought is via language. What is needed – but at least currently unavailable – is an account of the mental representation on other evidence than language behaviour. The closest we can come to a mental representation is to look at language behaviour in subjects. This means that any attempt to describe a mental representation is circular, as we base the mental representation on the linguistic information and then explain the linguistic information by means of mental representations. The second problem is that even if we are able to independently describe a mental representation, the first problem remains. That is, if we want to account for the meaning of the expressions of the mental representations, we have to refer to linguistic expressions. In other words, explaining linguistic expressions by referring to mental representations and vice versa only shifts the problem of meaning to another ‘language’¹. So, even though the two languages (the natural language and the language of thought) could be described independently, we are still stuck in a symbol grounding problem. For instance, determining the meaning of English by referring to a translation in French may seem to be useful, but how do we account for the meaning of French? Clearly not by translating into English...

What is missing from a theory along these lines [...] is something that is fundamental to the phenomenon of linguistic meaning, viz. that when we speak or think we typically speak or think *about* something. And [...] what we speak or think about are things in, or, more generally, parts of, that actual world. (Kamp & Reyle, 1993: 11)

To know the meaning of a symbol (e.g. a word) means that the symbol needs to be grounded by a reference into the actual world we live in. Recently, this symbol grounding problem has received a large amount of attention by so-called *embodiment theorists* (e.g. Barsalou, 1999; Glenberg, 1997). Embodiment theory rejects an amodal symbol system. According to the theory, the basis of linguistic and non-linguistic

¹ This is the standard ‘mentalese’ problem.

understanding is the sensorimotor experiences of actions. A commonly used argument against amodal symbol systems is the Chinese room experiment (Searle, 1980). In this thought experiment a person not knowing any Chinese is locked in a room with an instruction book. The book contains Chinese characters linking input strings to output strings. Through a slot in the wall the person receives pieces of paper with Chinese characters written on them and is asked to respond by looking up the input characters, match them with the output characters and return the output characters on a separate piece of paper. According to an amodal system theory this would simulate reading, thinking and responding in Chinese or in any other language. Clearly, it does not. The thought experiment shows that an amodal symbol system cannot account for human language processing, simply because the symbols are not grounded. Glenberg, Robertson & Members of the Honors Seminar in Cognitive Psychology's (in press) consider several solutions to the symbol grounding problem.

1. The symbol grounding problem does not exist. Like abstract symbols, concrete symbols are encoded in the language environment. This solution is rejected by Glenberg et al., because it brings us back to the actual symbol grounding problem in which the meaning of a symbol is another symbol.
2. Symbols are grounded by perception. Cognitive symbols are mapped onto entities in the real world. This solution is also rejected by Glenberg et al., because of the lack of a one-to-one relationship between symbol and perception. Categories are not Aristotelian, that is, they have fuzzy rather than sharp boundaries. A symbol can therefore not account for the rich source of information perception contains.
3. Symbols are encoded by other sensory modalities. Meaningful representations are constructed by co-occurrences in the natural environment. A unicorn is a combination of the 'pictures' of a horse, an animal, a horn, etc. Language understanding then is the encoding of language information along with other sensory modalities. Although this seems to be a solution that overcomes the problems noted in the other two solutions, it is rejected by Glenberg et al., because it does not explain why literal interpretations of proverbs and metaphors for instance do not make sense.
4. Glenberg et al. argue that the assumption of meaning being based on abstract symbols arbitrarily related to their referents needs to be abandoned. According to Glenberg et al. (in press) and Glenberg (1997) internal representations are

analogically structured, they are embodied. This solution forms the basis for the embodiment theory.

The embodiment theory comes from the ideas expressed in cognitive linguistics by Lakoff and Johnson (1980) and the mental model theories of language comprehension (Johnson-Laird, 1983). According to the embodiment theory language comprehension results in a representation of what the language is about and not of a representation of the language itself.²

Embodiment theory is mainly a criticism of the notion of propositions proposed by Van Dijk & Kintsch (1983) and used in Kintsch's CI Model (1998), and Latent Semantic Analysis (LSA; see Landauer and Dumais, 1997), as it is sceptical whether it is possible to use formal models for non-formal processes. According to Glenberg et al. (1999) propositions or LSA cannot model – or even approximate – human meaning, as something does not mean something because something else means something similar.

According to embodiment theory meaning is defined as a set of actions available in a certain situation. These actions are dependent on the affordances of the situation (i.e. how the comprehender can interact with the object), the experiences of the individual and goals for the actions. When these three determinants of meaning are combined they make a coherent set of actions, which form the individual's understanding of the situation.

The Indexical Hypothesis, proposed by Glenberg & Robertson (1999), relates the embodiment theory to language comprehension. According to the Indexical Hypothesis language comprehension involves three processes:

1. indexing phrases to actual objects or analogical perceptual symbols;
2. using the object or perceptual symbol to derive affordances;
3. meshing the affordances guided by the syntax of the sentence.

The three processes can be illustrated as follows. According to the hypothesis a sentence like "My neighbour played saxophone" involves the reference of concepts like *neighbour* and *saxophone* to those objects in the comprehender's environment or to prototypical neighbours and saxophones. In a next stage *neighbour* and *saxophone* are used to derive so-called affordances. Saxophones can be played, they can be put away, they can be broken,

² At this point it resembles the EI Model.

etc. Neighbours can play instruments, they can walk, eat, they can put things away, they can break things, etc. In the final stage of the comprehension process the surface structure of the sentence meshes the affordances. Hence, a sentence like *my neighbour plays saxophone* makes sense, but a sentence like *my neighbour eats saxophones* does not.

There are some difficulties with the embodiment theory in general and the *indexical hypothesis* in particular. The processes of the Indexical Hypothesis seem to show large similarities with the solutions offered for the symbol grounding problem, which were rejected by Glenberg et al. (1999). In the first process of the Indexical Hypothesis a direct reference is made between a symbol and a perceptual object in the actual world (the second solution for the symbol grounding problem). In the second process in which the comprehender interacts with the objects, it seems that the symbols are encoded by other sensory modalities: co-occurrences of a symbol in the natural environment determines its affordance (the third solution). Meshing these affordances is guided by the syntax of the sentence, and therefore seems to be a rather abstract process of mapping the affordances onto a coherent interpretation of the sentence (similarities to the first solution). This suggests that some processing is carried out at an abstract level.

Furthermore, the first solution to the symbol grounding problem, namely the refutation of the very existence of the problem, was rejected by Glenberg et al. But embodiment theory fails to explain how abstract symbols are processed. In other words, Glenberg et al. reject the proposal that concrete symbols are processed like abstract symbols, while they fail to explain how abstract symbols are processed like concrete symbols. And the very question of how abstract symbols are processed (for instance, in a sentence like this) in terms of embodiment theory brings us back again to the symbol grounding problem.

Could an amodal system (like LSA and propositions) be reconciled with Embodiment theory? The solution might lie in Deacon (1997). Deacon borrows his theory of classification of representational relationships from C.S. Peirce, and

distinguishes three categories of associative relationships, icon, index and symbol³. According to Deacon *icons* are mediated by a similarity between the sign and the object it refers to. *Indices* are mediated by contiguity between sign and object. *Symbols* are mediated by a conventional relationship between sign and object. Different levels of interpretation can now be formed based on the hierarchical relationships of classification. Symbolic relationships are composed of indexical relationships, indexical relationships are composed of iconic relationships. Symbols thus relate to other symbols as well as – indirectly – to objects. This system of higher-order relationships means that not only is a reference of a symbol (word) to an object needed, but also regularities that govern possible combinations (Deacon, 1997: 83). With this system of relationships (icon – index – symbol), Deacon argues, an explanation can be given why humans have (symbolic) language. Much symbol manipulation takes place in the prefrontal cortex, which is more developed in humans than in animals. Some animals are only able to make iconic relationships, other more developed animals can make indexical relationships (apes for instance). This is not the place to discuss Deacon's evolutionary and neurological conclusions. What Deacon's explanation does show is that this system of relationships can explain the 'miscommunication' in the Chinese room experiment. The person in the room is working with indexical relationships, whereas his output is considered to be a symbolic relationship. It also shows where the embodiment theory goes wrong. Language comprehension necessarily needs to refer to events in the actual world. However, at the same time it also uses symbolic relationships. Both abstract and concrete symbol processing can be explained this way. It thus seems that 'amodal'-processes and 'embodiment'-processes do not exclude each other, but are fully dependent on one another in the comprehension process.

Although the question of the evolutionary nature and neurological location of 'amodal'-processes and 'embodiment'-processes falls well outside the scope of this research, we would like to point out an important observation. In Chapter 2 we showed that the distinction between cohesion-based and coherence-based processes is similar to

³ Deacon's theory differs from Peirce's theory in some important ways. Compare for instance Peirce's examples of icon, index and symbol: "Take, for instance, 'it rains.' Here the icon is the mental composite photograph of all the rainy days the thinker has experienced. The index is all whereby he distinguishes *that day*, as it is placed in his experience. The symbol is the mental act whereby [he] stamps that day as rainy." (Peirce 1960: 2.438)

the one between perceptual and reflective processes in the Multiple Entry Modular Memory System. Perceptual processes depend on stimuli from the external world and are indexical in Deacon's terms. Reflective processes depend on stimuli from the internal world and are symbolic in Deacon's terms. The distinction between the complementary 'amodal'-processes and 'embodiment'-processes hence is similar to the one between the complementary cohesion-based processes and coherence-based processes on the other, and between the processes in the CI Model's construction- and integration-stage.

3.3 THE STRUCTURAL QUESTION: LEVELS OF REPRESENTATION

For the moment, we stick with the structural question and consider the cognitive evidence for a cohesion-based and a coherence-based language of thought. As we have seen in Chapter 2, one of the currently most influential models of text comprehension is the CI Model, which distinguishes between a propositional level and a situational level. Research presenting cognitive evidence for a language of thought has focused on these two levels.

3.3.1 Cognitive Evidence for a propositional level

Evidence for a propositional language of thought can already be found in Plato and Aristotle. Kneale & Kneale (1962: 229) report that with the availability of Aristotle's writings in Latin his *De Anima* and *De Interpretatione* gained increasing interest the 13th century.

[In *De Interpretatione*] it is said that the soul has states and modifications which are in some sense copies of external things; and so the old theory of three kinds of discourse, written, spoken and mental, received new life. Thought, it was generally held, proceeds by means of *propositiones mentales* formed from natural signs in the soul..." (ibid.: 229)

In later times [ML 14th century] the analogy between thought and language was sometimes taken so seriously that mental propositions were thought to have a grammar like that of spoken or written propositions. (ibid.: 230)

Centuries later, a propositional level in discourse processing has been tested in several experiments over the last three decades. Broadly speaking, experimental evidence for propositions is found in priming studies, cued and free recall experiments, and reading time experiments (for overviews, see Van Dijk and Kintsch (1983: 46ff); Kintsch (1998: 69ff); Fletcher (1994: 594ff). We will here briefly discuss some of these studies.

In a priming experiment reported in Ratcliff & McKoon (1978) subjects were presented with a series of sentences. They were then tested for recognition by deciding whether a test word was in one of the study sentences. Response times for one word of the study sentence preceded by another word of the same study sentence were significantly faster than response times for a word from a study sentence preceded by a word from a different study sentence, thus providing evidence for the role of atomic propositions in memory.

Buschke & Schaier (1979) tested the role of propositions in story recall. Subjects were asked to read a short story and to write the story as they remembered it, with each 'memory' on a separate line. It was argued that subjects might not remember everything in just one trial. Therefore, this recall task was repeated in six subsequent trials. The results showed that the material that was recalled corresponded to the propositional units determined in an independent propositional analysis. Furthermore, the correlation between the recall and the propositional units was found in all subsequent trials.

Kintsch & Keenan (1973) tested the reading time and recall of sentences. They constructed sentences containing approximately the same number of words, but a different number of propositional units. Subjects read one sentence at a time from a screen and pressed a button when they were finished. They then recalled the sentence on paper. The results in the experiment showed that the reading time increased proportionally with the number of propositions in the text, regardless of the number of words.

In a recall experiment, Kintsch & Glass (1974) presented subjects with blocks of five sentences. After listening to each block, subjects were asked to recall what they could remember from each block. The findings showed that complete recall was better for those sentences based on a single proposition than for sentences based on more-than-one proposition. Furthermore, recall for sentences based on a single proposition was better than for sentences based on two or three propositions.

In two experiments reported in Kintsch, Kozminsky, Streby, McKoon & Keenan (1975) subjects read a text and were asked to recall as much information as possible. The

results showed that the reading times were longer for texts based upon propositions containing many different arguments than for texts based upon propositions containing few different argument, despite the fact that the number of words and the number of propositions were held constant. The same patterns were found in an experiment using speech and in a 24-hour delay experiment.

In an experiment similar to Kintsch and Keenan (1973), Graesser, Hoffman & Clark (1980) conducted a self-paced reading time experiment, followed by a comprehension test. Graesser et al. replicated Kintsch & Keenan's results. Their results support Kintsch and Keenan's conclusion that reading time increases as a function of the number of propositions in the text is tenable. Reading times showed a positive correlation with the number of words, the number of new argument nouns, the number of propositions, familiarity and narrativity. Due to the intercorrelation of propositions with new argument nouns and narrativity, Graesser et al. conclude that the results in Kintsch & Keenan's study are inflated. Kintsch and Keenan's results may give a skewed picture as narrative passages tend to have fewer propositions than expository passages. This may be related to the conclusion drawn by Kintsch, Kozminsky, Streby, McKoon & Keenan (1975) that stories are remembered better than expository texts. Furthermore, Graesser et al. argue that sentences with more propositions tend to have more argument nouns introduced in a passage. An increase in reading time may therefore very well be *partly* due to other factors than the number of propositions.

Lesgold (1972) comes to a similar conclusion: there is more to it than only the number of propositions. Lesgold carried out two recall experiments in which sentences were compared that had similar syntactic structures and similar semantic structures. The hypothesis that probe words are more successful in proportion to the number of propositions in which the probe appears was falsified. Evidence for a weaker hypothesis stating that a sentence is more likely to be recalled when its propositions are connected by co-referential items was only partly found. For pronominalised and embedded sentences this was indeed the case, but for sentences connected with the connective *and* even the weaker hypothesis was falsified. Lesgold concluded that two criteria can be given for propositions to be connected in memory: they must be connected by coreferential items and they must be marked in the surface structure of the text, for instance by means of pronominalisation.

Although the results in Lesgold's study have often been referred to as evidence for propositions, there are some methodological problems with this study, which are also found for the other studies discussed in this section. In the syntactically similar sentences for instance, Lesgold found that pronominalised sentences were better recalled. Sentences like (1) and (2) were compared:

- (1) The aunt was senile and she ate the pie.
- (2) The aunt was senile and Alice ate the pie.

The second sentence was less well remembered. However, it seems that not only co-referentiality plays a role, but also general coherence (or plausibility). In the current (lack of) context, the second sentence simply makes less sense. Furthermore, in the semantically similar sentences the memory effect of pronominalisation the suggested plausibility effect is even stronger. Lesgold found that *and*-sentences were not as well remembered as sentences with a relative pronoun or pronominal adjective. Sentences like the following were used in this experiment:

- (3)
 - (a) The blacksmith was skilled and the anvil was dented and the blacksmith pounded the anvil (*coordinate conjunction*).
 - (b) The blacksmith was skilled and he pounded the anvil, which was dented (*relative pronoun*).
 - (c) The skilled blacksmith pounded the dented anvil (*pronominalised adjective*).

But again, even with a controlling for sentence length, the material differs significantly. Compared to the (b) and (c) sentences, (a) seems to be rather unnatural. Evidence for this can also be found in the percentages of lexical items recalled (59%, 66%, 68%). The conclusions from this study therefore need to be drawn with great caution, as more linguistic factors need to be controlled for than coordinate conjunction, relative pronoun and pronominal adjective. Similar comments could be made about Kintsch & Glass (1974) and Kintsch & Keenan (1973). In their experiments the number of words was held constant, but different materials were used in the different conditions (see also Ratcliff & McKoon, 1978: 405).

In sum, if experiments are controlled for material effects, evidence for a propositional representation turns out to be not that strong. Evidence mainly comes from cued recall and other recognition studies and it is not very surprising that recognition performance on paraphrases of the text will be good and will obviously be better than the exact wording of the text. In other words, evidence for propositions may thus be considered as evidence for general recognition of textual information rather than for propositions as such.

3.3.2 Cognitive evidence for a situational level

Even if we assume that propositions play a role in text comprehension, we at least have to conclude that text comprehension cannot stop at a propositional representation. The reason is that several phenomena in text comprehension cannot be explained by only assuming a propositional level (Van Dijk & Kintsch, 1983: 338-342; Fletcher, 1994: 597-598; Zwaan & Radvansky, 1998: 163-165). We briefly discuss some of them:

1. *Individual differences in comprehension*: as we have seen, one clause can only be represented by one proposition. This would mean that there is only one interpretation for each sentence. This is clearly not the case as various comprehenders may have different points of view. Hence, a level of representation is needed that incorporates background knowledge.
2. *Translation*: translating a sentence into another language involves more than the translation of the proposition of that sentence. In a translation of literary language (metaphors, proverbs, etc.), additional information from the context is needed that is usually not represented in propositions.
3. *Reordering*: various studies (e.g. Bower, Black & Turner, 1979) have shown that subjects have no difficulty restoring the canonical order of a story in which the order of events had been scrambled. This process cannot be explained in terms of a propositional net only. In other words, we need some global coherence, something that is not represented in propositions.
4. *Updating and relating*: without necessarily changing previous propositional nets, people often update their understanding of a text or experience. We often change our opinion, 'add' information and 'delete' information. This suggests that there needs to be something more than propositions.

5. *Learning*: learning from a text is usually not learning the text itself. A representation into propositions only would give us the meaning of the text and not the information how that meaning is applied, as would be useful in manuals and recipes for instance.
6. *Cross-modality integration*: often comprehension comes from different modalities (visual, auditory, written), which require integration into a larger framework. The description of our way to the cinema cannot be stored as a propositional network only, as we deviate from the route and will still be able to find our way.

In the 1970s it was generally assumed (e.g. Anderson & Bower, 1973; Kintsch, 1974) that only a propositional representation could explain processes in text comprehension. In the beginning of the 1980s a shift can be noticed from a representation of the text to a representation of the situation described by the text (see also Zwaan and Radvansky, 1998: 162). To account for the above shortcomings of a propositional representation two influential studies (Van Dijk & Kintsch, 1983; Johnson-Laird, 1983), both assumed that next to a propositional representation at least another representation is needed that would capture more information than just the syntax and lexical information. This 'situation model' or 'mental model' captures not only text elements but integrates these elements with background knowledge.

As we have seen in Chapter 2 Kintsch & Van Dijk's (1978) influential paper assumed that the product of text comprehension is a text base, a propositional representation of the input discourse in memory. Van Dijk & Kintsch (1983) elaborate this theory by introducing a situation model. Van Dijk & Kintsch thus distinguish three levels of representation: the verbatim form of the linguistic expression, the propositional representation and the situational representation. The latter is "a cognitive representation of the events, actions and persons, and in general the situation" (ibid. 12). Similar to Van Dijk & Kintsch (1983), Johnson-Laird (1983) accepts the importance of propositional representations. He proposes in addition to a propositional representation two types of mental representations: a situation (mental) model and images.

[P]ropositional representations ... are strings of symbols that correspond to natural language, mental models ... are structural analogues of the world, and images ... are the perceptual correlates of models from a particular point of view. (Johnson-Laird, 1983: 165)

According to Johnson-Laird (1983) images are mental models, i.e., a visual representation of the world, but – different from ‘objective’ mental models – seen from a certain perspective. Both propositional representations and images then form special subclasses of mental models (ibid.: 146).

In sum, we have seen that the inflexibility of a propositional representation makes a situation model or mental model necessary. However, independent evidence for such a level of representation is very limited. Most evidence is based on the inadequacy of a propositional level in text comprehension. More evidence for situational level is provided by evidence for separate levels of representation, to be discussed next.

3.3.3 Cognitive evidence for separate levels

If there is no evidence for situation models, can their existence only be concluded from the inadequacies of propositions? Several studies have investigated the simultaneous occurrence of surface text, propositional and situational levels in memory for text comprehension. Schmalhofer & Glavanov (1986) tested the degree of propositional and situational processing by manipulating reader’s study goals. They distinguished two groups of readers, ‘text summarisation-readers’ and ‘knowledge acquisition-readers’. It was assumed that in the first group a propositional encoding was emphasised by ‘hierarchical processing’. Those text segments higher in the hierarchical propositional graph would receive more attention and hence reading time than subordinate levels. Knowledge acquisition-readers on the other hand would spend more time on text segments presenting information about the subject domain. The results of a self-paced reading time experiment showed that knowledge acquisition-subjects read the text faster than text summarisation-subjects. However, for text summarisation-subjects the reading times were highest for those segments highest in the propositional graph. This effect was not found for knowledge acquisition-subjects. In a subsequent experiment subjects were asked whether a test sentence had occurred verbatim in the text. The test sentences either were the original sentence, a paraphrase, a sentence in which the meaning was changed, or a sentence in which the correctness was changed. Memory for the verbatim information was weak for both text summarisation-and knowledge acquisition-subjects. Performance on the propositional information (paraphrase) was the same for both of these groups. However, a significant difference was found in the retrieval of inferential

information between text summarisation-and knowledge acquisition-subjects, knowledge acquisition-subjects showing a higher level of accuracy. The differences in levels of accuracy on verbatim information, paraphrases and inferences made Schmalhofer and Glavanov conclude that the recognition performance is a function of levels of representation.

Fletcher & Chrysler (1990) conducted four experiments to replicate Schmalhofer & Glavanov's (1986) results and to provide further evidence for cognition memory of three types of textual information. In a recall test subjects were presented with a critical sentence from a text they had read. One word of this sentence was either the original word or a synonym, a new word consistent with the linear ordering of the text, or a new word violating the linear ordering of the text. For instance, the text described how the main character George bought a painting for \$12.000 and a necklace for \$13.500. George says that his wife was angry when she found out that the necklace cost more than the (carpet/rug). George also had a vase, which belonged to the most expensive 'treasures' he had for \$50.000. Test sentences are presented in (4).

(4)

- (a) *Surface test*: George says that his wife was angry when she found out that the necklace cost more than the carpet/rug.
- (b) *Text base test*: George says that his wife was angry when she found out that the necklace cost more than the carpet/painting.
- (c) *Situation test*: George says that his wife was angry when she found out that the necklace cost more than the carpet/vase.

In all three test sentences the information is correct: the necklace costs more than the other items. All three distractors (the second word of the two options given) differ from the surface representation by a single word (*carpet*). If subjects can distinguish between the distractor and the word in general, it means that evidence is found for the surface representation. In the surface test this difference is limited to the meaning of the word. In the text base-test a discrimination between carpet and the distractor painting would indicate that the subject knows to distinguish the surface representation. However, if the difference in performance in the text base test exceeds that in the surface test, it provides evidence for a propositional memory, as the distractor is different in the surface structure,

but consistent with the linear ordering in the text. If performance for the carpet - vase distinction exceeds the carpet - painting difference, evidence is provided for a non-linear (situation) memory. Results showed that best performance was found on the Situation Test, followed by the Text Base Test. Lowest scores for the Surface test, however still with significant recognition memory.

To allow for the conclusion that psychological evidence is found for the text base (the difference between the surface test and the text base test) and for the situation model (the difference between the text base test and the situation test), an equal surface change in all three tests is essential. That is, in the three test sentences given above, it is necessary that the difference between carpet and rug, between carpet and painting, and between carpet and vase is more or less equal. This was tested in subsequent experiments. Fletcher & Chrysler's experiments showed that subjects can distinguish between sentences they have seen and the meaning derived from the sentence. Furthermore, discrimination performance improves if the distractor also introduces a new meaning and is even better when the distractors are inconsistent at all three levels of representation.

More cognitive evidence for three levels of representation is provided by Zimny (reported in Kintsch et al., 1990) in sentence recognition for the surface text, text base and situation model. Subjects were tested either immediately after a study phase in which they read a series of texts, 40 minutes, two days or four days later. Subjects saw a sentence as it had appeared in the text (memory for the surface structure of the text), a paraphrase with a minimal word order or single word change (memory for the text base) or an inference (memory for the situation model).

To eliminate effects because of the saliency or recognisability of these test sentences, three versions of the texts were made, so that each of the test sentences could serve as verbatim, paraphrase or inferential test sentences. In addition, two base line test sentences were used, one context appropriate, the other one inappropriate. Subjects were asked whether they had seen the test sentence before.

Results showed a strong interaction between the error rates of the answers and the function of delay (immediately, 40 minutes, two days, four days). The probability of the yes-responses is presented in Figure 1. The figure shows how the probability of yes-responses for old sentences (that is evidence for the surface structure, text base and situation model) is highest, directly followed by paraphrases (text base and situation model). The difference between the old sentence and the paraphrase disappears over

time. The probability of yes-responses for inference (situation model only) was lowest. Next, the memory strengths for each of the three levels were calculated, by first removing delay-dependent bias effects (as shown by the ascending line) and next calculating the difference between the types of test sentences. It was argued that a difference between the old and verbatim sentence would mean evidence for a surface structure representation; between the paraphrase and inference evidence for the text base representation; and the difference between inference and context appropriate distractor sentence evidence for the situation model. The results are plotted in Figure 1 and Figure 2. As can be seen in this figure, memory strength for the surface structure is only present immediately after the text. Memory of the text base decreases over time, while memory of the situation model remains high, even after four days.

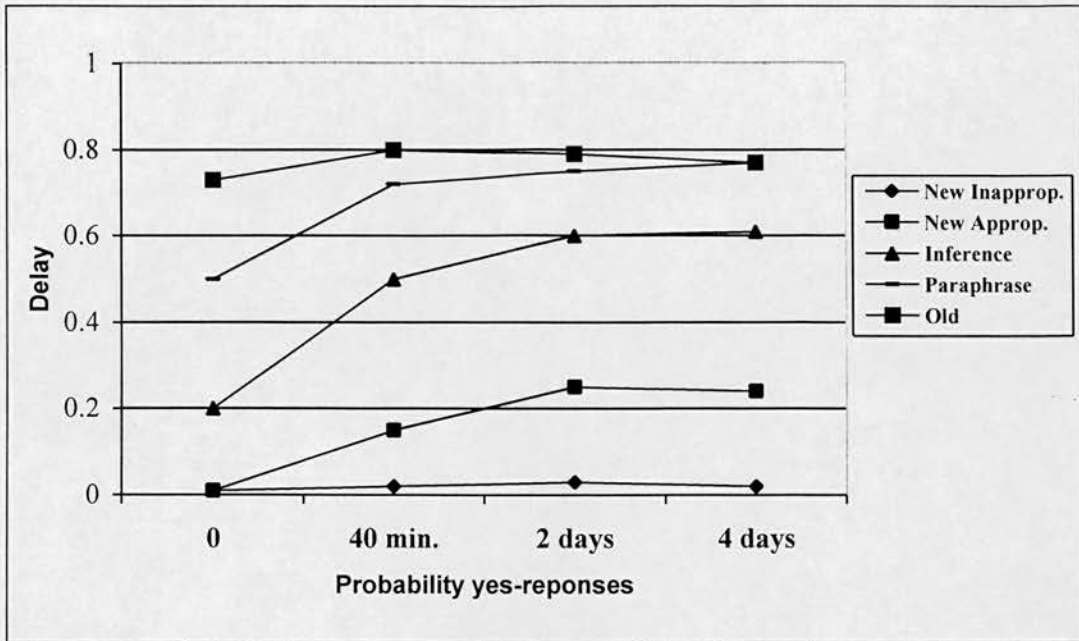


Figure 1 Probability yes-reponses (after Kintsch et al., 1990)

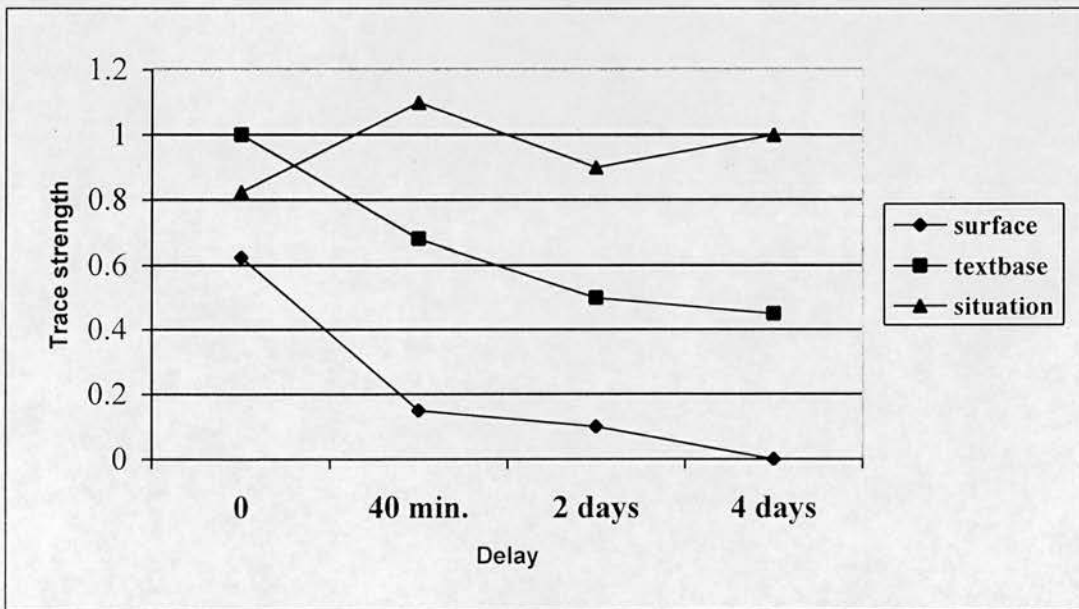


Figure 2 Estimated memory strengths (after Kintsch et al., 1990)

The studies discussed in this section suggest three levels of representation: a surface level that reflects the surface structure of the text, a propositional level that represents the meaningful information of the text, and a situational level that reflects the propositional level with added information from background knowledge and inferences. As we have seen, evidence for these levels can only be derived indirectly. This means that it might well be the case that there are more than three levels of representation (see

Johnson-Laird, 1983). It might also be the case that there are two levels of representation, a surface level and a situational level, with propositional information derived from these two levels (see Zwaan & Radvansky, 1998).

The question of the number of representations falls outside the scope of this research. The above studies at least show two levels of representation, a text-based and a knowledge-based level. These levels correspond to the cohesion- and coherence-based memory processes in Chapter 2. In that chapter we followed Gernsbacher's (1990) Shifting Hypothesis, which predicts that comprehenders forget the exact form of incoming information once they shift to a new substructure. In terms of the two levels of representation, it means that the cohesion-based information becomes less accessible once comprehenders shift to a new substructure. When comprehenders are cued to build such a substructure integration of cohesion-based information into a coherence-based mental substructure takes place. Cohesion-based and coherence-based information is what a representational system should represent, which is the answer to the structural question.

3.4 THE FUNCTIONAL QUESTION: PROPOSITIONS

3.4.1 Propositions in psycholinguistics

So far, we have addressed the structural question and looked at what representational systems represent. Although in the literature this question is often directly related to the functional question, the latter concerns merely a formalisation tool. To get insight in the comprehension of text, a formalisation of the events expressed in the text is desirable. This formalisation should at least be a working hypothesis representing what the basis of the meaning is and should describe the events described by the text as understood by the comprehender. Because a single, uniform format is desirable for this working hypothesis, the surface structure of the sentences of the text does not suffice, simply because this representation would be too variable. For instance, our understanding of an active sentence like "Bill kissed Monica" is more or less the same as that of the passive sentence "Monica was kissed by Bill", whereas the surface structure of the two sentences varies considerably. The representation needed should capture the meaning of

the text in a uniform format. Although a representation in other media than language (e.g. pictures, moving images or sounds) might be suitable, a representation in symbols is most convenient, as language can capture both concrete and abstract information, something pictures, for instance, cannot. Language can also be selective, leaving out information and focusing on other information, something that can hardly be achieved with a pictorial or auditory representation. Finally, symbols allow for computations, more than other forms of media do. Particularly in natural language processing (NLP) a formal representation in terms of propositions has been very common. Propositions are for instance the building blocks of NLP programming languages like LISP and PROLOG (e.g. Gazdar and Mellish, 1994: 380). Similarly, in psychology propositions have been used as a computational or analysing tool. So what do psycholinguists consider a proposition to be?

A proposition is a theoretical unit that contains a predicate (for example, a main verb, adjective, connective) and one or more arguments (for example, nouns, embedded propositions), with each argument having a functional role (for example, agent, patient, object, location). A proposition refers to a state, an event, or an action and frequently has a truth value with respect to a real or imaginary world. (Graesser, Gernsbacher & Goldman, 1997: 294)

Definitions like this can be found in almost the same wording elsewhere (e.g. Van Dijk & Kintsch, 1983: 111; Fletcher, 1994: 594). A proposition contains a predicator and a variable number of arguments. The predicator can be a verb, noun, adjective or connective. The argument can be any lexical item and even (embedded) propositions. The order of the arguments determines the participant (agent, experiencer, instrument, object, source, goal). Bovair & Kieras (1985) provide a guide to propositional analysis. Their proposal has particularly been written for a LISP implementation (1985: 317), but has served the psychological community as a first guide to propositionalising text. Their description of the propositional analysis is simple, which is the strength of their proposal. The researcher using propositions is for instance advised to use the simplest way to represent the text in case several reasonable ways are possible. That is, he is advised to avoid embedding, to avoid compound nouns and variants of terms (e.g. similar adjectives and adverbs) and to invent predicates where they result in a simpler representation (ibid.: 318). The rules for propositionalising text specified in Bovair &

Kieras (1985)⁴ are extremely useful in that they allow for a clear uniform representation.

Examples (5)-(10) give examples of a propositional representation.

(5)

- (a) Bill thinks.
- (b) P1 (THINK, BILL)

(6)

- (a) Bill tells the truth
- (b) P1 (TELL, BILL, TRUTH)

(7)

- (a) Why does Bill tell the truth?
- (b) P1 (WHY, P2)
- (c) P2 (TELL, BILL, TRUTH)

(8)

- (a) Monica believes Bill is an honest man
- (b) P1 (BELIEVE, MONICA, P2)
- (c) P2 (ISA, BILL, HONEST-MAN)

(9)

- (a) Because Bill kisses Monica, Kenneth sues him
- (b) P1 (BECAUSE P2, P3)
- (c) P2 (KISS, BILL, MONICA)
- (d) P3 (SUE, KENNETH, BILL)

⁴ Similar rules are given in Anderson & Bower (1973), Kintsch (1974), Van Dijk & Kintsch

(10)

- (a) If Bill hits Kenneth on the head with a stick, Kenneth sues him
- (b) P1 (IF, P2, P3)
- (c) P2 (HIT, BILL, KENNETH, STICK, HEAD)
- (d) P3 (SUE, KENNETH, BILL)

As can be seen in the above examples, each sentence is parsed into a predicate and one or more arguments. If more than one predicate can be determined, like in a two-clause sentence as (9), a meta-proposition is used that structures the two propositions. Arguments follow the predicate, usually in the order of agent, experiencer, instrument, object, source, goal. We will return to the participant roles later.

Using this formal representation, one is able to analyse summarisation and recall data in which differences in structure usually are not important, while differences in meaning are (e.g. Trabasso & Van den Broek, 1985). Propositions are also often used in computer programs that use elements of the meaning of the input text for calculations (e.g. Kintsch, 1988). In sum, propositions have for long been the answer to the functional question.

The idea of propositions as basic semantic units in text to explain psychological processes has become popular since the early work of Van Dijk (1972: 20), Anderson & Bower (1973: 3) and Kintsch (1974: 12). Van Dijk used propositions to characterise the sentential as well as the textual deep structure (Van Dijk, 1972: 37). Whereas Van Dijk's (1972) view is primarily to answer the functional question, others have combined the structural and functional question. According to Anderson & Bower (1973) for instance, propositions are configurations of elements with truth values, structured according to rules of formation (*ibid.*3). But they go one step further than an answer to the functional question and assume that information enters memory in propositional packages. Kintsch's (1974) use of propositions is similar to Anderson & Bower's (1973). However, whereas Anderson & Bower (1973) use propositions as binary units and accept decomposition of (binary) propositions into (binary) sub-propositions, Kintsch (1974) defines propositions as multi-element (non-binary) units. Both Anderson & Bower

(1983).

(1973) and Kintsch (1974) assume that propositions are not only useful as functional units, but they also serve as structural units in language understanding. Van Dijk & Kintsch's (1983) influential study follows the functional answer provided by Kintsch (1974) and the structural answer provided by Van Dijk (1972). The tension between the two questions and the confusion that has arisen since, becomes clear when one compares their claim that propositions are psychologically real (Van Dijk & Kintsch, 1983: 124) and their claim that they are merely a useful tool (Van Dijk & Kintsch, 1983: 38).

One must, however, guard against the view that they are all-purpose representations, and, in particular, provide "the" representation of meaning. They are no more than a tool – indeed, a rather primitive one – useful for certain purposes and useless for others. (Van Dijk & Kintsch, 1983: 38)

Our claim that propositions are suitable for a cognitive model is made in spite of repeated warnings from philosophers and logicians to the contrary. ... [S]everal philosophers and logicians have argued that, even if propositions can be taken as the meaning of (declarative) sentences, they should not be identified with mental objects of some kind, but rather treated as abstract constructs. (Van Dijk & Kintsch, 1983: 125)

The confusion of propositions being the answers to both the structural and functional question can be found in many other places. For instance in Perfetti & Britt (1995), who ask themselves where propositions come from. Like Perfetti & Britt many researchers would agree that propositions are directly derived from sentences by "some prepositional processes that operate on words, phrases, and sentences, whether spoken or written, in such a way as to yield something like propositions. These processes as a group are handily referred to as 'parsing'" (Perfetti & Britt, 1995: 11). Perfetti & Britt argue that syntactic tree structures of sentences can provide a guide in propositionalising sentences. Parsing supports the construction of propositions, for instance in sentences like "Monica sent Bill a present in the White House". Depending on the attachment of the PP (to the NP *Bill*, the VP *sent* or even to the NP *Monica*) a proposition is constructed. In other words, to construct propositions, the comprehender needs to apply parsing principles to understand the syntactic structures. Syntax and interpretative principles will then support the construction of propositions (Perfetti & Britt, 1995: 21). However, the question whether the analyser uses syntax in

the construction of a formal representation or whether the comprehender forms propositions on the basis of syntax is a fundamentally different one, as we will see later.

In sum, in psychology propositions are uniform formal representations of the meaning of the sentence. While some (Anderson & Bower, 1973; Kintsch, 1974) consider propositions as concrete memory structures, others (Van Dijk, 1972; Bovair & Kieras, 1985) merely see them as a short-hand notation to describe textual information.

It is important to note that propositions in psychology clearly mean something different than the propositions in linguistics and philosophy, as will be shown next. To avoid terminological confusion, the term 'propositions' as used in psychology on the one hand and in linguistics/philosophy on the other need to be distinguished⁵. Here we use *ψ-propositions* for those propositions used in psycholinguistic studies (e.g. as defined in Kintsch, 1998). The term *λ-propositions* will be used for those propositions used in formal semantic and philosophical studies (e.g. as defined in Lyons, 1977).

3.4.2 Propositions in philosophy and linguistics

In logic, philosophy and linguistics *λ*-propositions have always played a central role. The literature on *λ*-propositions is vast because the concept is neither clearly nor unanimously defined. Frege (1892) first offered a systematic insight in *λ*-propositions. Central to his ideas is the distinction between *Sinn* (sense) and *Bedeutung* (reference, meaning). The reference is the extra-linguistic entity denoted by a linguistic expression, the sense is the way the expression presents the referent, the cognitive value of the referent. The sense or 'thought' of the expression may therefore be seen as the *λ*-proposition.

Russell (1903) proposes not to make the Fregean distinction between sense and reference. This enables him to claim that thoughts too involve direct relations to objects.

⁵ In this study we will make a very rough distinction between psychology on the one hand, and linguistics and philosophy on the other. We are very well aware of the fact that by using this distinction we are not doing justice to the (interdisciplinary) character of these disciplines. With psychology we primarily mean psychological research on text and discourse. With linguistics/philosophy we primarily mean research in formal semantics.

In Russell's definition, λ -propositions consist of concrete objects as well as universals. Carnap (1942) on the other hand uses the concept of λ -proposition to relate to the semantic system of rules, as he states that there is no cognitive content to sentences. This system is constructed in a meta-language that refers to the object language. The rules, or rather definitions, of the system are part of a meta-language and determine the truth conditions for every sentence of an object language. Even within this brief description of λ -propositions as used by Frege, Russell and Carnap it becomes clear that the definitions vary considerably.

Despite the differences between the definitions of λ -proposition we could decide on a rather uniform definition of the term. In linguistic and philosophical terms, a λ -proposition is the semantic content of a statement. That is, "what is expressed by a declarative sentence when that sentence is uttered to make a statement" (Lyons, 1977: 141). Or: "[T]he proposition expressed by a sentence is that part of its meaning that provides information about the situations that can truly be described by the sentence" (Cann, 1993: 294). This then means "propositions are held constant in the translation from one language to another" (Lyons, 1995: 141). The λ -proposition "expressed by a declarative sentence uttered as a statement is true on some particular occasion if, and only if, that proposition corresponds to some state-of-affairs that obtains on that occasion" (Cann, 1993: 15)⁶. Consider the following examples:

(11)

- (a) Bill tells the truth.
- (b) Does Bill tell the truth?
- (c) Bill, tell the truth!
- (d) May Bill tell the truth.
- (e) If Bill tells the truth, Monica will.

All these sentences share a component of meaning, namely that they all make reference to a situation in which somebody called Bill engages in an activity of telling the truth. The λ -propositional content "that Bill tells the truth" are the truth conditions associated

with the declarative sentence (Cann, 1993: 19). The λ -propositional content is declared in (a), questioned in (b), encouraged in (c), wished for in (d) and conditioned in (e). λ -Propositions are objects of belief, that to which that-clauses refer to when preceded by the verb 'believe.'

The main characteristic of λ -propositions is that the predicates 'true' and false' apply. But what does it mean that a λ -proposition is true or false? It has to be kept in mind that "[i]t is not the sentence or form of words which is true or false, but what is expressed by it" (Kneale & Kneale, 1962: 49). Thus, it may be tempting to say that the sentence "Mike is writing Chapter 3" is true at one time and not true while Mike was writing Chapter 2 or when Mike will be writing Chapter 4, but this 'true or false' ('having been true', 'becoming true') is different from the true/false predicate of λ -propositions. The λ -proposition of the sentence "Mike is writing Chapter 3" is true if and only if Mike is writing Chapter 3. This does not mean that the proposition is only true while Mike writing Chapter 3 now, but every time that there is a reference to a situation in which somebody, called Mike, engages in an activity of writing a Chapter 3 in the present. Another example: the question whether the command "Mike, write Chapter 3!" is true seems odd, as commands are evaluated as wise or unwise (Kneale & Kneale, 1962: 53) rather than true or false.

A characteristic of that-clauses is that they create opaque contexts (e.g. Parsons, 1991: 31).

(12)

- (a) Monica believes Bill is an honest man.
- (b) Bill is the President.
- (c) Monica believes the President is an honest man.

If Monica knows that (a) is true and that Bill is indeed the President as expressed in (b), then (c) is true. In other words, only if (b) is true in the beliefs of the speaker in (a) as well as in those of Monica, then (c) is true. Hence, the λ -propositions represented by (a) and (c) are different. This can also be shown by a context where Kenneth might believe

⁶ Note that Cann uses state-of-affairs and situations interchangeably (cf. Cann 1993: 294 vs.

that Monica believes Bill is a dishonest man, without himself believing that Monica believes the President is a dishonest man.

At least two aspects of meaning cannot be explained in terms of truth-conditional semantics (Cann, 1993: 20). One concerns the illocutionary force of the utterance. Clearly, the sentences presented in (12) have different meanings in particular circumstances, despite the fact that their abstract sentence meaning (propositional content) is the same. This extra-linguistic information is not captured by λ -propositions. Secondly, implicatures cannot be accounted for in truth-conditional semantics. For instance, in case of a customer asking whether the barman has any white wine, it concerns a request rather than an informative question. The barman will infer that the customer would like to have a glass of wine, whereas a simple answer “I do” (without any subsequent actions) will not have the desired effect. Similarly, a two-clause sentence like (13)(a), tells us that “if somebody practises saxophone playing every day, I tend to like it”. However, truth-conditional semantics is not concerned with these implicatures. For text comprehension, however, they are essential. Consider for instance text (b) and (c).

(13)

- (a) My neighbour played saxophone. I didn't like it, although he practised every day.
- (b) ?I cannot stand neighbours who practise on their musical instruments every day.
My neighbour played saxophone. I didn't like it, although he practised every day.
- (c) I do not like it when neighbours play their musical instruments badly. But if they practise every day, I sometimes enjoy it. My neighbour played saxophone. I didn't like it, although he practised every day.

Text (b) sounds odd, because the implicature in the final clause is contradicted by the contextual information of the first clause. This contextual information cannot be captured in λ -propositions. But it seems that extra-linguistic information – background knowledge and inferencing – plays a very important role in text comprehension.

Cann 1993: 15).

In sum, a λ -proposition is true or false and may be known, believed or doubted. They can be expressed in declarative sentence, in particular that-clauses and correspond to a particular state-of-affairs (i.e. a real or imagined situation). As will be shown later, for these reasons λ -propositions differ considerably from the ψ -propositions used in psychology, as will be discussed next.

3.4.3 Why λ -propositions are not ψ -propositions

As we have seen, ψ -propositions have been borrowed from linguistics and philosophy. Numerous studies that use ψ -propositions include a disavowal that ψ -propositions are identical to λ -propositions (e.g. Kintsch, 1998: 37). Despite this, every definition of ψ -propositions contains a reference to truth-value and points out that the ψ -propositional structure is directly built upon the surface structure of the sentence.

Truth value

When we read a text, we assume – at least provisionally – all ψ -propositions are true, as stated in Grice's Cooperative Principle (see Chapter 1). We use ψ -propositions to build a model of represented events, and do not ponder on truth values, as has already been noted by Van Dijk (1972: 336). Although we can determine the truth value for a sentence like "snow is white", many sentences we use at different times and in different circumstances express different λ -propositions that can sometimes be true, sometimes be false. When the sentence "I am tired" is expressed by me, the λ -proposition is not the same as when this sentence is expressed by my office mate or when I express this sentence tomorrow. More generally: Is it of great importance to know whether ψ -propositions are true or false? We know that if a λ -proposition is true, all other entailed λ -propositions need to be true. In other words, the λ -propositional system needs to be consistent. In ψ -propositions this is different. The system does not need to be consistent, but it needs to be believed to be consistent by the participants in the communication process (writer/speaker and reader/listener).

Related to this question, we know the truth-value of λ -propositions is of importance for connected λ -propositions. Predicate logic allows us to determine the truth value for λ -propositions connected by conjunction, disjunction, implication and

equivalence. Strictly speaking, it does not allow us to calculate the truth-value of causally or temporally related propositional contents, because λ -propositions are atemporal, they exist outside time and space. Nonetheless, it seems that temporality and causality are essential in psycholinguistics.

Configuration of the surface structure

As we have seen, ψ -propositions are defined as basic language units, a semantic configuration of the surface structure of the text, both structurally and functionally (see Perfetti & Britt, 1995). However, λ -propositions do not allow a derivation of the sentence structure. They are abstract entities that lack a direct relation with the surface structure of the text. In other words, what psychologists would like to see in ψ -propositions, namely a re-configuration of the syntactic/semantic information of the text, cannot be established by λ -propositions.

In sum, ψ -propositions and λ -propositions are fundamentally different from each other and the term proposition is hence misleading. The questions then are how we can redefine ψ -propositions, what advantages such a redefinition has and what linguists use for semantic configurations other than λ -propositions. One of the answers to these questions will be discussed next.

3.5 SITUATIONS

3.5.1 What they are

As we have seen, λ -propositions correspond to state-of-affairs or situations (see Cann, 1993: 15). Similarly, we have seen that ψ -propositions refer to states, events and actions (see Graesser et al., 1997: 294). What are states, events and actions? What are situations?

When we think or talk about reality, we need some way of analyzing it. This we call a *system of classification and individuation*. Such a system consists of domains of situations, relations, locations and individuals. The commonplace that different schemes can be used to study the same reality is one to which situation theory subscribes. But this fact should not be thought of as showing that situations are structureless, with their properties projected onto them by language or thought. Rather, situations are rich in structure, and support a variety of schemes, suited (or unsuited) to various needs. (Israel & Perry, 1991: 8)

Situations are not true or false. They cannot be asserted, denied, known, believed or doubted. Instead, they hold or do not hold of an event and can be caused, prevented and perceived: they are occurrences in a world. Situations consist of eventualities and participants (see Parsons, 1990: 20-39)⁷. One situation can encompass one or more eventualities. Four kinds of eventualities: states, processes and events (accomplishments and achievements) can be distinguished, each denoted by a verb. Participant roles are related to the eventuality. Here we define five participant roles⁸ (agent, object, instrument, source and goal). The following classification can thus be made:

⁷ Following Parsons (1990: 20), we use the term eventualities rather than events to avoid confusion, as states, processes and events are covered by the term.

⁸ Parsons (1990: 73) uses slightly different participant roles:

Role	Typical position in active sentence in English
Agent	Subject
Theme	Direct object; subject of <i>is</i>
Goal	Indirect Object, or with 'to'
Benefactive	Indirect object, or with 'for'
Instrument	Object of 'with'; subject
Experiencer	Subject

EVENTUALITIES

STATE:

located in space, are perceivable, individual and last through time (14) Room 317 is on the third floor

PROCESS:

activities or happenings without finishing points (15) Mike ran

EVENT (ACCOMPLISHMENT):

happenings with finishing points taking a certain amount of time (16) Mike ran to the third floor

EVENT (ACHIEVEMENT):

instantaneous happenings (17) Mike reached the third floor

* PARTICIPANTS

AGENT:

instigator (performer) of an eventuality (18) *Mike* ran

OBJECT:

someone / something affected by (undergoing) an eventuality (19) Mike kicked the *door*

INSTRUMENT:

someone / something by means of which an eventuality is carried out (20) Mike kicked the door with *his foot*.

SOURCE:

someone / something from which some/something moves (21) Mike ran *from the computer lab*

GOAL:

someone / something toward which some/something moves (22) Mike ran to *office 317*

TEMPORALITY:

time when the eventuality takes place (23) *Early in the morning* Mike ran to office 317.

LOCALITY:

place where the eventuality takes place (24) Mike ran to office 317 in the *Adam Ferguson Building*

The distinction between eventualities may look like a task reserved for formal semantics rather than psycholinguistics. Nevertheless, eventualities play an important role in text comprehension, as will be discussed later in this chapter and later chapters. To facilitate

the task of classifying eventualities, the following memory aids can be applied (Parsons, 1990).

Pseudo-clefts can distinguish states from the other eventualities.

(25)

- State:*
- (a) Room 317 is on the third floor
 - (b) *What Room 317 did was be on the third floor

(26)

- Process:*
- (a) I ran.
 - (b) What I did was run

(27)

- Events (accomplishment):*
- (a) I ran to the third floor.
 - (b) What I did was run to the third floor.

(28)

- Events (Achievement):*
- (a) I reached the third floor.
 - (b) What I did was reach the third floor.

V-ing so (not) V-ed distinguishes events from processes. For Events (accomplishments/ achievements) one can say:

If x is V-ing then x has not V-ed.

Thus:

- (29) If I am running to the third floor, I have not run to the third floor (accomplishment).
- (30) If I am reaching the third floor, I have not reached the third floor (achievement).

For processes this rule does not apply. There, one can say:

If x is V-ing then x has V-ed.

- (31) If I am running, I have run.

Throughout the research we will use the term ‘situations’⁹ to describe eventualities plus their participants. The eventualities are denoted by the verbs in a sentence. Participants are denoted by the noun phrases in the sentence and are constrained by the eventualities they correspond with.

Lyons (1977: 483; 1995: 322) also uses the term ‘situations’ to cover actions, events and states. He distinguishes two kinds of situations: static and dynamic situations. Static situations are those that exist rather than happen and are homogeneous and continuous. They do not change throughout their duration. Dynamic situations do change throughout time. Lyons classifies states under static situations and processes and events under dynamic situations. We follow an argument brought forward by Kamp & Reyle (1993: 508) that differs from Lyons’ distinction. States differ from events in that the former involve a continuation, whereas the latter involve a termination. Processes do not have finishing points and hence show similarities with states. Obviously, such a higher-level distinction does not necessarily have to be made (as Parsons, 1990: 20 shows), but important here is that there are arguments given in the literature to classify only events under a common denominator and consider states and processes as being part of another.

In sum, situations consists of eventualities (states, processes and events) and participants (agent, object, instrument, source, goal). The eventualities denote verbs in the sentence, the participants are classified both by their syntactic functions and by the constraints of eventualities.

3.5.2 Underlying eventualities

Parsons follows Davidson’s (1980) ideas in natural language semantics, in that he assumes that semantic representations of sentences have underlying events. As we will adopt Parsons’ view on eventualities throughout the research, it is worthwhile discussing it here in more detail.

⁹ We are aware of the fact that the term ‘situations’ may cause terminological confusion with ‘situation model’. However, we prefer to use an established term in formal semantics.

Parsons compares verbs with common nouns. They do not stand for something, but for *kinds* of things. Similarly, ordinary verbs stand for *kinds* of actions or states. This means that a sentence like (32)(a) can be represented as (b).

(32)

(a) Bill kissed Monica

(b) $(\exists e)$ [Kissing(e) & Agent (e, bill) & Object (e, monica) & Culminate (e, before now)]

The representation¹⁰ in (b) says that there is a kissing event whose agent is Bill and whose object is Monica that culminated some time in the past. In this way three things present in the sentence become separate conjuncts that constrain the event of Bill kissing Monica. Thus, (b) involves an event of kissing in which two individuals (denoted by proper nouns) are involved, namely Bill being the agent of the event and Monica being the object of the event. Treating the event as a common noun and putting it in a key position of a semantic representation offers some interesting advantages over other formal semantic theories. We will discuss two of these advantages: logic of modifiers and explicit quantification over events.

Logic of modifiers

With a underlying event-structure it can be explained why a sentence like (33)(d) 'Bill kissed Monica on the cheek in the White House' entails (a) 'Bill kissed Monica', (b) 'Bill kissed Monica on the cheek' and (c) 'Bill kissed Monica in the White House'; (c) entails (a), and (b) entails (a).

(33)

(a) Bill kissed Monica.

(b) Bill kissed Monica on the cheek.

- (c) Bill kissed Monica in the White House.
- (d) Bill kissed Monica on the cheek in the White House.

The formal representation of these four sentences looks as follows. Sentence (a) reads that there is a kissing of Monica by Bill and that kissing took place before now; (b) adds that the event took place on the cheek, (c) that it took place in the White House, and (d) that it took place on the cheek in the White House.

- (a) $(\exists e)$ [Kissing(e) & Agent (e, bill) & Object (e, monica) & Culminate (e, before now)]
- (b) $(\exists e)$ [Kissing(e) & Agent (e, bill) & Object (e, monica) & On (e, cheek) & Culminate (e, before now)]
- (c) $(\exists e)$ [Kissing(e) & Agent (e, bill) & Object (e, monica) & Location (e, white house) & Culminate (e, before now)]
- (d) $(\exists e)$ [Kissing(e) & Agent (e, bill) & Object (e, monica) & On (e, cheek) & Location (e, white house) & Culminate (e, before now)]

Parsons (1990: 14) emphasises that not both (b) and (c) entail (d) as there may be a kissing event on the cheek and a separate kissing event in the White House where Bill did not kiss Monica on the cheek. The bottom line is that by using an underlying event analysis, the events are separated by their logical relations between the modifiers.

Explicit quantification over events

Another example Parsons (ibid. 20) gives for an underlying events account is the explicit quantification over events. When there is reference, there is quantification and in traditional logic inferring (c) from (a) and (b) is problematic.

¹⁰ For reasons of clarity, we omit marking the type of eventuality (state, process, event accomplishment, event achievement in the formal representation. Nevertheless, we do identify these types. For more information on the notation of the formal representation see Parsons (1990) and Cann (1993).

(34)

- (a) In every burning oxygen is consumed
- (b) Bill burned the wood
- (c) Oxygen was consumed.

Intuitively we know that (c) follows from (a) and (b). The inference however can be made by an underlying event approach as Parsons shows:

- (a) $(\exists e1) [\text{Burning}(e1) \rightarrow (\exists e2) [\text{Consuming}(e2) \ \& \ \text{Object}(e2, \text{oxygen}) \ \& \ \text{In}(e1, e2)]]$
- (b) $(\exists e2) [\text{Burning}(e2) \ \& \ \text{Agent}(e, \text{Bill}) \ \& \ \text{Object}(e2, \text{wood})]$
- (c) $(\exists e3) [\text{Consuming}(e3) \ \& \ \text{Object}(e3, \text{oxygen})]$

The above example reads that if there is a burning then there is a consuming of oxygen. There is a burning whose agent is Bill and whose object is wood and there is a consuming of oxygen.

Why is this digression on underlying events of any importance for text comprehension? The underlying event account explains various semantic phenomena, even very detailed ones as the examples above show.

3.5.3 Situations versus λ -propositions: why they are not the same

In the discussion of situations some differences between situations and λ -propositions may already have become clear. λ -propositions have a truth value, situations do not; λ -propositions are not derived from the sentence level, situations are. In other words, a situation is denoted by the linguistic expression. More specifically, its eventuality is denoted by the main verb of a clause, its participants by the syntactic information of the linguistic expression and the eventuality of the situation. Next, λ -propositions denote situations. λ -Propositions are true or false with respect to these situations. Hence, there are at least two fundamental differences between λ -propositions and situations: they point out different meanings and operate on different levels.

Another meaning

Consider the following three sentences:

(35)

- (a) Bill remembers Monica's arrival
- (b) Bill remembers that Monica arrived
- (c) Bill remembers the fact that Monica arrived

If λ -propositions and situations are identical (or should be represented in the same way because of their identical meaning) the meaning of sentence (a) and (b) would be the same. This is clearly not the case (after Zucchi 1993): In (35)(a) Bill may not have known Monica, where such a presupposition is impossible in (b). Example (b) entails (a) whereas it does not work the other way around. Both (b) and (c) are identical in meaning, but they differ from (a). Although a λ -propositional representation is not concerned with (and cannot account for) this difference, the difference can be given in terms of eventualities:

(36)

- (a) $(\exists e_1 \exists e_2)$ [remembering(e_1) & Agent(e , bill) & arriving (e_2) & Agent(e_2 , monica) & Obj(e_1 , e_2)].
- (b) $(\exists e_1)$ [remembering(e_1) & Agent(e_1 , bill) & Obj(e_1 , $\exists e_2$ [arriving (e_2) & Agent(e_2 , monica)]]].

There are two eventualities, *remembering* and *arriving*. In (36) the object of *remembering* is *arriving*, in (b) it is the λ -proposition containing an eventuality *arriving*. Thus, the two events in (36) appear on one level, whereas they are on different levels in (b). In (a) the object of *remembering* is the event of *arriving*. In (b), however, the complement of *arriving* is the λ -proposition *that Monica arrived*. This shows λ -propositions cannot be the same as situations because they mean different things.

Another level

The confusion between the two levels, one of λ -propositions on the one hand and situations on the other is understandable. The mistake of addressing properties of one level to the other can already be found in Aristotle's *De Interpretatione* (Kneale & Kneale, 1962: 54). Kneale and Kneale (1962: 591) give the following examples to point out the difference between the two levels:

- (37) He said, "I didn't hear you", which was true enough.
- (38) He said, "Ah've not 'eerd thi", which she didn't understand.

According to Kneale & Kneale (1962:54) inverted commas can for instance be used to designate λ -propositions in a sentence. The part inside the inverted commas of the second sentence can be translated without changing the meaning of the sentence. This cannot be done with the clause between inverted commas in the first sentence.

Lyons (1977: 442-446) makes a similar distinction in terms of first, second and third order entities:

- I. FIRST ORDER ENTITIES are located in a three-dimensional space. They may be referred to, properties may be ascribed to them within the framework of first order-languages (i.e. lower predicate calculus for instance);
- II. SECOND ORDER ENTITIES are events, processes and states, located in time, occurring or taking place, rather than existing;
- III. THIRD ORDER ENTITIES are abstract entities as propositions, outside time and place.
 - I. Properties of first-order entities may be ascribed to individuals;
 - II. Properties of second-order entities may be ascribed to first-order properties;
 - III. Properties of third-order entities may be ascribed to second-order properties.

The distinction between first-order entities and second-order entities is one of 'abstractness'. The former is relatively constant with respect to its perceptual properties, whereas the latter is more abstract (or rather less concrete, as they do have a spatio-temporal location). The distinction between second-order and third-order entities is one

of a spatio-temporal nature. The former are observable and have a temporal duration (or are instantaneous), the latter are not observable and do not occur in space or time.

Finally, Hengeveld (1989) makes the distinction between different levels in his multi-layered structure of an utterance. Four levels and their operators are distinguished, level 2 and 3 being identical to Lyons' level 2 and 3.

- | | | |
|----------------|---|----------------------|
| 1. predicate | → | property or relation |
| 2. predication | → | situations |
| 3. proposition | → | possible act |
| 4. clause | → | speech act |

Anaphoric reference can be made to different levels. Referring expressions (in the (b)-sentences) pick out antecedents at different levels (in the (a)-sentences) for each level:

(39)

- (a) Kenneth lost his game.
- (b) How sad, *he* tried so hard.

(40)

- (a) Kenneth lost his game.
- (b) *That's* not very surprising

(41)

- (a) It's not surprising that Kenneth lost his game.
- (b) *That's* true, I am afraid

(42)

- (a) Kenneth lost his game.
- (b) Do you mean *that* ironically?

Although the differences are subtle, the examples show how the pronoun in (39)(b) refers to a particular person in (a). In (40)(a)-(b) the second clause refers to a particular

situation that contains the eventuality losing of the game by Kenneth. In (41) we move to 'another level': (b) does not refer to the situation, but to the actual proposition stated in (a). Finally, in (42) extra-linguistic information is questioned, when the demonstrative does not refer to the proposition only, but to the speech-act. Important here is the distinction Hengeveld (1989) makes between the levels 2 and 3, λ -propositions and situations.

Temporality and causality

As we saw in Chapter 1, temporality and causality play a central role in discourse. In contrast to λ -propositions, situations have an internal and external time structure. The internal time structure is represented in the situation, the external time structure is a temporal relation to other situations in the universe of the discourse. λ -Propositions do not have such a temporal relation, they are solely connected by ψ -propositional connectives (*and, or, if... then, etc.*). Temporality therefore plays a role only in reference to situations. As a formal representation of the events described by the text requires some notion of temporality and causality, λ -propositions are not the right representation for this purpose.

In sum, situations and λ -propositions denote different meanings and operate on different levels; λ -propositions have truth-values, situations have not; situations are derived from the syntax of a sentence, λ -propositions are not; situations have an internal and external time structure, λ -propositions have not.

3.6 SITUATIONS VERSUS Ψ -PROPOSITIONS

3.6.1 Similarities between situations and ψ -propositions

We have seen that ψ -propositions are fundamentally different from λ -propositions. We have also seen that λ -propositions are fundamentally different from situations. First, neither ψ -propositions nor situations directly deal with truth values. Sentences may be considered to be true or false only in a derivative sense of expressing a true or false λ -proposition. Second, ψ -propositions and situations map onto the sentence structure. λ -

Propositions do not have such a relationship with sentences. Situations and ψ -propositions could thus be considered as more or less the same.

Ironically, Kintsch (1974) criticises Anderson & Bower (1973) for their psychological use of a historically defined term (namely “associations” in memory). Kintsch states that the historical term has stood for something different than what it is used for in psychology. The same criticism – though in a different context – nicely concludes the use of ψ -propositions in psychology: “This is good for their psychology, but bad for their history. Perhaps, it would be better to coin a new term for a new concept rather than to muddy in historical waters” (Kintsch, 1974: 42). Replacing ψ -propositions by situations is good for their history, for psychology and for linguistics.

3.6.2 Situations and ψ -propositions

Despite their similarities, situations and ψ -propositions are not synonymous. In their criticism of (both the functional and structural question of) ψ -propositions Sanford & Moxey (1995) give two examples of sentences whose meaning cannot adequately be captured by a ψ -propositional representation: the spatial problem and the multiple quantifier problem. In addition, tense, aspect and causality are problematic in a ψ -propositional account. For all these cases we will show that a representation into situations is preferable.

Spatial problem

That extra-linguistic information is needed to interpret a text can be seen in the following examples (after Sanford and Moxey, 1995: 167-168):

(43)

- (a) Hilary put the wallpaper on the wall.
- (b) Then she rested his mug of coffee on the wallpaper.

A traditional representation in ψ -propositions is presented in (a) and (b) of (43):

(44)

- (a) (PUT-ON, HILARY, WALLPAPER, WALL)
- (b) (PUT-ON, HILARY, MUG, WALLPAPER)

If a ψ -proposition is a simple linguistic representation, as in (43)(a) and (b), the incoherence cannot be detected. The anomaly becomes clear after an inference is made. In fact, the representation in ψ -propositions itself is not anomalous at all. It is the occurrence of the event in the world that makes it peculiar. The fact that a part of the event (in which the object is put on the wall) is not possible makes the situation odd. Note that the content of the sentence is certainly imaginable in a possible world, and a representation should therefore be able to give the structure. A representation into situations reads that there is a putting of wallpaper on the wall by Hilary; and there is a putting of a mug by Hilary on the wallpaper; and the putting of the wallpaper on the wall takes place prior to the putting of the mug on the wallpaper. Or into more detail:

(45)

- (a) $(\exists e1) [\text{Putting}(e1) \ \& \ \text{Agent}(e1, \text{hilary}) \ \& \ \text{Obj}(e1, \text{wallpaper}(x)) \ \& \ \text{On}(e1, x, \text{wall}(y))]$
- (b) $(\exists e2) [\text{Putting}(e2) \ \& \ \text{Agent}(e2, \text{hilary}) \ \& \ \text{Obj}(e2, \text{mug}(z)) \ \& \ \text{On}(e2, z, \text{wallpaper}(x)) \ \& \ \text{On}(e1, x, \text{wall}(y)) \ \& \ e1 < e2]$

It is true that situations cannot solve the problem either. But they do not have to when dealing with the functional question. What is needed is that they can clarify where background knowledge is needed to understand why the situation is odd. Thus, the heart of the problem lies in

$$[\text{On}(e2, z, \text{wallpaper}(x)) \ \& \ \text{On}(e1, x, \text{wall}(y)) \ \& \ e1 < e2]$$

Or, more specifically, in the transitivity of 'On'. Hence, situations do not solve the problem, but point out where the problem lies. Even this small achievement makes this representation preferable over ψ -propositions.

Multiple quantifier problem

Similar interpretation problems arise in the so-called multiple quantifier problem. Compare the following two ambiguous sentences and their preferred meaning (after Sanford and Moxey, 1995: 169):

(46)

- (a) Each student has a tutor (All students have at least one tutor)
- (b) (HAVE, STUDENT, TUTOR)

(47)

- (a) Each room has a bath (Each room has its own bath)
- (b) (HAVE, ROOM, BATH)

Sentence (46) represents a situation in which one student has one tutor, but one tutor may have more than one student, whereas in (47) each room has its own bath and that bath is not shared by any other room. A representation into ψ -propositions cannot point out the distinction between the two interpretations. Again, situations do not solve the problem either. What they can do, however, is show the two possible interpretations.

(46)

- (a) $(\exists e \forall x \exists y) [\text{Having}(e) \ \& \ \text{Agent}(e, \text{student}(x)) \rightarrow \text{Obj}(e, \text{tutor}(y))]$
- (b) ? $(\exists e \exists y \forall x) [\text{Having}(e) \ \& \ \text{Agent}(e, \text{student}(x)) \rightarrow \text{Obj}(e, \text{tutor}(y))]$

(47)

- (a) $(\exists e \exists y \forall x) [\text{Having}(e) \ \& \ \text{Agent}(e, \text{room}(x)) \rightarrow \text{Obj}(e, \text{bath}(y))]$
- (b) ? $(\exists e \forall x \exists y) [\text{Having}(e) \ \& \ \text{Agent}(e, \text{room}(x)) \rightarrow \text{Obj}(e, \text{bath}(y))]$

Example (46) reads that there is a having event whose agent is students and for all students there is a tutor. This is almost the same as (46)(b), but now there is a tutor for every student. Similarly, (47)(a) reads that there is a having event whose agent is room and for each agent there is a bath. In (47)(b) there is one bath for all rooms. Note that for both (46) and (47)

both representations should be allowed. Just because of our experiences in the world, we know that (46)(a) is more natural than (b) and (47)(a) more natural than (b).

Tense and aspect

A representation of tense and aspect in a ψ -propositional representation is also problematic. As we have already seen, in situations aspectual information is included in different types of eventualities (state, process, event accomplishment and event achievement). But other instances of tense and aspect provide further evidence for the difference between ψ -propositions and situations, and why the latter is preferable. Consider the following sentences:

(48)

- (a) Bill kisses Monica.
- (b) Bill kissed Monica.
- (c) Bill has kissed Monica.
- (d) Bill had kissed Monica.
- (e) Bill is kissing Monica.
- (f) Bill was kissing Monica.

A ψ -propositional representation of the examples (48) would look like:

(48)

- (a) P1 (PAST(P2))
- (b) P2 (KISS, BILL, MONICA)

Clearly, such a representation does not take into account important information from the surface structure of the sentence. We need a representation that captures the essence

of the meaning as well as the aspect and tense information. This is offered in a representation into situations. Sentences read as follows (following Parsons, 1990)¹¹:

(49)

- (a) For some event e : e is a kissing, the agent of e is Bill and the object of e is Monica and e culminates before now.
- (b) For some event e : e is a kissing, the agent of e is Bill and the object of e is Monica and e 's resultant-state holds now (where e 's resultant-state holds at time $t \equiv e$ terminates at some time at or before t)
- (c) For some event e : e is a kissing, the agent of e is Bill and the object of e is Monica and e 's resultant-state holds before now (where e 's resultant-state holds at time $t \equiv e$ terminates at some time at or before t)
- (d) For some event e : e is a sleeping, the agent of e is child, and e 's in progress-state holds now (where the in-progress state holds while e is in progress and at no other time)¹².
- (e) For some event e : e is a sleeping, the agent of e is child, and e 's in progress-state holds before now (where the in-progress state holds while e is in progress and at no other time).

As can be seen, whereas the essence of the meaning of the sentence remains the same in the examples [*Kissing(e) & Subject (e, Bill) & Object (e, Monica)*] and is also expressed by ψ -

¹¹ In a more formal and detailed representation:

- (a) $(\exists e)$ [*Kissing(e) & Agent (e, bill) & Object (e, Monica)*].
- (b) $(\exists e)$ [*Kissing(e) & Agent (e, bill) & Object (e, Monica) & Cul(e, before now)*].
- (c) $(\exists e)$ [*Kissing(e) & Agent (e, bill) & Object (e, Monica) & $(\exists t)$ [*RS(e,t) & Holds(e,t)*]*].
- (d) $(\exists e)$ [*Kissing(e) & Agent (e, bill) & Object (e, Monica) & $(\exists t)$ [*RS(e,t) & Holds(e,t) & Cul(e, before now)*]*].
- (e) $(\exists e)$ [*Kissing(e) & Agent (e, bill) & Object (e, Monica) & $(\exists t)$ [*IP(e,t) & Holds(e,t)*]*].
- (f) $(\exists e)$ [*Kissing(e) & Agent (e, bill) & Object (e, Monica) & $(\exists t)$ [*IP(e,t) & Holds(e,t) & Cul(e, before now)*]*].

¹² In fact, a second interpretation in which [is kissing] is not the progressive verb, but [kissing] is an adjective reads as follows: for some state s : for some event e : e is sleeping & $s = e$'s in-progress state, the agent of s is Bill, the object is Monica and e holds now.

propositional representation. The differences in tense and aspect are additions to this core representation into situations.

Temporality and causality

ψ -Propositional networks can be constructed from the text and connected ψ -propositions can be marked by a connective as their predicate. However, as pointed out in the previous section, representing coherence relations in ψ -propositions is problematic, as the construction of a coherence relation often does not come from clausal information, but rather from the contextual information. Consider the following clauses and their ψ -propositional representations.

(50)

- (a) Monica hit Bill, because he kissed her
- (b) P1 (BECAUSE, P2, P3)
- (c) P2 (HIT, MONICA, BILL)
- (d) P3 (KISS, BILL, MONICA)

(51)

- (a) Monica hit Bill after he kissed her
- (b) P1 (AFTER, P2, P3)
- (c) P2 (KISS, BILL, MONICA)
- (d) P3 (HIT, MONICA, BILL)

(52)

- (a) Bill kissed Monica before she hit him
- (b) P1 (BEFORE, P2, P3)
- (c) P2 (HIT, MONICA, BILL)
- (d) P3 (KISS, BILL, MONICA)

(53)

- (a) Monica hit Bill. He kissed her
- (b) P1 (HIT, MONICA, BILL)

(c) P2 (KISS, BILL, MONICA)

What we need is a formal representation that captures the information in the text, but also allows a representation of the possible implicatures. Situations offer such a representation.

(54)

- (a) Monica hit Bill because he kissed her
- (b) $(\exists I) [I > \text{now} \ \& \ (\exists e_1) (\exists t_1) [t_1 \in I \ \& \ \text{Kissing}(e) \ \& \ \text{Subject} (e_1, \text{Bill}) \ \& \ \text{Object} (\text{Monica}) \ \& \ \text{Cul} (e_1, t_1) \ \& \ (\exists e_2) (\exists t_2) [\text{Hitting}(e_2) \ \& \ \text{Subject} (e_2, \text{Monica}) \ \& \ \text{Object} (e_2', \text{Bill}) \ \& \ \text{Cul}(e_1, t_2) \ \& \ \mathbf{CAUSE}(e_1, e_2)]]]$.

(55)

- (a) Monica hit Bill after he kissed her.
- (b) $(\exists I) [I > \text{now} \ \& \ (\exists e_1) (\exists t_1) [t_1 \in I \ \& \ \text{Kissing}(e) \ \& \ \text{Subject} (e_1, \text{Bill}) \ \& \ \text{Object} (\text{Monica}) \ \& \ \text{Cul} (e_1, t_1) \ \& \ (\exists e_2) (\exists t_2) [\text{Hitting}(e_2) \ \& \ \text{Subject} (e_2, \text{Monica}) \ \& \ \text{Object} (e_2', \text{Bill}) \ \& \ \text{Cul}(e_1, t_2) \ \& \ \mathbf{t2 \ is \ after \ t1}]]]$.

(56)

- (a) Bill kissed Monica before she hit him.
- (b) $(\exists I) [I > \text{now} \ \& \ (\exists e_1) (\exists t_1) [t_1 \in I \ \& \ \text{Kissing}(e) \ \& \ \text{Subject} (e, \text{Bill}) \ \& \ \text{Object} (\text{Monica}) \ \& \ \text{Cul} (e, t_1) \ \& \ (\exists e_2) (\exists t_2) [\text{Hitting}(e_2) \ \& \ \text{Subject} (e_2, \text{Monica}) \ \& \ \text{Object} (e_2, \text{Bill}) \ \& \ \text{Cul}(e_2, t_2) \ \& \ \mathbf{t1 \ is \ before \ t2}]]]$.

(57)

- (a) Bill kissed Monica. She hit him.
- (b) $(\exists I) [I > \text{now} \ \& \ (\exists e_1) (\exists t_1) [t_1 \in I \ \& \ \text{Kissing}(e) \ \& \ \text{Subject} (e_1, \text{Bill}) \ \& \ \text{Object} (\text{Monica}) \ \& \ \text{Cul} (e_1, t_1) \ \& \ (\exists e_2) (\exists t_2) [\text{Hitting}(e_2) \ \& \ \text{Subject} (e_2, \text{Monica}) \ \& \ \text{Object} (e_2', \text{Bill}) \ \& \ \text{Cul}(e_1, t_2) \ \& \ \mathbf{CAUSE}(e_1, e_2)]]]$.

These four sentences can – and most likely are – interpreted in the same way, i.e., that Monica hit Bill because he kissed her. As a ψ -proposition is an abstract representation of

the meaning of the clauses, we would expect a representation like the one presented in (54)(a) But at the same time, such an abstract representation does not do justice to *possible* different interpretations. In other words, implied interpretations, e.g. in the case of implicit coherence relations, are difficult to represent in ψ -propositions. They can be represented in situations. Except for the parts in bold, the examples (54)-(57) are identical. The parts in bold make the representations unique to the particular sentence: they specify the event. The overlap between the sentences points out the *possible* different interpretations.

The examples in this section show some of the problems a ψ -propositional representation is concerned with. The main problem lies in the rigidity of ψ -propositional representations: they do not allow for the flexibility often needed. In recent years formal semantics often used a representation in terms of situations for this purpose. We have shown that such a representation offers more (necessary) detail than ψ -propositions and is therefore preferred.

3.7 COHESION AND COHERENCE REPRESENTED IN SITUATIONS

In the beginning of this chapter we made the distinction between the structural question and the functional question, that is, between what the system represents and what the system looks like. So far, we have shown that situations are the preferred answer to the functional question. This claim would become stronger if we can show that situations might provide us with insight in the answer to the structural question.

3.7.1 Specification

In Chapter 1 we defined five cohesion and coherence strands: REFERENTIAL, LOCATIONAL, CAUSAL, TEMPORAL and ADDITIVE strands. We ended that chapter with several questions that would be answered in this research, one concerning the extent to which each of the cohesion strands is independent of the others in its effects on the comprehender. In Chapter 2 we gave a tentative answer to this question. We argued that cohesion relations independently affect the comprehension process, because a cohesion strand is mapped onto the developing structure, but they also interdependently affect the comprehension process, because once a cohesion strand is activated it may get

enhanced if it interrelates with other activated strands. We claimed that interdependent relations are more specific than independent relations and predicted that less specific relations direct resources toward cohesion-based information, while more specific relations direct to coherence-based information (Specification Hypothesis). This means that the answer to the functional question should point out the interdependency and specification of cohesion and coherence relations. This is what situations do. Consider sentence (58):

(58)

- (a) Bill kissed Monica in the White House at 17.00 in the afternoon and that was the reason Monica hit him in the White House at 17.01 in the afternoon.
- (b) Bill kissed Monica at 17.00 in the afternoon and Monica hit him at 17.01 in the afternoon
- (c) Bill kissed Monica in the White House and Monica hit him in the White House.
- (d) Bill kissed Monica and Monica hit him.

The situation expressed in (a) entails the conjunction of the situations in (b) and (c), and (b) either (c) entail (d). This means that more specific situations entail less specific situations. Consider sentence (59):

(59) Bill kissed Monica in the White House in the afternoon. For that reason, Monica hit him.

- (a) $(\exists e)$ [Kissing(e) & Agent (e, Bill) & Object (e, Monica) & Location (e, White House) & Time (e, afternoon) & Culminate (e, before now)]
- (b) $(\exists e)$ [Hitting(e) & Agent (e, Monica) & Object (e, Bill) & Location (e, White House) & Time (e, afternoon) & Culminate (e, before now)]
- (c) $(\exists e)$ [Hitting(e) & Agent (e, Monica) & Object (e, Bill) **& Location (e, White House) & Time (e, afternoon)** & Culminate (e, before now)]

Although (a) and (b) give the correct analysis in situations of sentence (59), we read the second clause of the sentence as taking place in the White House in the afternoon, that is, the implicature is the bold part in (c). This would mean that unless there is a

REFERENTIAL, LOCATIONAL, CAUSAL, TEMPORAL or ADDITIVE cohesion strand, the particular strand from preceding situations is to be assumed. In other words, unless there is a discontinuity of a particular strand, the continuity of the strand may be assumed. This is what we called 'global cohesion and coherence' in Chapter 1 (see also conclusion of Chapter 2). This issue is further taken up in the next chapter.

If it is true that more specific situations entail less specific ones, this 'specification rule' may explain why (a) entails (b) and (c), and (b) entails (c) in example (60).

(60)

- (a) Because Bill kissed Monica, she hit him.
- (b) After Bill kissed Monica, she hit him.
- (c) Bill kissed Monica and she hit him.

- (a) $(\exists I) [I > \text{now} \ \& \ (\exists e1) (\exists t1) [t1 \in I \ \& \ \text{Kissing}(e) \ \& \ \text{Subject} (e1, \text{Bill}) \ \& \ \text{Object} (\text{Monica}) \ \& \ \text{Cul} (e1, t1) \ \& \ (\exists e2) (\exists t2) [\text{Hitting}(e2) \ \& \ \text{Subject} (e2, \text{Monica}) \ \& \ \text{Object} (e2', \text{Bill}) \ \& \ \text{Cul}(e1, t2) \ \& \ \text{CAUSE}(e1, e2)]]]$.
- (b) $(\exists I) [I > \text{now} \ \& \ (\exists e1) (\exists t1) [t1 \in I \ \& \ \text{Kissing}(e) \ \& \ \text{Subject} (e1, \text{Bill}) \ \& \ \text{Object} (\text{Monica}) \ \& \ \text{Cul} (e1, t1) \ \& \ (\exists e2) (\exists t2) [\text{Hitting}(e2) \ \& \ \text{Subject} (e2, \text{Monica}) \ \& \ \text{Object} (e2', \text{Bill}) \ \& \ \text{Cul}(e1, t2) \ \& \ \text{after} (e1, e2)]]]$.
- (c) $(\exists I) [I > \text{now} \ \& \ (\exists e1) (\exists t1) [t1 \in I \ \& \ \text{Kissing}(e) \ \& \ \text{Subject} (e1, \text{Bill}) \ \& \ \text{Object} (\text{Monica}) \ \& \ \text{Cul} (e1, t1) \ \& \ (\exists e2) (\exists t2) [\text{Hitting}(e2) \ \& \ \text{Subject} (e2, \text{Monica}) \ \& \ \text{Object} (e2', \text{Bill}) \ \& \ \text{Cul}(e1, t2)]]]$.

The analysis of sentences (a)-(c) show that CAUSAL strands entail TEMPORAL strands, and TEMPORAL strands entail ADDITIVE strands. We return to this issue in Chapter 5.

Important to note here is that that a representational system with underlying events offers insight in the cohesion relations between situations by pointing out how specific the cohesion of a situation is.

3.7.2 Eventualities in text comprehension

We have seen that the distinction of eventualities into states, processes and accomplishments and achievements capture aspect of the verb. The question is whether this division is useful for psycholinguistic research, as it could be argued that the use of eventualities is too fine-grained for psycholinguistics.

Several studies have shown verb aspect has an impact on the perception of the duration of situations in narrative. Subjects perceived the location of a character in a narrative differently depending on the aspect of the verb (perfective, imperfective) (Morrow, 1985a). Carreiras (1997) found differences in subjects between foregrounded imperfective situations and background perfective situations. Recently, Magliano & Schleich (2000) found further evidence that aspect provides processing instructions for situation construction and the maintenance of information in working memory. Magliano & Schleich investigated the role of verb aspect in text comprehension. Subjects saw texts like (61) with either imperfective or perfective aspect sentences.

(61)

Aspect sentence:

- (a) Gabe was climbing toward the top of the tower. (imperfective)
- (b) Gabe climbed onto the top of the tower. (perfective)

Post aspect sentence:

- (a) He was never more scared.
- (b) His friends tried to calm him down.
- (c) Gabe tried his best to listen to them.

Critical test question:

Has Gabe reached the top of the tower yet?

Subjects were asked three yes/no questions, one during the introduction of the text, one during the experimental sentences and one during the conclusion. The questions were about whether the activity was completed or still ongoing. Results showed that subjects considered imperfective aspect sentences as ongoing activities and perfective aspect

sentences as completed activities. Furthermore, the likelihood an activity was considered ongoing decreased across the four experimental sentences. This can be explained by the fact that subjects assumed the activity would be completed, the more the story progressed. Magliano & Schleich's experiments showed that comprehenders are sensitive to aspectual information in the text and that activation of this information is dependent on working memory capacities. They demonstrated that comprehenders keep track of whether or not activities are completed.

Using aspect in the representation of the text is not only useful because aspectuality plays a role in the comprehension process, but also because it offers other practical information. Particularly the aspectual features eventualities contain, constrain the combinations of events in terms of temporality and causality. Hence, on the basis of lexical and syntactic information, we can predict situational structures.

Simultaneous situations most likely consist of two processes or two states:

(62) Bill ate (and at the same time) he drank (process + process)

Temporal sequences of situations most likely consist of two events accomplishment/achievement:

(63) Bill ate a sandwich (and then) he drank a beer (event (acc.) + event (acc.))

Causal relations most likely consist of a process and a state:

(64) Bill ate a sandwich (because) he was hungry. (event (acc.) + state)

In sum, we have seen that a categorisation using eventualities is also useful because experimental evidence shows differences in comprehension for aspectual information. Although we have mainly focussed on situations as the answer to the functional question, this shows that a link to the structural question. Some relation between the two may be useful, as a representational system that has no link to a psycholinguistic theory may lead us astray.

3.8 CONCLUSION

In this chapter we have proposed a representational system that best describes the rich structure textual understanding is associated with. Two questions are of importance with regard to a representational system. A functional question asks what the representational system looks like, a structural question asks what the system represents. Although we are mainly concerned with the functional question, that is, in finding a tool of describing the rich structure associated with textual understanding, we started this chapter with addressing the structural question. We discussed the symbol grounding problem and two of its solutions: an amodal system (like the CI Model's LSA and propositions) and Embodiment theory. We then argued that these two solutions could be reconciled. The embodiment theory seems to involve indexical relations, that is, resembles those relations between the sign and the external world. The amodal system on the other hand seems to resemble a symbolic relationship, that is, a relationship built upon the indexical relationships. We argued that this distinction is very similar to the one we made in Chapter 2 between cohesion-based and coherence-based processes, two interdependent levels of representation in the comprehension process. Cognitive evidence for this distinction also comes from studies that investigated separate levels of representation. Although these studies generally argue for three levels – a surface structure, propositional and situational level – we concluded that they do at least not contradict the cohesion-coherence distinction.

Most commonly the representational system used in psycholinguistics has been propositional. We argued that the use of propositions as the answer to the functional question does not suffice and proposed the general formal semantic use of situations. Situations, particularly eventualities, represent aspectual properties expressed in language, something λ -propositions are not able to represent and ψ -propositions do not represent. λ -Propositions are abstract objects existing outside time and space. On the other hand, ψ -propositions are meant to be mental representations of some kind that reflect the propositional content of a sentence. This representation includes time and space. The information conveyed by ψ -propositions is an abstraction of the (surface) syntax of a text but bears a direct relation to it. However, the representation language of ψ -propositions is not fine-grained enough and fails to accommodate the rich structure that appears to be associated with textual understanding according to the experimental data. Hence, we need a

representation language that does not take the λ -proposition (or expressions that denote λ -propositions) as its basis but must use more expressive logic to represent textual meaning. The relation between the semantic objects denoted by these representations and λ -propositions in the philosophical and linguistic literature remains to be explained further.

In this chapter we have answered the question what representational system is best to be used in describing the rich structure textual understanding is associated with. The structure of underlying events has several advantages over the most commonly used representational system. One of these advantages is that it can point out the interdependency and the specificity of a cohesion relation.

If situations is the answer to what a representational system should look like and if cohesion relations can be pointed out in multiple situations, can such a representational system be used in understanding how textual cohesion supports representational coherence? The answer to this question will be given in the next chapter.

CHAPTER 4

VOCABULARY-DRIVEN COHESION AND COHERENCE RELATIONS: A COMPUTATIONAL MODEL

4.1 INTRODUCTION

In Chapter 1 we defined four types of cohesion and coherence: local and global, and grammar-driven and vocabulary-driven relations. We also defined five strands REFERENTIAL, LOCATIONAL, CAUSAL, TEMPORAL and ADDITIVE. In Chapter 2 we presented a blueprint for comprehension and defined the Specification Hypothesis. In order to test this hypothesis we proposed a representational system. With all this information we now have all ingredients to provide a first answer to the main question we formulated in Chapter 1, that is, how textual cohesion supports representational coherence. We do this by looking at vocabulary-driven cohesion and coherence.

Vocabulary-driven strands have received much attention in the psycholinguistic literature. However in most studies the strand under investigation has not been controlled for effects from interdependent strands. Furthermore, mutual interdependence of cohesion and coherence strands has rarely been studied. Computational models lend themselves well to such an investigation, as cohesion strands can precisely be manipulated. Vocabulary-driven cohesion can then be represented as a large number of relations with weights between the elements of the situations described by the text. Computational studies can measure the effects of vocabulary-driven cohesion on summary and recall data. The aims of the computational study are to answer the questions 'whether cohesion relations support coherence, whether interdependent relations facilitate comprehension and to predict the textual information essential for the coherent mental representation.

Three questions related to the main question in this research play a central role in this chapter: whether the presence of vocabulary-driven cohesion strands facilitates comprehension (Cohesion Question), whether these strands independently and/or interdependently affect the comprehension process (Interdependency Question), and whether multiple cohesion strands facilitate comprehension (Multiple Strands Question).

Before we address these questions, we need to address another issue that can serve as an introduction to connectionism. In Chapter 1 and Chapter 2 we showed that by default situations are cohesively described in the text and comprehenders construct a coherent mental representation of this cohesion. In effect, we have discussed cohesion and coherence, while disregarding incoherence. We will address this issue first.

4.2 COHERENT, NOT COHERENT, INCOHERENT

A characterisation of coherence is provided by Thagard & Verbeurgt (1998), who consider coherence as a maximal satisfaction of multiple constraints. Their proposal can be summarised as follows (Thagard and Verbeurgt, 1998: 3):

1. Elements are representations such as concepts, propositions, parts of images, goals, actions, and so on;
2. Elements cohere (fit together) or incohere (resist fitting together). Coherence relations include explanation, deduction, similarity, association, and so on. Incoherence relations include inconsistency, incompatibility, and negative association;
3. If two elements cohere, there is a positive constraint between them. If two elements incohere, there is a negative constraint between them;
4. Elements are to be divided into ones that are accepted and ones that are rejected;
5. A positive constraint between two elements can be satisfied either by accepting both of the elements or by rejecting both of the elements;
6. A negative constraint between two elements can be satisfied only by accepting one element and rejecting the other;
7. A coherence problem consists of dividing a set of elements into accepted and rejected sets in a way that satisfies the most constraints.

Thagard & Verbeurgt's argument is as follows: two elements cohere if there is a positive constraint between them, and they incohere if there is a negative constraint between them. Thus, if we have a set of elements, e_1 , e_2 and e_3 , so that e_1 explains e_2 , we have to make sure that when we accept e_1 we also have to accept e_2 (positive constraint). If e_1 is inconsistent with e_3 , we can accept only one of the two (negative constraint). Now consider the following elements: $\{e_1 = \text{Bill loves Monica}\}$, $\{e_2 = \text{Bill kisses Monica}\}$, $\{e_3 = \text{Bill hits Monica}\}$. The element $\{e_1 = \text{Bill loves Monica}\}$ fits with $\{e_2 = \text{Bill kisses Monica}\}$ but conflicts with $\{e_3 = \text{Bill hits Monica}\}$. Now "[m]aximizing coherence is a matter of maximizing satisfaction of a set of positive and negative constraints" (Thagard &

Verbeurgt, 1998: 1). Hence, a sentence like *Bill kisses Monica, because he loves her* is coherent, a sentence like *Bill hits Monica, because he loves her* is incoherent. This example has been kept simple in order to ensure that partitioning the elements into an accepted set of positive constraints and a rejected set of negative constraints does not cause too many conflicts. Sometimes, however, the coherence problem becomes more interesting when one needs to satisfy as many constraints as possible and give more significance to some constraints than to others.

For instance, consider the famous duck-rabbit image (see Figure 1), which can either be seen as a duck or as a rabbit.

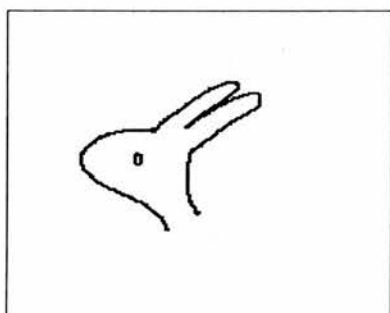


Figure 1 Duck-rabbit picture

Now, let E be a finite set of elements of the picture, say $\{e_1 = \text{beak}\}$, $\{e_2 = \text{eye}\}$ and $\{e_3 = \text{ears}\}$. Let C be a set of constraints on E understood as a set of pairs of elements of E . Thus: $\{(e_1, e_2) = (\text{beak}, \text{eye})\}$, $\{(e_1, e_3) = (\text{beak}, \text{ears})\}$, $\{(e_2, e_3) = (\text{eye}, \text{ears})\}$. This set of constraints C can be divided into positive constraints on E ($C+$) and negative constraints ($C-$). Each constraint has a certain strength, defined as the weight w . The coherence problem entails the partitioning of the picture E into two sets, one accepted set A and one rejected set R . We need to decide which of the pairs of elements are accepted and which ones are rejected. Elements $\{(e_1, e_3) = (\text{beak}, \text{ears})\}$ resist fitting together and are part of the rejected set. A coherent rabbit image contains $\{(e_2, e_3) = (\text{eye}, \text{ears})\}$, a duck image $\{(e_1, e_2) = (\text{beak}, \text{eye})\}$, both pairs of elements are part of the accepted set A . However, it is impossible to satisfy both $C+$ constraints simultaneously – see a duck and a rabbit at the same time – so we have to satisfy as many constraints as possible and give preference to more important ones. On the basis of this description of coherence, Thagard & Verbeurgt are now able to compute coherence by using a connectionist (neural network) algorithm. $C+$ constraints form the excitatory links,

while the *C*- constraints form the inhibitory links of the network. Maximising the goodness-of-fit or harmony of the network is maximising coherence.¹

Thagard & Verbeurgt's approach is insightful and useful, because it breaks coherence in smaller components and enables us to calculate coherence problems. Nevertheless, it is a simplification of cohesion and coherence. For instance, they argue that the positive constraint for discourse comprehension is semantic relatedness, while a negative constraint is inconsistency. Givón (1995: 75) describes the extreme bounds of cohesion in a similar way. The upper bound of cohesion is logical tautology (e.g. sentence pair (1)), the lower bound is logical contradiction (e.g. sentence pair (2)).

- (1) Bill kissed Monica, Bill kissed Monica.
- (2) Bill kissed Monica, Bill didn't kiss Monica.

According to Givón (1995: 75) a sentence pair like (1) coheres maximally, because all elements of the second clause correspond to all elements of the first clause. The same can be said for sentence (2), except for its truth value. He adds that a "common cognitive, pragmatic sense of incoherence involves the absence of recurrent element(s) across the text" (Givón, 1995: 75) as in sentence pair (3).

- (3) Bill kissed Monica, the cow jumped over the fence.

"Most coherent – interpretable texts fall somewhere in the middle between the two extremes of total redundancy and utter incoherence" (Givón, 1995: 75). Givón does not say whether "utter incoherence" characterises sentence (2) or (3). Although Givón's point about most coherent interpretable texts is plausible, the argument leaves some open questions. Sentence (1) is not really coherent, as it is maximally redundant. It is not really incoherent either, as logical tautology *could* be part of a text, as in (4):

- (4) She thought about the alternatives. But she wouldn't go. She wouldn't go. She simply wouldn't go. Even if they begged her, she wouldn't go.

¹ As we saw in Chapter 2, Kintsch's (1988, 1998) CI Model, shows how the maximisation of constraints may take place in a connectionist environment. Thagard & Verbeurgt (1998: 5) refer

Sentence (2) is not coherent, because it is logically untrue. But it is not really incoherent either, because it could indeed be part of a text, as in (5).

(5) Monica simply wasn't sure. She loved him and she didn't love him.

And even the more common incoherence in (3), could be coherent in a text where the kissing event takes place in a field surrounded by a fence, where cows are grazing.

If tautologies, contradictions and sentence pairs in which recurrent elements are absent can be coherent, when do we speak of *incoherence*? We consider a text incohesive if there are no cohesive links between the text segments, either vocabulary-driven or grammar-driven, either at a local or at a global level. More concretely, if no REFERENTIAL, LOCATIONAL, CAUSAL, TEMPORAL or ADDITIVE strands can be found between the clauses, they are considered (textually) incohesive. Representational coherence is more problematic. In Chapter 1, we saw that incohesive texts do not have to be incoherent. But in that chapter we also saw that provided that the speaker appears to obey Grice's Cooperative Principle in the communicative event, the comprehender will try to make the text coherent even if tautologies, inconsistencies or disjointed information occur. Hence, before a text is considered *incoherent*, the Cooperative Principle needs to be – purposely – violated.

It thus seems coherence relations can take one of three values. They can either be excitatory (value 1), passive (value 0), or inhibitory (value -1). Whether all relations are excitatory (upper bounds), all are passive (lower bounds), a text could still be coherent. If one coherence relation is inhibitory, the text is most likely to be perceived as incoherent. This translation of cohesion and coherence into values brings us closer to a representation that is susceptible to connectionist modelling.

Before we can answer the question whether and to what extent a relation is computationally excitatory, passive or inhibitory we need to review the cognitive evidence for the defined cohesion and coherence strands in order to answer the Cohesion Question.

to a word identification problem presented in Kintsch (1988) as an example of coherence

4.3 COGNITIVE EVIDENCE FOR COHESION AND COHERENCE STRANDS

In Chapter 1 we defined cohesion and coherence relations. Givón (1995: 61) for instance defines coherence as “the continuity or recurrence of some element(s) across a span (or spans) of text.” We have tentatively assumed five cohesion strands: REFERENTIAL, LOCATIONAL, CAUSAL, TEMPORAL and ADDITIVE. Because of the peculiar role of ADDITIVE relations, outlined in Chapter 1, we will next focus on the first four of these strands. So far, we have merely assumed these relations and have not discussed whether there is any cognitive evidence for the effect of these strands on comprehension. The answer to this Cohesion Question will be presented in this section. The four strands are as follows:

REFERENTIAL cohesion: consistency in the who or what that is communicated, often signalled by anaphora. Events are referentially cohesive/coherent if they refer to the same persons, things or places.

TEMPORAL cohesion: consistency in when the events occur and often signalled by the tense and aspect of the verb. Events are temporally cohesive/coherent if they share the same time span.

LOCATIONAL cohesion: consistency in where the events occur signalled by adverbial phrases or point of view. Events expressed by two clauses are locationally cohesive/coherent if they share the same place.

CAUSAL cohesion: consistency in why the events occur. Events expressed by two clauses are causally cohesive/coherent if one clause expresses the cause of an event and the other its effect.

4.3.1 REFERENTIAL coherence

REFERENTIAL cohesion/coherence connects persons, things or places. Particularly explicit grammar-driven REFERENTIAL cohesion/coherence relations have received a lot of attention in the form of anaphora resolution studies (see Emmott, 1999). Here some of the vocabulary-driven evidence will be discussed.

problem in discourse comprehension.

Haviland & Clark (1974) tested the acquisition of new information in a series of experiments. In a first experiment two groups of subjects were presented with sets of direct antecedent pairs as in (6) and indirect antecedent pairs as in (7).

(6)

- (a) We got some beer out of the trunk
- (b) The beer was warm.

(7)

- (a) We checked the picnic supplies.
- (b) The beer was warm.

In a non-cumulative self-paced reading time experiment direct antecedent pairs were read faster than indirect antecedent pairs, thus providing evidence that not only are repeated concepts considered cues for REFERENTIAL coherence, as in (6). However, an alternative explanation may be that the results were obtained simply because the noun was repeated. Haviland & Clark therefore tested other indirect antecedent sentence pairs, like (8):

(8)

- (a) Andrew was especially fond of beer
- (b) The beer was warm.

Again, direct antecedent pairs were read faster than indirect antecedent pairs. REFERENTIAL continuity thus facilitated the comprehension process.

Similar results were found in an experiment by Manelis & Yekovich (1976) in which effects of repetitions on reading time and immediate recall were tested. Reading times were faster and immediate recall was better for sentences containing repeated nouns, than for those sentences that did not. Furthermore, this effect was stronger for longer sentences. Yekovich & Walker (1978) extended these experiments by looking at five conditions: repetition of the noun or a synonym with either a definite article or an indefinite article, supplemented with a (non-repetition) control condition.

In two experiments, subjects read the first clause whose exposure was fixed. They were then asked to read the second (target) clause and hit a button when they had read and understood the sentence pair. A definite repetition was read faster than an indefinite repetition. The latter was read faster than definite synonym repetition, which was read faster than indefinite synonym repetition. Non-repetitions in the control group were read slowest, thus providing evidence that REFERENTIAL cohesion influences the reading time of sentence pairs.

More recently, Gernsbacher & Robertson (in press) presented sets of about fifteen sentences to two subjects groups. One group saw stories with only noun phrases with indefinite articles, the other group saw stories with only noun phrases with definite articles. Subjects read the sentences of the texts with the definite articles 23% faster than the texts with sentences using the indefinite article. Sentences with definite articles were also better recalled than those with indefinite articles, suggesting that comprehenders use the definite article *the* as a cohesion cue for coherence (or use the indefinite article as a cue to shift to a new substructure, which takes processing time). A second experiment replicated the first experiment, but with an additional priming-in-item verification task. After subjects read two sets of sentences, they were asked to perform a timed recognition task. Sets of two test sentences were either already seen by the subjects or they were new. Subjects did not know that the test list was constructed in such a way that an old sentence was preceded by either an old sentence from the same set or from a different set of sentences. Subjects who read sentences with the definite articles recognised old sentences faster when they were preceded by a sentence from the same versus different set, than subjects who saw the indefinite article sentences. Gernsbacher & Robertson's results in the second experiment replicated those in the first and provide further evidence for a processing benefit for REFERENTIAL cohesion.

In sum, REFERENTIAL continuity decreases reading times (Gernsbacher & Robertson, in press; Haviland & Clark, 1974) and improves immediate recall (Yekovich & Walker, 1978) and hence facilitates comprehension.

4.3.2 TEMPORAL coherence

As we have seen in the first chapter, TEMPORAL cohesion is often grammar-driven. However, it can also be vocabulary-driven by means of temporal adverbial phrases.

Anderson, Garrod & Sanford (1983) investigated the influence of scenario-dependent characters and main characters on time shifts. The first part of their experiment contained a pre-test in which subjects were asked to determine the boundaries of 20 stereotypic situations by estimating the minimum and maximum duration of an event. The pre-test in itself is interesting as it shows when time shifts (TEMPORAL discontinuities) occur. For instance, the time frame for going to a movie was estimated between 30 minutes to 4 hours. It thus seems likely that a sentence pair like (9) will not be considered temporally continuous.

- (9) Bill and Monica went to the cinema. Seven hours later Bill fell asleep.

Anderson et al.'s main aim however was to look at the effects of the character in a text. They used texts like (10):

(10)

- (a) At the cinema (*title*)
 - (b) Jenny found the film rather boring (*introduction of main character or scenario dependent character*)
 - (c) The projectionist had to keep changing the reels (*scenario dependent character mentioned*)
 - (d) It was supposed to be a silent movie (*filler to continue story*)

 - (e) Ten minutes later (*time shift within the time boundary*)
 - (f) Seven hours later (*time shift outside the time boundary*)
 - (g) He/she was fast asleep (*target*)
- } the film was forgotten

In a self-paced reading time experiment, subjects were presented with the first four clauses of the text and were asked to add a sentence that would naturally follow the story. The aim of the experiment was to investigate whether a sentence with the main character or scenario-dependent character would be added. In a second experiment the fifth sentence was given with either a reference to the scenario-dependent character or the main character. Each text was followed by a yes/no question referring either to the scenario dependent character or the main character. Above all, the results showed that the reading times for the conditions beyond the range of the time boundary were higher than for the conditions within the range of the time shift. TEMPORAL discontinuity thus requires additional processing time. Furthermore, when a shift in scenario occurred cued by a time shift outside the time frame, scenario dependent characters appeared to be less accessible compared to the main character. Response times on the yes/no questions in the outside-time-boundary condition for instance, were lower for the main character than for the scenario dependent character. Whereas there was hardly a difference in response times of reference to the main character between the within and beyond time boundary, a clear difference was found for the scenario dependent character. Anderson et al. thus showed the advantageous effect of TEMPORAL continuity on text comprehension and the interaction between REFERENTIAL coherence and TEMPORAL coherence.

In a series of experiments Zwaan (1996) addressed the problem of interaction between time shifts and location shifts. Subjects read stories similar to Anderson et al. (1983). However, texts included three time shifts: a moment later, an hour later and a day later in the cinema scenario. Time shifts would not only move events out of the scenario, it was also more likely that the location would be different and that subjects would keep track of the main character rather than the scenario dependent character. Results of a reading time and priming experiment showed that the comprehension was affected by whether events were temporally contiguous or not. Events within the same time frame that immediately followed each other appeared to have a facilitating effect in comprehension.

Similar results were found in Ohtsuka & Brewer (1992) who tested the effects of temporal arrangements of events in the text on the event structure in memory. Subjects listened to a set of stories each in one of the following five conditions and answered yes/no questions:

1. the *canonical* text, with no changes;
2. *backward* passages in which the linguistic structure was reversed from the event structure;
3. *flashback* passages, in which one event occurring in the beginning of the event structure was presented later in the linguistic structure;
4. *embedded* passages, in which the start of the narration contained underlying events which were emphasised;
5. *flash-forward* passages in which events later in the event structure were presented early in the linguistic structure.

The results showed a clear effect for narrative organisation on the comprehension of temporal order in narratives. Comprehension scores for the canonical texts were highest, those for the flash-forward texts lowest. When events are presented in their canonical order, processing is facilitated.

The time range in stereotypical events and the presentation of the event structure are two of the examples of factors in TEMPORAL coherence that influence comprehension. Anderson et al. (1983), Ohtsuka & Brewer (1992) and Zwaan (1996) show that TEMPORAL discontinuity causes more processing effort.

4.3.3 LOCATIONAL coherence

LOCATIONAL coherence can for instance be obtained via the perspective of the protagonist, via the type of verb (*come/go*), and via LOCATIONAL adverbial phrases. De Vega (1995) studied the comprehender's ability to track the protagonist's location. In five experiments Spanish subjects were given short stories in which a character moved around through an environment. After the text described a layout, the character was introduced entering or leaving a building or moving up or down a tower. With these topological relations (inside – outside, up – down) target objects were described. Subjects read texts like (11):

(11)

- (a) Carmen likes to walk around the museum area. (introduction)
- (b) The museum had a free entrance so that people can explore the past. The museum had a famous room with very well preserved Egyptian mummies. In the street, just in front of the museum, many pigeons came, because people used to feed them. (*layout*)
- (c) Carmen went into (c') / went outside (c'') the museum. (*biasing sentence*)
- (d) And she walked a few steps (*filler*)
- (e) and she approached the mummies (e') / pigeons (e'') quietly (*last sentence*)

The results of the self-paced reading time experiment showed that subjects spent considerably more time on the last sentence when this sentence included an object inconsistent with the location of the character (c' + e''; c'' + e'). In subsequent experiments dynamic situations that expressed motion were used and both the source and goal of the motion were explicitly mentioned in the text. In these experiments subjects responded to a test probe judging whether the probe had appeared in the text. Both speed and accuracy were measured. The target probe word contained an object either consistent or inconsistent with the character's location. In all experiments strong effects were found for consistency of location. The protagonist's interaction with the object consistent with his/her location thus facilitates the comprehension process.

This interaction was also investigated in three experiments by Haenggi, Kintsch & Gernsbacher (1995). Subjects were asked to memorise the layout of a fictional building. In the first experiment subjects memorised the floor plan of a castle and read stories about the characters moving around in the castle. They were then asked to do a reading comprehension test, a card rotation test and a cube comparison test. The latter two tests were designed to test the spatial imagery of the subject. After reading the text subjects answered 12 multiple choice questions. Measures of reading comprehension and the spatial imagery tasks were entered in a regression analysis on response times. Lowest result times were found for objects from the same room when the main character was in that room. The second experiment used a target room that needed to be inferred, and in the third experiment subjects studied a list of rooms with objects instead of a layout. Both experiments replicated the results of the first: lowest response times were found for same-room test words when this room was the target room of a

motion sentence, showing that subjects infer spatial information relevant to the main character's movements.

As we mentioned earlier, locational coherence can also be established by point of view. Black, Turner & Bower (1979) investigated *LOCATIONAL* point of view in text comprehension, comprehensibility and memory. Sentence pairs like (12) and (13) were used as materials:

(12)

A. Bill was sitting in the living room reading the paper

- (a) when John came into the living room (*consistent continuation*).
- (b) when John went into the living room (*change continuation*).

(13)

B. Alan hated to lose at tennis

- (a) Alan played a game of tennis with Liz.
- (b) after winning, she came up and shook his hand (*consistent continuation*).
- (c) after winning, she went up and shook his hand (*change continuation*).

In the first part of the A texts each sentence expresses a narrator's location by introducing a character and his/her spatial location. The second part describes a motion into (*came into*) or out of (*went into*) that location. In the B texts the first two sentences introduced the character and the third sentence described a motion from his/her (*came up*) or somebody else's perspective (*went up*).

In a first series of experiment subjects read sentence pairs of A each with either a consistent or a change continuation. The comprehension experiment involved a self-paced reading time experiment. Results showed that subjects spent more time on reading the sentence with a change in continuation of location than with a consistent continuation. In the comprehensibility experiment higher ratings were given for those sentences with a consistent continuation. In a delayed verbatim recall experiment the percentage of correct recalls was higher for consistent point of views than for changes of point of view. The same comprehension, comprehensibility and recall tests were carried out for the B sets. The difference between the two sets lay in the explicitness of the point of view. In the B sets the narrator's point of view was made clearer. Identical

results were found for comprehension and recall. No significant effects were found for comprehensibility. Sentences that maintain the point of view show the facilitating effect of **LOCATIONAL** continuity.

LOCATIONAL continuity thus facilitates the accessibility of persons and objects in the text. The results of these experiments show that comprehenders keep track of the locations described in the text.

4.3.4 CAUSAL coherence

CAUSAL coherence seems to be less straightforward than the other strands. Usually it is assumed that two situations are causally related if (Van den Broek, 1994: 544):

- a. the cause is temporally prior to effect;
- b. cause and effect are operative;
- c. cause is necessary and sufficient for the effect in the context described by the story (an event A is sufficient in the circumstances for event B, if it is the case that if A occurs, then B is likely to follow, given the context of the story; an event A is necessary in the circumstances for event B, if it is the case that if A had not happened, B would not have happened given the context of the story)

Myers, Shinjo & Duffy (1987) tested the recall of sentences with varying **CAUSAL** relatedness. Subjects saw one of the pairs of sentences like (14) with (a) having the highest and (d) having the lowest causal relatedness:

(14)

- (a) Patty's husband died suddenly from a heart attack. She became hysterical and needed a sedative.
- (b) Patty's husband found an error in her check book. She became hysterical and needed a sedative.
- (c) Patty's husband helped her balance her check book. She became hysterical and needed a sedative.
- (d) Patty's husband sat next to her after dinner. She became hysterical and needed a sedative.

In a norming study subjects rated the CAUSAL relatedness on a 7-point scale. These ratings were used in the analysis of the results of a self-paced reading time experiment, in which subjects read sentence pairs and carried out a cued recall task. Subjects were given either the first or the second sentence of the pair as a cue. The reading time for both sentences decreased as CAUSAL relatedness increased, showing it facilitates the comprehension process. Similarly, for recall of both the first and the second sentence the recall probability increased as the CAUSAL relatedness increased, showing that it facilitates recall. However, at the highest level of CAUSAL relatedness, the recall declined. The most likely reason for this is that if you state causes or effects that are necessary, you may be violating Gricean maxims and the statement may counterproductively elicit inferential processes (i.e. "why should they tell me this?").

In a similar experiment, Keenan, Baillet & Brown (1984) tested the effects of CAUSAL cohesion in referentially coherent sentences on comprehension and memory. Materials similar to the ones in Myers et al. (1987) were used that contained sentence pairs of which the second sentence was the effect of the first sentence. The first sentence differed in CAUSAL relatedness. The results of a self-paced reading time experiment, which was followed by a comprehension test, showed that the reading time for second sentences increased as the CAUSAL relatedness decreased. In a second experiment the reading time test was followed by 35-seconds delayed recall and recognition tests. Here, results showed that the recall and recognition was best for intermediate levels of causality. An explanation for the decline of reading time as CAUSAL relatedness decreases is straightforward: in clauses with a weak CAUSAL relation, the cause is only sufficient for the effect in the circumstance of the story. When clauses are strongly causally related, the cause is both sufficient and necessary for the effect in the circumstance of the story. Recall on the other hand is better for intermediate causally related sentence pairs because of the extent to which inferences need to be drawn. It can be assumed that more inferences means more connections in memory and hence better recall, but too many inferences leads to a poor recall. An intermediate level of CAUSAL relatedness – between sufficient and necessary – apparently requires the right number of inferences to be drawn for a coherence: there is not too much or too less information.

Similar results were found in Singer, Halldorson, Lear & Andrusiak (1992). They examined the processing of CAUSAL relations and more in particular the validation of these relations against world knowledge. In a self-paced reading time experiment,

subjects read a sentence pair, which was either more causally or more temporally related. Next, they answered a yes/no question. An example of the materials is given in (15):

(15)

- (a) The coach asked the karate expert to hit the concrete brick. (*causal antecedent*)
- (b) The coach asked the karate expert to move the concrete brick. (*temporal antecedent*)
- (c) The brick broke in two. (*outcome*)
- (d) Do karate experts break bricks? (*question*)

Both reading time and response time were significantly lower for the CAUSAL sentences than for the TEMPORAL sentences. The same experiment was carried out with brief passages, with a greater inferential distance and with cause and effect reversed. All experiments showed the facilitating effect for CAUSAL coherence.

These experiments clearly show that causally related clauses are read faster than less causally related clauses, showing that CAUSAL cohesion facilitates comprehension. Furthermore, recall for causally related clauses is better than for non-causally related clauses, but an intermediate level results in the best recall.

4.4 INTERACTION OF COHESION AND COHERENCE RELATIONS

In the discussion of cognitive evidence for the four cohesion and coherence strands we have provided a clear answer to the Cohesion Question: all four vocabulary-driven strands facilitate comprehension. However, as we have already concluded in Chapter 1, cohesion and coherence strands interact (Interdependency Question). In fact, it is rather difficult to construct sentence pairs in which REFERENTIAL, LOCATIONAL, CAUSAL or TEMPORAL strands operate fully independently. The likely interaction between strands might add to the results of the experiments discussed earlier. For instance, as we have seen in the Haviland & Clark (1974) experiment the following three sentence pairs were used:

(16)

- (a) We got the beer out of the trunk.
- (b) We checked the picnic supplies. } The beer was warm (*target*).
- (c) Andrew was especially fond of beer.

The lowest reading times were recorded for (a) and the target. However, this sentence pair can also be interpreted causally, whereas such an interpretation is much harder for the (b) and (c). It may very well be the case that the effect comes either from REFERENTIAL continuity and discontinuity, CAUSAL coherence, or combinations of these three. A similar conclusion can be drawn from the experiments by Yekovich & Walker (1978), discussed earlier. Particularly for the indirective verb condition, the texts show that the stronger the REFERENTIAL coherence is, the more likely a CAUSAL relation can be made.

In one of the conditions in Anderson et al.'s experiment the following text was used:

(17)

- (a) Jenny found the film rather boring.
- (b) The projectionist had to keep changing the reels.
- (c) It was supposed to be a silent movie.
- (d) Seven hours later the film was forgotten.
- (e) She was fast asleep.

Results showed that this fragment was read faster than a temporally continuous fragment. However, large time shifts are likely to be accompanied by large location shifts. In the text in example (17), Jenny is most likely not in the cinema. The differences in reading time may thus (also) be ascribed to a shift in location. As we have seen, Zwaan (1996) addresses this question by making a further subdivision in time shifts, showing the interaction between character, time and place. In Ohtsuka & Brewer's (1992) experiment in which the TEMPORAL structure was broken down, a similar effect was found: not only was the TEMPORAL order disrupted, but so were LOCATIONAL, REFERENTIAL and CAUSAL patterns. Finally, De Vega (1995) and Haenggi

et al. (1995) showed that subjects keep track of the main character and his location, thus showing the interactive effect of REFERENTIAL and LOCATIONAL coherence.

In other words, some of the studies discussed above address interaction effects of coherence relations, but only indirectly, for instance by comparing two relations rather than one. This means that the experiments reported so far may have inflated or weakened the actual effects of coherence relations. For a full understanding of coherence in text comprehension it is necessary to take into account the interaction of coherence strands.

Recently, Taylor & Tversky (1997) tested the interaction of coherence relations in event organisation in autobiographical memory and narrative comprehension. In three experiments they studied how people index events in memory and comprehension. Taylor & Tversky argued that an event contains six event components, each component responding to a who, what, where, when, why or how question about the event. These questions include the REFERENTIAL, LOCATIONAL, CAUSAL and TEMPORAL strand. Any of these components can be an index, i.e., a cue for organising the event in memory. Taylor & Tversky propose the following three hypotheses for indexing²:

1. Combined Index Hypothesis: all indexes are combined and serve as one (combined) index in the memory of events;
2. Index Dominance Hypothesis: some indexes are more effective than others and will therefore be used more often in memory;
3. Equipotential Index Hypothesis: all cohesion relations serve equally well as indexes for memory, but one coherence relation is used for retrieval of information.

Support for the Combined Index Hypothesis mainly comes from autobiographical memory rather than from narrative comprehension. Autobiographical memory contains extended event time lines relating either to personal history or historical events. Because these time lines incorporate groups of multiple events spanning long time frames, Taylor and Tversky argue that this hypothesis is less relevant to, and cannot be well tested in, text comprehension research, which mainly focuses on relatively small texts containing a relatively small number of events. Both the Index Dominance Hypothesis

² Taylor & Tversky call this, analogous to the EI Model, *event indexing*.

and the Equipotential Index Hypothesis, on the other hand, can be tested in most comprehension research.

The Index Dominance Hypothesis predicts that any of the four cohesion and coherence strands that we have defined is a potential index. But Taylor and Tversky argue that it is not only the index, but rather the uniqueness of the component of the index (like referentiality, temporality, locality, causality) that is important, i.e. how well a component distinguishes one event from another. Thus, if a comprehender recalls either a unique person, a unique time, a unique location or a unique cause of an event this would mean support for the hypothesis.

The Equipotential Index Hypothesis predicts that all event components can be used to access memory, and that all event components (like referentiality, temporality, locality, causality) are of equal importance, i.e., that not one component is more dominant than another. This could mean that different indexes work on different situations: for one narrative text one can find all indexes, but there are differences in where these indexes are used in different parts and contexts of the text.

In a series of experiments Taylor and Tversky tested the three hypotheses. In the first experiment subjects read two counter-balanced descriptions, one in which the events were grouped by character, the other one in which events were grouped by time. Subjects thus either saw two time descriptions, two character descriptions or one time and one character description. A part of a description with temporally grouped events looked like example (18) describing events in a retirement centre (ibid. 518):

- (18) First they looked at the schedule of morning activities. Arnold wrote a letter to his son. His son is stationed in South Korea with the Air Force. During the morning Conrad painted a picture of a bird. This particular bird regularly perches on a tree outside the cafeteria. [...] That morning, Jerry baked cookies in one of the kitchenettes.

After subjects studied a description they were presented with a memory test. In this test subjects were asked whether an event was performed by the same or by different characters (character focus test) or whether an event occurred at the same time or at different times (time focus test). After having completed the two memory tests, one for each description, subjects were asked to draw diagrams of the events.

Results showed that study time was slower for time descriptions than for character descriptions and that it decreased when subjects saw the time description first

followed by the character description, but not when they saw the character description first followed by the time description. Furthermore, subjects made more errors in the memory test after studying the time description than after studying the character description. A similar pattern was found for the response times, with lower times for character descriptions than for time descriptions. Finally, the diagrams of events differed more from the original event organisation in time descriptions than from the event organisation in the character descriptions. Taylor and Tversky concluded that the evidence supported the Index Dominance Hypothesis: character seems to be a far more dominant index than time. They argued that indexing takes place by character and sequencing of events takes place by time.

In a second experiment the indexes place and character were used, and in a third scenarios whose activities either correlated with characters or with time. In both experiments support was found for the Index Dominance Hypothesis. In the second experiment character was the dominant index, in the third scenario. Generally, the results showed that activity association was the most important factor, with subjects responding faster and more accurately to character tests if the character was associated with the activities and to the time tests if the activity was related to time. Taylor and Tversky concluded that indexing is flexible, as it heavily depends on context.

Taylor & Tversky's results resemble Sanford & Garrod's (1981, 1998) Scenario-Mapping and Focus Theory (SMF) discussed in Chapter 2. The SMF theory states that the principal task for comprehenders is to relate incoming information (like the characters, location and time) to scenarios.

In their general discussion Taylor and Tversky (*ibid.* 526) report they have found primary support for the Index Dominance Hypothesis. In the first experiment subjects indexed by character, in the second experiment the indexed depended on what the narrative dictated them to index and in the third experiment the activity dictated index use. But the evidence is not as strong as Taylor and Tversky present it to be. First of all, at least in the second and third experiment no clear evidence is found for the Index Dominance Hypothesis, as neither one of the indexes tested appeared to be dominant. In the first experiment there is evidence that comprehenders index by character, but sequence by time. It may very well be the case that this process of sequencing should be considered as an index. Furthermore, in all three experiments some subjects draw diagrams that support an Equipotential Index Hypothesis. Finally and most importantly,

the procedure in these experiments may have given a different picture on indexing events. Subjects read for memory: they studied a text containing facts and knew that they had to recall these facts. It could be argued that this way of reading deviates from natural reading and comprehension processes, as both the experiments by Zwaan, Magliano & Graesser (1995) and our own studies will show.

Zwaan et al. (1995) investigated the combination of several coherence relations by primarily testing the interaction of *LOCATIONAL*, *TEMPORAL* and *CAUSAL* cohesion strands on reading times of sentences. In addition, they used the auxiliary variables syllables, serial position, new arguments and argument overlap. First, judges scored the continuity of each of strands in two 3000-word stories. Sentences were used as the unit of analysis. They were scored as temporally continuous when congruent events were expressed or when two events directly followed each other; as spatially continuous when no new spatial setting was introduced, and causally continuous when the events contained a direct necessary *CAUSAL* link. The auxiliary variables were scored similarly: the number of syllables as a measure of sentence length, the serial position of a sentence (comprehenders for instance tend to read faster towards the end of a text), the number of new arguments, that is, noun phrases not earlier introduced in the text and finally argument overlap in the case of a repetition of a noun phrase³. The scoring data served as independent variables in a multiple regression analysis on reading time.

In the first experiment half of the subjects read the text as they would normally do (normal reading condition), the other half read the text for memory (memory reading condition). After the experiment they wrote a summary of the text in order to test whether they had understood what they had read. A correlation analysis of the predictor variables (the index assigned to an event by the judges) showed no significant effects for intercorrelations. This suggested that each of the three indexes captured a different aspect of the coherence of the situation. The predictor variables were entered in a multiple regression analysis with reading times as the dependent variable. In the normal reading condition both *TEMPORAL* and *CAUSAL* discontinuities predicted an increase of the reading times. This was also the case for spatial discontinuity, though this result did not reach the significance level. Argument overlap (*REFERENTIAL* cohesion) decreased the reading time somewhat, but not significantly. The memory reading condition

³ In addition, text was used as a predictor variable, dummy coded for the different stories used.

showed similar patterns as the normal reading condition, but no effects reached significance. The auxiliary variables appeared to be more robust predictors of reading time: higher numbers of syllables and higher number of arguments predicted higher reading times, while higher serial positions of the sentence (i.e. the more toward the end of the text) and higher number of argument overlap predicted lower reading times.

In a second experiment Zwaan et al. (1995) tested readers with less reading practice than in the first experiment. A new set of stories was chosen to generalise the results of the first experiment. In the scoring by two judges no interfering intercorrelations were found, suggesting that the variables captured different aspects of coherence. The results for the first reading were consistent with those found in experiment 1, with effects for both TEMPORAL and CAUSAL discontinuities, but not for LOCATIONAL discontinuities.

Zwaan et al. (1995) thus found evidence that comprehenders monitor multiple strands, with strong effects for TEMPORAL and CAUSAL discontinuities and marginal effects for LOCATIONAL discontinuities. Furthermore, encountering new noun phrases in the text led to an increase in processing time. Zwaan et al.'s results are presented in Figure 2 and Figure 3. Although the two figures suggest a difference between normal reading and memory reading, this difference is not significant. The only significant difference Zwaan et al. found between the two reading conditions was for CAUSAL discontinuities with higher processing times in the normal reading condition compared to the memory reading condition.

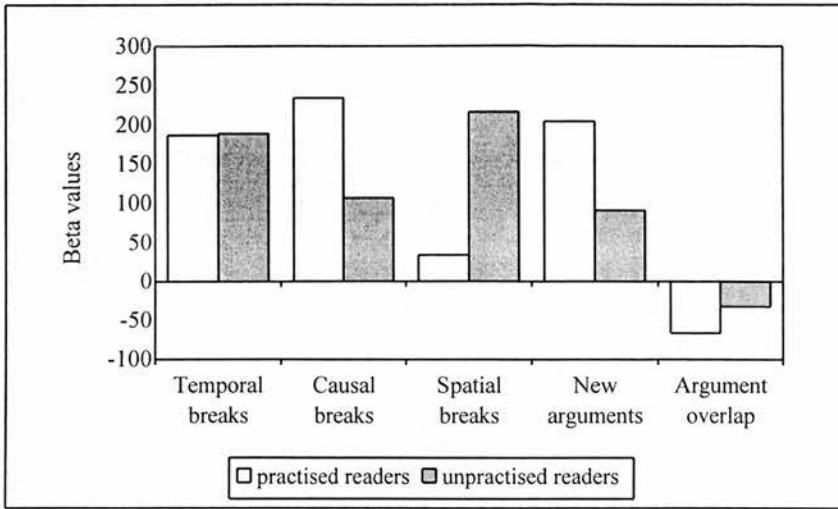


Figure 2 Normal reading (after Zwaan et al., 1995)

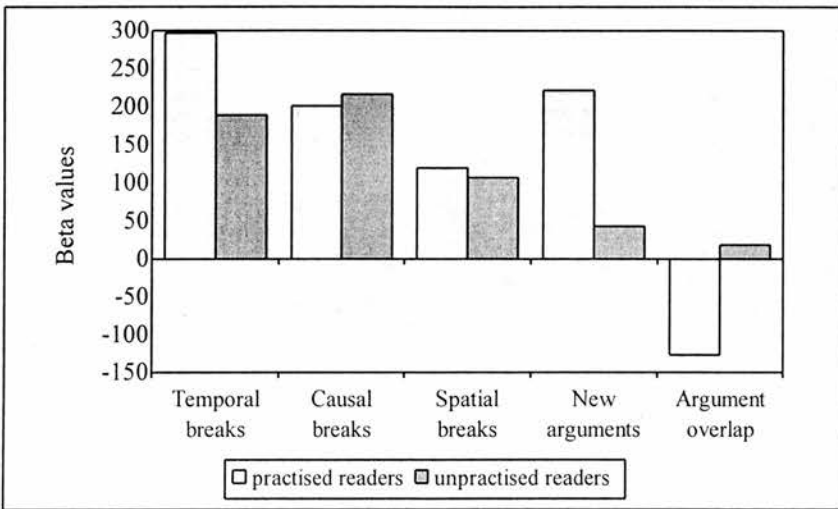


Figure 3 Memory reading (after Zwaan et al. 1995)

Looking back at Taylor & Tversky's (1997) and Zwaan et al.'s (1995) studies, we can see some important similarities as well as differences. Both Taylor & Tversky and Zwaan et al. investigated multiple cohesion and coherence strands in narrative texts. The advantage of this is that a possible anticipation effect, in which subjects focus on only one of the four strands, can be eliminated. Taylor and Tversky investigated the effect of cohesion and coherence relations on recall of events in a narrative text. Zwaan et al. tested the effect on both reading time and recall. They found similar effects, except for CAUSAL discontinuities.

But there are also differences between the two studies. Taylor & Tversky found that REFERENTIAL coherence appeared to be the most dominant index, followed by

LOCATIONAL coherence. The least important index was temporality. Zwaan et al.'s study on the other hand showed that LOCATIONAL discontinuities had the least effect on processing time, while TEMPORAL and CAUSAL discontinuities had the biggest impact. This discrepancy can be explained by the fact that Zwaan et al. looked at discontinuities, while Taylor and Tversky looked at continuities in the text.

4.5 HYPOTHESES

The overview of the studies investigating cohesion relations shows us the following:

1. There is strong evidence that REFERENTIAL, LOCATIONAL, CAUSAL and TEMPORAL cohesion facilitates various aspects of comprehension, like reading time and recall. However, in those studies isolating one cohesion strand, the interdependency of others is not controlled for. This could mean that the effects found for one cohesion strand are inflated because of the unwanted effects from other strands;
2. Cohesion strands affect coherence not only by their continuity, but also by their discontinuity. This has been shown in studies investigating one strand (Sanford & Garrod, 1983; De Vega, 1995) as well as in studies investigating the interdependency of strands (Zwaan et al., 1995). This finding is not surprising, as discontinuity marks the beginning and the end of continuity and often cues thematic breaks, as was outlined in the discussion of global cohesion in Chapter 1. Particularly the similar effects for continuous TEMPORAL, LOCATIONAL and REFERENTIAL strands in Taylor & Tversky (1997) and the same discontinuous strands in Zwaan et al. (1995) suggest the link between continuity and discontinuity;
3. Some strands are more effective than others and are hence used more often in the comprehension process. Zwaan et al. (1995) found the largest effect for TEMPORAL and CAUSAL discontinuities, while LOCATIONAL discontinuity had the least effect. Taylor & Tversky (1997), on the other hand, found a facilitating effect for characters compared with time, but for location compared to characters.

The overview showed that the four strands facilitate comprehension (Cohesion Question) and that they interact (Interdependency Question). That multiple interdependent cohesion strands facilitate comprehension – Cohesion Question and Interdependency Question – is likely, but not certain (Multiple Strands Question).

To distinguish these three questions in the Specification Hypothesis formulated in Chapter 2, which states that less specific cohesion strands direct the comprehenders' resources toward cohesion-based information, while specific strands direct the comprehenders' resources toward coherence-based information, we formulate the following hypotheses to be tested in the computational study.

I. Cohesion Hypothesis

Clauses containing a vocabulary-driven cohesion relation (and hence more specific) are comprehended better than clauses without a vocabulary-driven cohesion relation.

II. Interdependency Hypothesis

Vocabulary-driven cohesion and coherence strands do not only independently but also interdependently influence comprehension.

III. Multiple Strands Hypothesis

Those clauses that contain more cohesion strands (and hence are more specific) are comprehended better than clauses with less cohesion strands.

A summary of these hypotheses and the predictions for summary and recall is given in Table 1.

Question	Name of hypothesis	Prediction for summary and recall
<i>Cohesion Question</i>	<i>Cohesion Hypothesis</i>	If a situation contains a vocabulary-driven cohesion relation to another situation, that situation is more likely to be summarised and recalled.
<i>Interdependency Question</i>	<i>Interdependency Hypothesis</i>	If a situation contains a vocabulary-driven cohesion relation to another situation, it is likely that that relation contains various cohesion strands.
<i>Multiple Strands Question</i>	<i>Multiple Strands Hypothesis</i>	Those situations that are most likely to be summarised and recalled have the highest number of cohesion relations.

Table 1 Hypotheses for vocabulary-driven cohesion relations

In the next section we will first argue that certain computational models offer some important advantages in testing these three hypotheses.

4.5 COMPUTATIONAL MODELLING

Computational models (like many mathematical models) have several advantages over other forms of analysis. They require clarity of assumptions and definitional and conceptual precision, and can therefore test the internal consistency of a theory. They allow for theoretical uncertainty by simulating hypothetical sub-processes. Furthermore, although they are designed to reflect reality, they are not constrained by it, and can test hypotheses with counterfactual information that cannot be tested otherwise (Taber & Timpone, 1996; see also Louwerse, 1999b).

A program can be said to have understood if it can type a paraphrase or a summary of what has been put into it ... Inevitably, any program which can do this will incorporate useful ideas about how to characterize comprehension. While these ideas may lead to a working model, they need not reflect the way in which human beings actually comprehend – but nevertheless they should not be ignored in any analysis of the process. (Sanford & Garrod, 1981: 4)

As we have seen in the differences between the CI Model, the Landscape Model, the EI Model and the Structure Building Framework discussed in Chapter 2, the construction of a mental representation of the text is not a single straightforward process (see Kintsch, 1998: 198; Fletcher et al., 1998: 146). Many processes are likely to be involved, depending on task demands, reader choice and background knowledge. Connectionist models offer such options in flexible configuration of the nodes and their links and in their adaptation to input – output constraints.

Let us take a closer look at a connectionist model. It roughly contains the following aspects⁴:

- a. a set of processing units, simple elementary processors which are excited and/or inhibited;
- b. an activation value for each unit at each point in time which evokes the unit to fire to its neighbours;

- c. a pattern of connectivity among the units, which interrelates the various units;
- d. connectivity weights to determine the strength of the links between units;
- e. a learning rule that changes the network's behaviour by changing the weight of the connections.

Looking at some general aspects of the model, we can see that connectionist models have several advantages over other models:

1. The model is rather simple: it is not looking for the perfect, but for the best possible (or most probable) option at a time. The model is always tuning itself by adjusting its weights: existing connections are modified, new connections are strengthened and old connections are weakened;
2. The model is very flexible: it is characterised by its continuous adjustments to the input of information. Changes in connections or nodes does not have catastrophic effects for the model: it will reconstruct itself automatically. It can hence be used and has been proven extremely useful in various disciplines. Most importantly, there is a strong relation between the model and the empirical evidence in fields such as neuroscience and psychology.
3. The ideas of connectionist models can be easily translated in a computational model (in fact, it is a computational model): the theoretical explorations can thus be tested;
4. The model incorporates a bottom-up approach, as well as a top-down approach. Because it is able to 'learn', top-down models can slowly be built inductively;
5. In psycholinguistic studies, connectionist models – taken into account their simplicity – have been proven successful for various areas: visual word recognition (McClelland & Rumelhart, 1981), speech perception (Elman & McClelland, 1988), lexical ambiguity (Kawamoto, 1988), sentence processing (McClelland & Kawamoto, 1986), learning past tense (Rumelhart & McClelland, 1986c), context effects in discourse processing (Kintsch & Welsch, 1991). For an overview of connectionist models in language studies, see Rumelhart & McClelland (1986) and Kintsch (1998). The fact that connectionist models work on many different levels of language, from phonology, morphology, syntax, to discourse processing, makes it particularly useful.

⁴ For a more detailed insight in the PDP model, cf. McClelland and Rumelhart, 1986a; Anderson, 1995; Bechtel and Abrahamsen, 1991.

In the remainder of this chapter the structure of a proposed connectionist coherence model will be discussed and the role of the four vocabulary-driven strands in comprehension will be tested.

4.6 SETTING UP THE MODEL

4.6.1 The CI Model and the Landscape Model

In Chapter 1 the theoretical aspects of the CI Model and the Landscape Model were discussed. In this section we will provide an overview of the computational implementation of the two models. Clearly, many other computational approaches could be discussed in disciplines like cognitive science, psychology and computational linguistics. We will here focus on the CI Model and the Landscape Model for two reasons. First, the model we propose is heavily based on these two models and the best insight can thus be given by comparing it to them. Secondly, the influence the CI Model and the Landscape Model have had on theories of text comprehension invites a discussion of their computational aspects.

As we have seen the CI Model is a bottom-up model that consists of two stages, the construction stage in which the propositions of the text are constructed and interrelated and the integration stage in which these interrelations are filtered. In the computational implementation the construction stage is fully user defined. The integration stage on the other hand is fully automated.

According to Kintsch (1998: 96) four types of rules are applied in the construction of a network of propositions, rules for

1. *Constructing ψ -propositions*: These rules have extensively been discussed in Chapter 3 and concern the parsing of linguistic information into ψ -propositions.
2. *Interconnecting the propositions in a network*: direct, indirect and subordinate relations between ψ -propositions are made by the user. For instance, co-occurrences of parts of the ψ -proposition are linked.

3. *Activating knowledge*: The user defines links between the ψ -propositions: This means that the ψ -propositional net includes a knowledge net. Some ψ -propositions link to this network.
4. *Constructing inferences*: background knowledge sometimes requires that some ψ -propositions are linked despite the fact that no textual information is available to support this link.

When the links between the propositions have been established, the user needs to decide on the strength of links between the propositions. The strength can be considered equal over all connected propositions or it may vary. In the latter case, the decision that some links are stronger than others can be theoretically motivated. At the integration stage, irrelevant and redundant links between the propositions are filtered out when activation spreads around the network. Once the network stabilises, the result is a list of activation values for each proposition showing its strength in the mental representation.

In the Landscape Model a similar application of rules takes place. The user applies a set of simple plausible rules to the concepts of a text, by linking concepts on a 5-point scale. If concepts are not repeated or initiated after an initial activation, activation decreases to zero. Theoretically, this is possible when new information overwrites old information abruptly, gradually or partially. The Landscape Model reduces activation of concepts not subsequently activated. It does this by halving the original value in the second cycle if the concept is not re-activated and reducing it to zero in a third cycle if it is not re-activated. A landscape model of the activation throughout the cycles arises from the recorded activation of each of the concepts.

We can point out three problems in the CI Model and the Landscape Model that need to be resolved: the input for the model, the process by which the final weights are set and the relations between the nodes.

Input

In both the CI Model and the Landscape Model the input of the model are propositional structures that look like a sequence of words derived from the sentence. Although participant roles do play an important role in the Van Dijk & Kintsch (1978)

and Kintsch & Van Dijk (1983) model, it is generally left out of the CI Model: though participant roles could be defined, they usually are not. In the Landscape Model, participant roles are not integrated at all. It is the surface structure of the text that connects persons, things and places irrespective of the role they have in the situation. However, as we have seen in Yekovich & Walker (1978) and Magliano & Schleich (2000) differences between eventualities play an important role in the comprehension process and should hence be included in a computational model on coherence. In other words, as we have shown in the Chapter 3, the prepositional structure needs to be replaced by a situational structure.

Cycles

Both the CI Model and the Landscape Model use cycles to settle the final weights. The reason behind this is that limited memory capacity allows only limited chunks of information to be processed at a time. Regardless of the role of short-term memory capacity in text comprehension, instantiating the mechanism of reading cycles in a computational model of text comprehension has two major drawbacks.

First, setting the size of the cycle seems highly problematic. Van den Broek et al. (1999: 174) set the information carried over from one cycle to the other at one statement. However, the structure of the statement (the decision whether to use paragraphs, propositions, sentences or clauses), the length of the statement⁵, the length of the words in the statement, their general frequency and their frequency in the text, all seem to affect the size of the reading cycle. A statement containing very long and infrequent words is much harder to process than a statement with frequently occurring names and high frequency words. It may therefore very well be the case that we can include three easy-to-process statements in one reading cycle, but only one difficult-to-process statement in another. In the CI Model, on the other hand, the number of propositions carried over from each reading cycle is a free parameter of the model, but is generally one proposition (Kintsch, 1998: 102). However, setting the cycle as a free parameter per text does not solve the problem of diversity of the information in the cycle: some propositions may still be harder to process than others. Accounting for this

⁵ Statements in the Landscape Model do considerably vary in length (cf. Van den Broek, 1999: 170).

by setting the cycle per paragraph, proposition, sentence or clause (that is, tagging easy- and difficult-to-process units) makes generalisations difficult and the analysis subjective.

Second, the use of reading cycles makes it impossible for concepts with low activation levels in any cycle to be included in the computationally generated summary. This seems to be a serious flaw of a computational model of text comprehension. Seemingly unimportant information may turn out to be important at the end of the text (this is in fact the difference between the integrated and complete model in the EI Model). If a seemingly unimportant clause in the beginning of a text is initially not included in the reading cycle, this clause will miss the opportunity to be included in later reading cycles, when its importance in the coherence of the text could become clear.

Cohesion relations

The processes and coherence relations defined in the CI Model and the Landscape Model have extensively been discussed in Chapter 2. In every computational model the important question is how to integrate these psychological processes in a computational framework. Particularly because of the theoretical and practical criteria defined for the model, we need to make optimal use of the automated tasks and limited user effort.

In both the CI Model and the Landscape Model rules are applied to texts in a rather *ad hoc* way. The user needs to decide which links to make between propositions and which scale to use for the weights between the links.

One often heard the complaint that with that many degrees of freedom, any structure could predict any data set. It is an ill-founded complaint, however. It is the structure of the model that yields the good predictions, not the free parameters. Although the model has many potential parameters (conceivably, any link strength might be estimated separately), actual simulations use this freedom with constraint. (Kintsch, 1998: 266)

Indeed, applying the weights on the basis of experimental results and reflecting the findings of experimental results have proven extremely informative (e.g. Kintsch & Welsh, 1991). In fact, even if the weights are randomly changed the models can describe, explain and predict comprehension processes. However, the downside of this 'freedom' is that generalisations over other texts than the ones analysed are hard to

make. Ideally, we are looking for standardised weights that can be applied over a large range of texts.⁶

4.6.1 CoCon

The aim of the model we propose is to build a hierarchical text structure with only a limited amount of user effort, while overcoming the three problematic issues outlined in the previous paragraph.

Available software packages like the CI Model (Mross & Roberts, 1992) did not meet our needs, i.e. they did not use situations, did use cycles, and did not have predefined cohesion relations. We therefore wrote a computer program in Microsoft Visual Basic, using Microsoft Access, which we called *CoCon* (Coherence Connectionist model). The program distinguishes between two stages. In the cohesion stage, the links between the text units are established and the strengths of these links are calculated. In the connectionist stage activation spreads around the network of units and their links. In other words, where in the first stage all kinds of possible links between text units are made, these links are filtered in the second stage.

Three main criteria motivate the structure of the model: psychological validity, and theoretical and practical transparency. The model needs to be psychologically valid in that it should describe processes as presented in models of text comprehension. Obviously this is constrained by computational means. Practical transparency concerns the effort involved in running the computer program. The criterion here is that the user only has to do a minimum of text encoding while the model should do maximum analysis. Finally, despite the ambitious aim of the model, it needs to be simple, with only limited uncontroversial theoretical implications. In short, *CoCon* does not aim at finding the ultimate answers, but settles for something that works, simple but efficient. It is a proof of concept rather than a psychological simulation.

⁶ Clearly, it could be argued that finding standard weights would be a futile task, because humans creatively approach each individual text. Such a view of individual interpretation is held by Relevance Theory, briefly mentioned in Chapter 2. However, if this were the case most of the experiments reported so far would not find significant effects, as the results for different subjects would differ considerably from each other. By subjects analyses show this is not the case.

In many respects the proposed model looks similar to the CI and the Landscape Model. Like the CI Model it uses two stages: one to construct the links between the units, and one to distribute activation over the links. Like both the CI Model and the Landscape Model it uses basic matrix algebra for the connectionist stage. But it differs in the absence of cycles, the use of situations and the predefined cohesion relations.

Situations

Formulating text into situations allows *CoCon* to distinguish the type of situation expressed in a clause: state, process, event accomplishment or event achievement. Furthermore, unlike the CI Model and the Landscape Model, *CoCon* takes into account participant roles in the situation.

Cycles

CoCon does not use cycles in which information is carried over in chunks. Instead, in the connectionist stage of the model all the input information is filtered. Although this technique may not reflect the actual reading process in which information may be suppressed or forgotten during reading itself, it avoids the problems with the use of cycles, without giving up the idea of a process of filtering redundant information.

Cohesion relations

Although the process of encoding text in situations and causal relations could, in principle, be carried out computationally, the *CoCon* user presently has to categorise the text into situations (eventualities and participant roles) and has to define the CAUSAL links between the situations. On the basis of this information *CoCon* applies a large set of cohesion relations. These relations are based on those proposed in the Structure Building Framework, the EI Model, the CI Model and the Landscape Model, but are adjusted to the computational options. For instance, the process Advantage of First Mention used in the Structure Building Framework is adjusted to a relation that looks for the first time a person or object is mentioned in the text. Another example:

LOCATIONAL and TEMPORAL references are changed into a relation that looks for the presence of LOCATIONAL or TEMPORAL markers, since subsequent TEMPORAL and LOCATIONAL information maps onto the previous TEMPORAL and LOCATIONAL information until another marker requires shifting of time and place. We define a large set of cohesion relations that can be implemented in the computational model, in order to test the hypotheses as extensively as possible.

1. *Activation of first mention* activates the first time a concept is mentioned in the text. This is not a cohesion relation as such, but does play a role in the comprehension process, as has been shown in Gernsbacher (1990). What is said first has advantages in the comprehension process over what is said later (ibid. 10). This ties in with Zwaan et al.'s finding that new arguments in the text have a significant effect on the processing time of a sentence.
2. *Activation of eventuality* gives different weights to different kinds of eventualities. Strictly speaking this is not a coherence relation either. However, as we argued in the previous chapter, different eventualities are likely to have different effects on the comprehension process. There is cognitive evidence for aspect (Magliano & Schleich, 2000), and combinations of eventualities yield certain coherence strands.
3. REFERENTIAL *cohesion* connects the same persons or objects of the same participant role in a text. REFERENTIAL cohesion as discussed so far, links persons and objects in the text. REFERENTIAL cohesion as used here only links those persons and objects that are identical and have the same participant role. Hence, we assume that if two persons or objects are the same and also share the same participant role ($Bill_{Agent1}$ and $Bill_{Agent2}$), they are connected differently than if they do not share a participant role ($Bill_{Agent1}$ and $Bill_{Object}$).
4. REFERENTIALITY *chain* is the type of cohesion relation that connects a series of referentially connected persons or objects in a text. A text may look more coherent if the referentiality of a series of sentences is not 'disturbed', if a chain of REFERENTIALITY can be established. Evidence for such a chain can for instance be found in the facilitating effect of recurrent anaphora (e.g. Emmott, 1999) and can be concluded from Gernsbacher & Robertson's (in press) experiments in which *series* of sentences were used with definite (or indefinite) articles.

5. *Cross-REFERENTIALITY* is the type of cohesion that connects the same persons or objects in a text regardless of their participant role. This cohesion relation follows from the evidence for REFERENTIAL cohesion discussed in the first part of this chapter. In these studies the participant role was not of importance.
6. *Cross-REFERENTIAL coherence chain* is the relation that connects a chain of events that are cross-referentially related. This cohesion relations is similar to the REFERENTIALITY chain, except that the participant role is ignored.
7. *CAUSAL coherence* connects situations that are causally related. Situation x is causally related to situation y if situation x precedes situation y (causality implies temporality); if situation x occurs situation y may occur (sufficient condition); y occurs only if x occurs (necessary condition).
8. *CAUSALITY chain* is the type of coherence relation that connects a chain of causally related situations.
9. *Disruption of TEMPORALITY* is the cohesion relation that marks a discontinuity of temporally related events. This relation is similar to Zwaan et al.'s (1995) TEMPORAL discontinuity.
10. *Disruption of LOCATION* is the cohesion relation that marks a discontinuity in spatially related events. Again, this relation is similar to Zwaan et al.'s (1995) LOCATIONAL discontinuity.

CoCon consists of three stages (see Figure 4). We will briefly mention them first, followed by a more detailed explanation:

1. **Input stage:** the user enters the situations of a text in a spreadsheet. This means that a clause of a text is divided into an eventuality (state, process, event accomplishment, event achievement) and one or more participant roles (agent, object, instrument, source, goal). Chapter 3 has extensively discussed how to form these situations.
2. **Cohesion stage:** links between the various components of the situations are made on the basis of predefined cohesion relations (as discussed before and to be discussed in detail below). The weights for these links are also predefined, and are determined by the correlation of each of the relations with the number of times that in a summarization experiment.

3. **Coherence stage:** the weights for the links between the components of the situations form a network of nodes and values. Activation is spread around the network (from each node to all its neighbours) until all the activation values settle in a stable pattern. This pattern is assumed to be the text hierarchy (or summary).

Let us now have a closer look at the model and what the user needs to do.

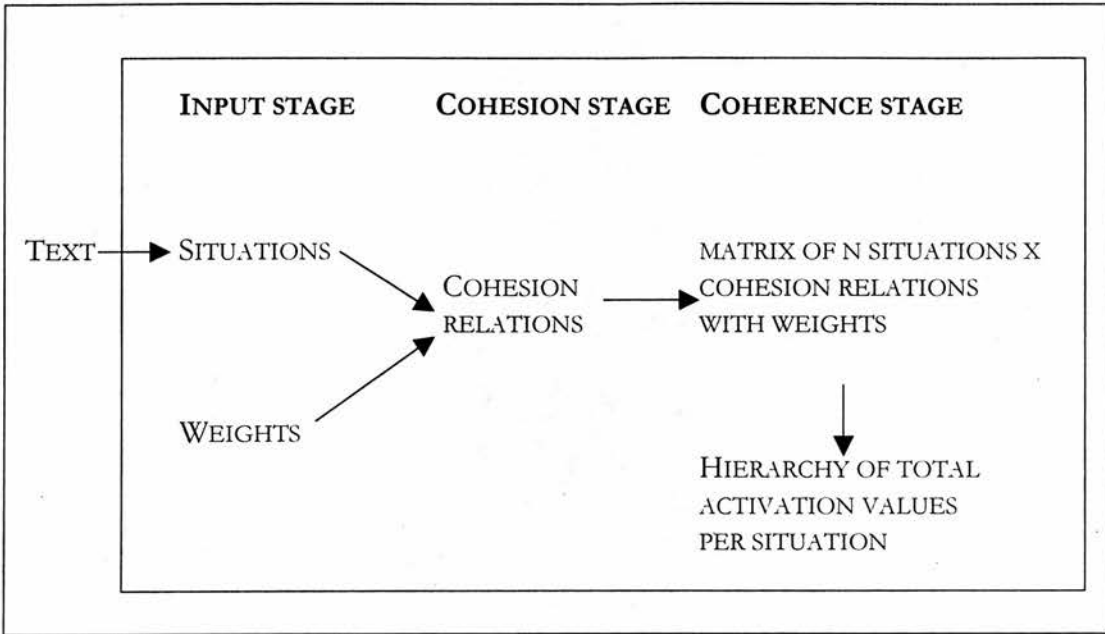


Figure 4 Three stages of Cocon

Input stage

Let us assume that we want to determine the summary of the following text:

- (1) One day Mark and Sally were sailing their toy sailboat in the pond
- (2) Suddenly, the sailboat began to sink
- (3) Mark was surprised
- (4) He lifted the boat up with a stick
- (5) and found a turtle on top of it
- (6) The turtle became frightened
- (7) and tried to crawl off the boat
- (8) The turtle put Mark in a playful mood
- (9) Mark thought the turtle was hurt
- (10) Mark has always wanted Sally to see the turtle
- (11) So he waded out to the turtle
- (12) and brought it back to her
- (13) Sally thought Mark was going to hurt the turtle
- (14) Sally felt sorry for Mark
- (15) Sally tried to touch the turtle
- (16) but the turtle bit her
- (17) Sally didn't like this
- (18) and threw the turtle into the pond
- (19) The turtle crashed into the sailboat
- (20) Sally knew she had made a mistake

We first need to transform the text into situations, following the theory outlined in Chapter 3. Verbs are translated into eventualities, nouns are translated into participant roles. An example of the text translated into situations is given in Table 2.

no	Original clause	Situations										
		State	Process	event(acc)	event(ach)	Agent	object	instru	source	goal	location	time
1	One day Mark and Sally were sailing their toy sailboat in the pond		Sail			Mark & Sally	& sailboat				pond	one day
2	Suddenly, the sailboat began to sink			sink		Mark	sailboat					
3	Mark was surprised	be surprised				Mark						
4	He lifted the boat up with a stick			lift		Mark	sailboat	stick				
5	and found a turtle on top of it				find	Mark	turtle					
6	The turtle became frightened	be frightened				Turtle					sailboat	
7	and tried		try			Turtle	8					
8	to crawl off the boat			crawl off		turtle			sailboat			
9	The turtle put Mark in a playful mood			put		turtle	Mark			playful mood		
10	Mark thought	think				Mark	11					
11	the turtle was hurt	be hurt				turtle						
12	Mark has always wanted	want				Mark	13					
13	Sally to see the turtle		see			Sally	turtle					
14	So he waded out to the turtle			wade out		Mark			water	turtle		
15	and brought it back to her			bring back		Mark	turtle			Sally		
16	Sally thought		think			Sally	17					
17	Mark was going to hurt the turtle		hurt			Mark	turtle					
18	Sally felt sorry for Mark	feel sorry				Sally				Mark		
19	Sally tried		try			Sally	20					
20	to touch the turtle		touch			Sally	turtle					
21	but the turtle bit her			bite		turtle	Sally					
22	Sally didn't like this	like not				Sally	21					
23	and threw the turtle into the pond			throw		Sally	turtle			pond		
24	The turtle crashed into the sailboat			crash		turtle				sailboat		
25	Sally knew		know			Sally	26					
26	Sally had made a mistake	make mistake				Sally						

Table 2 Example of text categorised into situations.

Cohesion stage

After the clauses are categorised into eventualities and participant roles, CoCon decides on the links between the components of the situations by applying the cohesion relations defined in the previous sections. A ‘computational’ translation of these relations looks as follows:

1. *First mention*

- If the content of $\text{unit}_{\in x}$ with participant role t is not equal to $\text{unit}_{\in y}$ with participant role t
- then assign weight w to unit x ;
- (where \in is element of, x is a situation number, y is a situation number smaller than x , t is the participant role *agent* or *object*, and w is the weight assigned to the participant role t).

2. *State, process, event accomplishment, event achievement*

- If $\text{unit}_{\in x}$ with eventuality e is not empty
- then assign weight w to $\text{unit}_{\in x}$
- (where \in is element of, x is a situation number, e is eventuality *state, process, event accomplishment* or *event achievement*, and w is the weight assigned to the eventuality e).

3. *REFERENTIAL cohesion*

- If the content of $\text{unit}_{\in x}$ with participant role t equals the content of $\text{unit}_{\in y}$ with participant role t ,
- and if the participant role t of $\text{unit}_{\in x}$ equals the participant role t of $\text{unit}_{\in y}$
- and if x does not equal y ,
- then assign weight w to the connection $\text{unit}_{\in x} * \text{unit}_{\in y}$
- (where \in is element of, x and y are situation numbers, t is the participant role (*agent, object, instrument, source* or *goal*), and w is the weight assigned to the participant role t).

4. *REFERENTIAL cohesion chain*

- If the content of $\text{unit}_{\in x}$ with participant role t equals the content of $\text{unit}_{\in y}$ with participant role t ,
- and if the content of $\text{unit}_{\in z}$ with participant role t equals the content of $\text{unit}_{\in x}$ and $\text{unit}_{\in y}$
- and if the participant role t of $\text{unit}_{\in x}$ equals the participant role t of unit y
- and if the participant role t of $\text{unit}_{\in z}$ equals the participant role t of $\text{unit}_{\in x}$ and $\text{unit}_{\in y}$
- and if x does not equal y and z does not equal y or x
- then assign weight w to the connection $(\text{unit}_{\in x} * \text{unit}_{\in y})$ and $(\text{unit}_{\in y} * \text{unit}_{\in z})$
- (where \in is element of, x, y and z are situation numbers, t is the participant role (*agent, object, instrument, source* or *goal*), and w is the weight assigned to the participant role t).

5. *Cross-REFERENTIAL cohesion*

- If the content of $\text{unit}_{\in x}$ with participant role t equals the content of $\text{unit}_{\in y}$ with participant role t
- and if the participant role t of $\text{unit}_{\in x}$ does not equal the participant role t of $\text{unit}_{\in y}$,
- and if x does not equal y ,
- then assign weight w to the connection ($\text{unit}_{\in x} * \text{unit}_{\in y}$)
- (where \in is element of, x and y are situation numbers, t is the participant role (*agent, object, instrument, source or goal*), and w is the weight assigned to the participant role t).

6. *Cross-REFERENTIAL cohesion chain*

- If the content of $\text{unit}_{\in x}$ with participant role t equals the content of $\text{unit}_{\in y}$ with participant role t
- and if the content of $\text{unit}_{\in z}$ with participant role t equals the content of $\text{unit}_{\in x}$ and $\text{unit}_{\in y}$
- and if the participant role t of $\text{unit}_{\in x}$ does not equal the participant role t of $\text{unit}_{\in y}$,
- and if the participant role t of $\text{unit}_{\in z}$ does not equal the participant role t of $\text{unit}_{\in y}$,
- and if x does not equal y and z does not equal x or y ,
- then assign weight w to the connection ($\text{unit}_{\in x} * \text{unit}_{\in y}$) and ($\text{unit}_{\in y} * \text{unit}_{\in z}$)
- (where \in is element of, x, y and z are situation numbers, t is the participant role (*agent, object, instrument, source or goal*), and w is the weight assigned to the participant role t).

7. *CAUSAL cohesion*⁷

- If situation x and situation y are causally connected,
- then assign weight w to the connection ($x * y$)
- (where x and y are situation numbers).

8. *CAUSAL cohesion chain*

- If situation x , situation y and situation z are causally connected,
- then assign weight w to the connection ($x * y$) and ($y * z$)
- (where \in is element of, x, y and z are situation numbers).

9. *TIME*

- If the content of $\text{unit}_{\in x}$ with thematic role t is not empty,
- then assign weight w to $\text{unit}_{\in x}$
- (where \in is element of, x is a situation number and t is temporality).

10. *LOCATION*

- If the content of $\text{unit}_{\in x}$ with thematic role t is not empty,
- then assign weight w to $\text{unit}_{\in x}$ (where \in is element of, x is a situation number and t is spatiality).

The cohesion relations for the example text are presented in Table 3.

⁷ Causality is defined here as follows:

Situation x is causally related to situation y if situation x precedes situation y ; it is likely that if situation x occurs situation y occurs; situation y only occurs if x occurs.

As we saw in the previous sections, the advantage of connectionist models generally is that they can calculate the optimal weights to match the observed output with the expected output. This process, called 'back-propagation', sends the output back to the input and adjusts the weights in order to achieve a better match between observed and expected output. The disadvantage of computational models of text comprehension – at least the ones discussed here – is the lack of back-propagation. Because of the initial stage in each of the models, in which relations between the text units are created, back-propagation is very hard to integrate. As a large number of relations are active and as these relations do not always apply to all units in the network, the weights cannot be adjusted to an ideal situation in this first stage. Hence, back-propagation can only be applied in the final stage. The result of this is that we don't know how well the model achieves when the weights are adjusted, because of the indefinite number of possible weights and the lack of a theory of optimal weights. One way to circumvent the problem is by approximating optimal weights on the basis of a comparison between the computational model and experimental results obtained in summarisation and recall experiments. For instance, we could calculate the correlation between the number of cohesion relations of the input situations with the number of cohesion relations of the summarised and recalled situations and take this correlation as the weight for a relation. We will discuss a proposed method in a discussion of the first experiment. If the weights obtained by the comparison with summarisation and recall results can be generalised, these approximate weights can be entered in the model and summaries and recall data can be generated. The results of the computer program can then be compared with the experimental results.

Relations	State	Process	event(acc)	event(ach)	Agent	object	instru	Source	goal	location	time
1 a b c g j k l m q		Sail			Mark & Sally	sailboat				pond	one day
2 c h l n q r s			sink			sailboat					
3 b f l m q r s	be surprised				Mark						
4 b c h l m n q r s			lift		Mark	sailboat	stick				
5 a b c i j l m n q r s				find	Mark	turtle				sailboat	
6 b f l m q r s	be frightened				Turtle						
7		try			Turtle	8					
8 b g l m q r s			crawl off		Turtle			sailboat			
9 b h l m q r s			put		Turtle	Mark			playful mood		
10	think				Mark	11					
11 b h l m q r s	be hurt				Turtle						
12	want				Mark	13					
13 b f l m q		see			Sally	turtle					
14 b h l m q r s			wade out		Mark			water	turtle		
15 b c h l m n q r s			bring back		Mark	turtle			Sally		
16		think			Sally	17					
17 b c g l m n q		hurt			Mark	turtle					
18 b f l m q	feel sorry				Sally				Mark		
19		try			Sally	20					
20 b g l m q		touch			Sally	turtle					
21 b c g l m n q		bite			turtle	Sally					
22 b g l m q r s	like not				Sally	21					
23 b f l m q r s			throw		Sally	turtle			pond		
24 b c h l m n q r s			crash		turtle				sailboat		
25 b h l m q s	make mistake	know			Sally	26					
26					Sally						

Table 3 Cobesion relations defined in CoCon

First mention = a Goal = e Event (ach) = i Agent Chain = m Cross Ref. Chain = q
 Agent = b State = f Location = j Object Chain = n Causality Chain = r
 Object = c Process = g Time = k Source Chain = o Causality = s
 Source = d Event (acc) = h Cross Ref = l Goal Chain = p

Coherence stage

The result of all situations linked to all other situations with which they share one or more cohesion relations now form a network of $n * n$ units (where n is the number of situations), whose nodes are the sum of the weights for the relations they share.

Next, An activation rule similar to the one used in the CI Model and the Landscape Model is used:

$$a_i(t+1) = \frac{\sum_{i=1}^n a_i(t) w_{ij}}{\sum_{i=1}^n A(t+1)}$$

The activation value per situation is given by the vector $A = (a_1, a_2, a_3, \dots a_n)$. Each activation value is multiplied with each of the connection strengths (w_{ij} , where weight is given to the connection between i and j). Hence, the activation now spreads over the network according to the following formula (where a is activation per situation, A is total activation of all situation s and t is time t).

The initial activation value is the same for each situation and formed by 1 divided by the total number of situations. The initial activation value is multiplied with each node in the matrix resulting in the total activation value per situation (top part of the formula). To keep the result within bounds, a normalisation procedure is used which divides each total activation value by the total of total activation values (bottom part of the formula). The total activation values per situation give the activity of each situation in the text. The values of the coherence relations show the role of the relation in connecting the text components.

This process filters out the weak and incidental links and keeps the strong and frequent links from and to situations. The result of the basic matrix algebra is a total activation value for each situation. The higher the value the more salient the situation is in a summarisation of the text.

Let's consider the first five situations of the example text in Table 4.

state	process	event(acc)	event(ach)	Agent	object	instru	srce	gl	location	time
	Sail			Mark & Sally	sailboat				pond	one day
		sink			sailboat					
be surprised				Mark						
		lift		Mark	sailboat	stick				
			find	Mark	turtle				sailboat	

Table 4 First five situations of example text

If we focus on only the referentiality relation and assume that its weight is 0.2, situation 1 will be linked to 3, 4 and 5, as they all share the $Mark_{agent}$. The activation matrix will hence look like Table 5.

Situations	s1	s2	s3	s4	s5
s1	0	0	0.2	0.2	0.2
s2	0	0	0	0	0
s3	0.2	0	0	0.2	0.2
s4	0.2	0	0.2	0	0.2
s5	0.2	0	0.2	0.2	0
Total activation	0.25	0	0.25	0.25	0.25

Table 5 Activation matrix of first five situations of example text

The initial activation value is the same for all five relations, i.e. $1/n$ situations = 0.2. If we multiply 0.2 across the nodes in the network, the resulting activation pattern for the five situations is 0.25, 0, 0.25, 0.25. In terms of the model, only three situations have remained coherent.

In the remainder of this chapter we will investigate a method of determining the weights of the cohesion relations and we will test the success of the model in summarising text.

4.7 TESTING THE MODEL

Three computational studies using *CoCon* will test the hypotheses for vocabulary-driven relations. We repeat the three hypotheses defined earlier next:

Cohesion Hypothesis:

If a situation contains a vocabulary-driven cohesion relation to another situation, that situation is more likely to be summarised and recalled.

Interdependency Hypothesis:

If a situation contains a vocabulary-driven cohesion relation to another situation, it is likely that that relation contains various cohesion strands.

Multiple Strands Hypothesis:

Those situations that are most likely to be summarised and recalled have the highest number of cohesion relations.

The aim of the first study was to obtain information on each of the cohesion relations. With the help of this information we gain a clearer idea of how to set the weights for each of the coherence relations. The success of the model was tested in the second and third study in which *CoCon* generated a summary and recall of the input texts.

4.8 STUDY 1

The aims of the first study are twofold. First, to test the Cohesion, Interdependency and Multiple Strands Hypotheses. Second, to determine the weights of the cohesion relations to be used in the connectionist model to predict the likelihood of a situation being summarised.

Materials

Materials used in summarisation experiments by Omanson (1982) and Trabasso & Van den Broek (1985) were used. The materials consisted of three versions of three stories, called *Turtle*, *Bee*, and *Airplane*. The versions differed from each other in the response or

reaction of the main character in central parts of the text (see Omanson, 1982: 329). The texts are given in Appendix I. A total of 54 undergraduate psychology students, all native speakers of English, were asked to write a summary of one version of each of the three stories while consulting the text⁸. Another group of subjects was asked to recall the texts.

The texts were categorised into eventualities and participant roles, according to the definitions given earlier. An example of this categorisation is given in Appendix I. The results of the summarisation experiments were categorised in the same way. Because the Omanson (1982) and Trabasso & Van den Broek (1985) data used propositions rather than situations as the unit of analysis and because the data analysis was often not clear about embedded situations, the decision was made to remove the main clauses from the analysis and keep the subordinate clauses. Thus, in a sentence like "Sally thought Mark was going to hurt the turtle" only the situation "Mark hurt the turtle" could be included. Furthermore, two judges determined the CAUSAL relations between the situations of the text. They mutually agreed on the final result.

On the basis of the results of the summarisation and recall experiment, the total frequency of each summarised and recalled situation among all subjects in each version of the text was calculated. This number was used as a measure of likelihood that the situation would be included in a summary or recall.

With the situations of the text as input and the likelihood of these situations being summarised, the importance of the selected relations could then be calculated.

Procedure

In the first study the number of links between the situations was calculated for each of the coherence relations in each of the nine texts, like we presented in Table 3. It was assumed that the number of links of a cohesion relation among the various situations in the text would reflect its importance in the coherence of the text. The number of times a situation was summarised and recalled by all subjects in the experiments reported in

⁸ These data were kindly made available to me by the authors of these studies: Tom Trabasso, Paul van den Broek and Rich Omanson.

Trabasso & Van den Broek (1985) was used to estimate the importance of that situation and its links in the comprehension process.

Results and discussion

Because of the lack of normal distribution, the criteria for a parametric test are not fulfilled. Nevertheless, tests like Analysis of Variance and Multiple Regression are often robust enough to account for this lack. Because our primary aim is to determine the weights of the relations, we are at this point less bothered about committing a Type I error (rejecting the Null Hypothesis even though it is true). We therefore used a Kendall's tau correlation, which was preferred here over Spearman's rho because of the way it calculates partial correlation and because it is a better estimation of the population the sample came from (Clark-Carter, 1997: 325).

The number of links per cohesion relation per situation per text was entered in the non-parametric correlation and was compared with the number of times a situation was summarised and recalled in the Trabasso & Van den Broek (1985) experiment. Correlation results are presented in Table 6. Significant effects for summary were found for *first mention*, *object*, *event accomplishment*, *event achievement*, *location*, *time*, *cross referentiality*, *referential chain (object)*, *cross referential chain* and *causality* (see Table 6). Neither in the *referential cohesion* nor in the *referential cohesion chain* were significant effects found for the participant roles *instrument*, *source* or *goal*. *State* and *process* were also significant, but had a negative correlation value. For the activation of eventualities no significant effects were found for *state* or *process*. Recall shows a similar pattern, however, *state*, *process*, *cross referentiality*, *cross referentiality chain* and *causality* did not reach the significance level.

The lack of a positive significant correlation for *referential agent* and *referential agent chain* and *referential object chain* are unexpected, and so are the non-significant effects for the participant roles *instrument*, *source* and *goal* in both the *referential* relations and *referential chain* relations. These results can be explained as follows: *instrument*, *source* and *goal* had very low frequencies in the analysed texts. It is therefore very likely that we are seeing the effect of sparse data. There are simply not enough cases to make any predictions for these relations. For the lack of significant effects for *agent* (*referential* and *referential chain* relations) and *object* (*referential chain* relations) the opposite explanation can be given in terms of a ceiling effect. When units are connected with these coherence relations, the

numbers are so high that there is hardly any differentiation to make between situations. No significant or negative significant effects are the result.

Other coherence relations without positive significant effects are *state* and *process*. We might assume that the effect of static situations (*states*) or dynamic situations extended in time (*processes*) might have less impact on the mental representation than momentary situations. States differ from events in that the former involve a continuation, whereas the latter involve a termination. As processes do not have finishing points they show similarities with states Kamp & Reyle (1993: 508). In other words, what happens in a narrative is mainly decided by accomplishments and achievements, which are distinguished from states and processes of having output (result) states as terminal points.

Most important to note here is that the cohesion relations that significantly correlate with summarisation and recall results significantly correlate with many other cohesion relations.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1 summary																				
2 recall	549**																			
3 firstment	220**	292**																		
4 agent	-073	037	077																	
5 object	312**	232**	197**	-038																
6 source	069	-048	-073	-058	046															
7 goal	-098	-083	113	114	-109	-031														
8 state	-128*	-119	-035	-061	-295**	-027	-157*													
9 process	-120*	-096	007	-036	-039	-027	199**	-519**												
10 event acc	199**	158**	-109	070	207**	084	-011	-410**												
11 event ach	123*	133*	234**	062	268**	-040	-060	-200**	-200**	-158*										
12 location	172**	286**	291**	168**	057	-068	-103	-036	-064	036	124									
13 time	261**	311**	447**	-007	065	-041	-063	-086	035	-030	144*	161*								
14 cross ref	126*	055	214**	097	269**	068	218**	-172**	-032	191**	056	095	114							
15 chain agent	-084	010	029	951**	-034	-057	110	-051	-019	038	066	106	-085	073						
16 chain object	279**	201**	158*	-035	961**	049	-106	-279**	-046	197**	270**	021	-027	258**	-016					
17 chain source	074	-046	-063	-061	-020	866**	-027	-002	-002	025	-035	-059	-036	053	-063	-018				
18 chain goal	-083	-070	068	053	-068	-015	459**	-073	141*	-058	-028	-048	-029	077	047	-066	-013			
19 cross ref chain	120*	054	213**	104*	266**	072	222**	-163**	-031	181**	055	099	110	975**	083	255**	054	088		
20 caus chain	093	005	-160*	-061	-063	-018	-074	017	013	-057	038	-082	-117	-118*	-035	-032	-016	-120	-120*	
21 Causality	112*	010	-162*	-081	-065	-021	-078	013	006	-049	047	-092	-125	-120*	-055	-033	-018	-122	-123*	977**

Table 6 Coherence relations correlating with summarisation and recall (Kendall's tau)

Note: Decimal points are omitted; bold is significant; *italics* is negative significant correlation

** Correlation is significant at the .01 level (2-tailed); * Correlation is significant at the .05 level (2-tailed)

The correlation results in Table 6 provide evidence for the Interdependency Hypothesis. For instance, the TEMPORAL strand correlates with *summarisation*, the LOCATIONAL strand correlates with *summarisation* and the TEMPORAL strand correlates with the LOCATIONAL strand. The next question is whether the significant cohesion relations in Table 6 also independently affect comprehension, as the results presented here may create the impression that some correlations rely on the correlations of others. For instance, the occurrence of events accomplishments predicts the occurrence of objects: objects register a change of state as a result of an event.

Although a partial correlation analysis could be carried out, we preferred the more robust test of Multiple Regression, using stepwise regression in which the relative uniqueness of the variable is used. Only a limited number of the cohesion relations we defined independently contribute to summarisation and recall values: *time*, *object*, *event accomplishment*, *causality* and *location* (see Table 7 and Figure 5), (Summary: $R_2 = .258$, $F(6,189) = 15.863$, $p < 0.01$; Recall: $R_2 = .426$, $F(6,189) = 17.224$, $p < 0.01$).

Cohesion relation	Summary	Recall
Time	.314**	.653**
Object	.737**	.878**
Event (accomplishment)	.187**	.127*
Causality	.210**	
Causality Chain		.123*
Location	.149**	.278**
Object Chain	-.466**	-3.636**
Cross Referentiality	-.172**	-.171**

Table 7 Multiple regression results

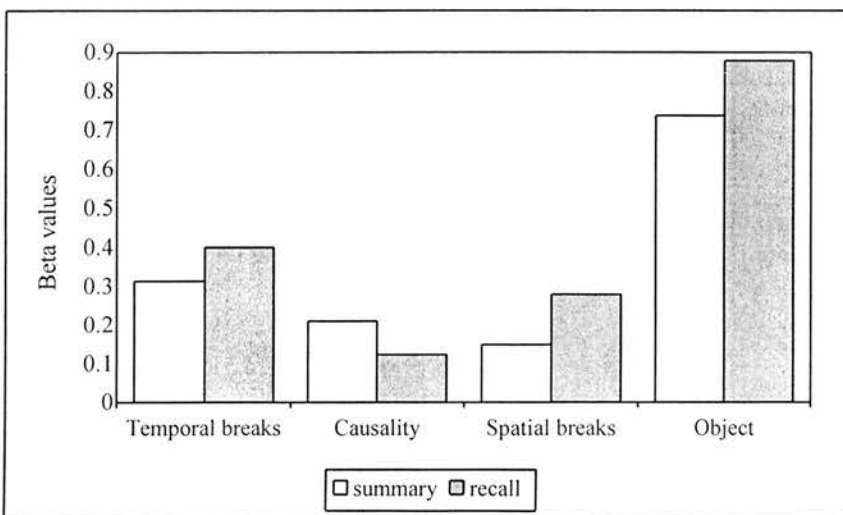


Figure 5 Multiple regression results

But the results we find show similar effects as those found by Zwaan et al. (1995), with effects for temporal breaks, spatial breaks and causality. However, in Zwaan et al. (1995) negative effects were found for argument overlap. In our results object argument overlap shows to have the strongest positive effect.

Causality is significant, but not as strong as we expected. Causality is only significant in the summary results, causality chain only in the recall results. The relative importance of causality is odd in the light of its importance in other studies (Trabasso & Van den Broek, 1985; Langston, Trabasso & Magliano, 1999). Kintsch, investigating one of the *Turtle*-stories we have used, comes to a similar result, and argues that

whether or not subjects actually infer causal relations during reading, more or less the same recall pattern is predicted. At least for recall, readers do not have to infer causal links in a story, they can do just as well with weak, general strategies, based on syntactic and semantic relations as reflected by argument overlap. (Kintsch, 1995:152).

In our experiment, these weak general strategies turn out to be “overlap” of the object participant role and the role of eventualities. The latter have not previously been used in a computational implementation. The role of causality may thus be taken by eventualities in the comprehension process.

The final hypothesis we formulated is the Multiple Strands Hypothesis. We predicted that those situations that are recalled best would have the highest number of cohesion links. We tested this hypothesis by dividing the summary and recall data into four approximately equal groups of situations that were summarised or recalled worst, bad, well and very well. Because the number of summarised situations was generally higher than recall situations, we divided summary data and recall data separately. For each of the four groups the number of cohesion relations per situation was calculated. An Analysis of Variance showed a significant difference between the quartiles in both the number of links in summarised ($F(3, 54) = 2.949, MS_e = .466, p = .041$) and recalled situations ($F(3, 54) = 3.152, MS_e = .210, p < .032$). The differences between the quartiles are presented in Figure 6.

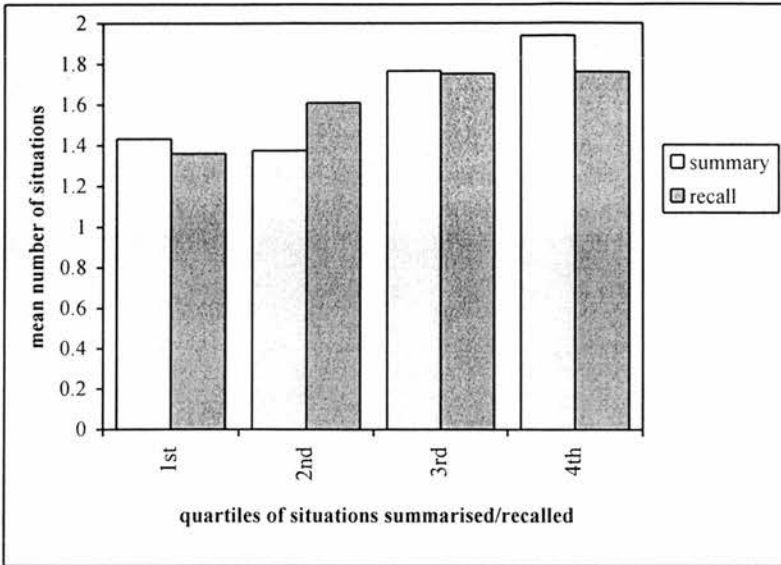


Figure 6 Number of cohesion relations per quartile

The graph shows that the number of cohesion relations for the situations that are least recalled and summarised are less than the number of relations that are most summarised and recalled, thus supporting the Multiple Strands Hypothesis (and hence the Specification Hypothesis).

One of the aims of this experiment has been to determine the statistical size of the effects, in order to have a device to determine the weight of the coherence relations. When we know which coherence relations influence the summarisation results and to what extent, we can enter the weights in the model and predict the summary of a text. This is what we do next.

4.9 STUDY 2

This study examined summaries of texts generated by *CoCon* which were compared with the summaries obtained in summarisation experiments. In the previous experiment we calculated the correlations between the number of cohesion relations per situation and the frequency of summarisation. We assumed that this value could serve as the weight in the connectionist model. This experiment tested whether this is indeed the case. If the number of cohesion links of a situation with other situations gives an approximation of the importance of that situation, and if the importance of the links can be defined by the correlation between the number of links and the number of situations being recalled, then – as we predict – *CoCon* approximates summaries generated by subjects.

Materials

The same nine texts as in experiment 1 were used. As the model has been 'trained' with the same texts that are used to test the model, one could object that the model only applies to these nine texts. However, it is unknown whether the correlations in the previous experiment can serve as weights for the links of the coherence relations.

Procedure

The weights of those relations that had a positive significant effect on the likelihood of summarisation were used in a second experiment in which the summary of each text was predicted. The significant positive correlation values from study 1 as reported in Table 6 served as weights in the model. To test the accurateness of the model, the summaries generated by *CoCon* were compared with the summaries obtained from the summarisation experiments by Omanson (1982), also reported in Trabasso & Van den Broek (1985).

Results and discussion

The activation analysis was repeated until the activation stabilised over the network. This occurred after an average of 10 epochs. A non-parametric correlation⁹ analysis showed that results were significantly correlated with the results obtained in the summarisation experiment (see Table 8) on six out of the nine texts. Two of each text versions (e.g. version 1 and 3 of the Turtle story) significantly correlated with the summarisation results, one version at the .01 level and one at the .05 level¹⁰.

⁹ The non-parametric correlation is implemented in *CoCon*: the user gives the expected results (e.g. based on summarisation and recall data) and *CoCon* calculates the correlation value.

¹⁰ It remains unclear why this neat pattern of two versions of each story and two stories per version significantly correlated with the *CoCon* analysis.

	Version 1	Version 2	Version 3
<i>Turtle</i>	316*	133	406**
<i>Bee</i>	212**	245*	122
<i>Plane</i>	162	369**	246*

Note: decimal points are omitted

** Correlation is significant at the 01 level (1-tailed)

* Correlation is significant at the 05 level (1-tailed)

Table 8 Correlation between CoCon output and experimental output (Kendall's tau)

Using the correlations obtained from comparing the number of links per relation with the number of situations summarised, *CoCon* is able to predict summaries that look like those experimental subjects produce. For instance, the full text of the *Turtle* text given earlier can be summarised in the following six situations:

(19)

- (a) One day Mark and Sally were sailing their toy sailboat in the pond.
- (b) Mark lifted the boat up with a stick.
- (c) and found a turtle on top of it.
- (d) (Mark wanted) Sally to see the turtle.
- (e) and brought it back to her.
- (f) but the turtle bit her.

The question is whether these results can be generalised to other texts, and whether they can be used for larger texts. This is investigated in the third study.

4.10 STUDY 3

Here too we used reported data and had to rely on judgements of importance for the situations by two judges, instead of the likelihood a situation being summarised (see Trabasso & Sperry, 1985).

Materials

To test whether the obtained results could be generalised and to investigate whether the effect was also found for larger texts, *The Father, His Son and Their Donkey* reported in Trabasso & Sperry (1985: 599) was used in this experiment. The text contained a total of 63 situations (see Appendix I).

Procedure

The text was categorised in eventualities and participant roles by two judges. Corrections were made on mutual agreement. These situations were then entered in *CoCon*. The coherence relations and weights as calculated in study 1, and used in study 2 were used in the analysis.

Results and discussion

A non-parametric correlation analysis was carried out between the activation values of the situations and the judgements of importance. The output of *CoCon* correlated significantly with the judgement of importance values ($\tau = .262$, $p = .003$). The hierarchy generated by *CoCon* thus clearly resembles the hierarchy based on judgements of importance.

4.11 CONCLUSION

In this chapter an attempt was made to show how cohesion relations can be studied by means of a computational model. The computational model presented here is based on various theories of text comprehension, notably the Structure Building Framework, the EI Model, the CI Model and the Landscape Model. It differs from the latter two computational models in that it uses situations as text input, it does not use reading cycles to account for all possible connections over the network, and uses a large number of predefined coherence relations. A summarisation analysis of nine texts was compared with the predictions of cohesion relations. Next, summaries were predicted and the results were compared with the human experimental results. With a minimum of user

effort and a large number of computational options *CoCon* has shown to be able to give relatively accurate summaries of texts on the basis of coherence relations that are psychologically plausible compared those produced by human subjects.

The three aims in the construction of the model were psychological validity, theoretical transparency and practical transparency. The model is based on at least four theories in text comprehension. Its cohesion stage involves straightforward links between text units, its connectionist stage invokes a simple matrix algebra. But with the user having to encode the text in situations, have we also achieved the third aim, practical transparency? The problem of parsing and encoding is apparent in every computational model of text comprehension (e.g. Kintsch, 1998: 54). For the model presented here, we may assume that the parsing of sentences could theoretically be carried out automatically. Verbs can be classified in the eventualities like state, process and events accomplishments and achievements. Once we have determined the eventuality, we know which participant roles to expect. In this way a computational parser could classify the words of a clause in the correct eventuality and participant role.

We have here analysed only narrative texts, and in particular short stories. We can only speculate about the results of the model for expository text. However, it is possible that the success rate will be much lower. It seems that expository texts use more states and processes than narrative texts and that global coherence – crucial for thematic analyses – may play a less important role than local coherence. Nevertheless, the model may still work well, though with other cohesion relations and other weights for another text type. The methodology used here, calculating the weights by comparing the relationship with experimental results, can still be applied.

Finally, the issue that needs to be addressed here has always been an important topic in studies, and criticism, of connectionist models. The impression may have arisen that *CoCon* is a representation (although a very poor one) of a part of the brain and that the model simulates discourse processes. This is not what the model is or is supposed to be. However, the model does clarify how discourse processing may take place. Simulating these processes may open new insights into studies on text comprehension. Even if we adopt a very sceptical view towards computational modelling, a model like *CoCon* is useful in automated summarisation. Furthermore, where psycholinguistic theories help us to construct computational models, those models enable us to help to explain psycholinguistic phenomena.

In conclusion, this chapter answered three questions: the Cohesion Question, the Interdependency Question, and the Multiple Strands Question. The psycholinguistic literature answers the Cohesion Question presenting cognitive evidence for at least four vocabulary-driven cohesion and coherence strands: REFERENTIAL, LOCATIONAL, TEMPORAL and CAUSAL relations. Generally, these relations correspond to the who, where, when and why in the text. The relations we defined for the computational model are directly derived from these strands. The results of the computational model follow the literature: the presence of the four strands between situations results in a better summary and recall of these situations, thus supporting the Cohesion Hypothesis.

But the presence of a strand does not mean that a strand independently affects comprehension. Vocabulary-driven cohesion relations interact. The number of links a situation has with other situations correlates with the number of links to other relations. This is at least the case for the four vocabulary-driven relations defined here. Nevertheless, each of these relations independently contributes to the construction of the coherent mental representation. This supports the Interdependency Hypothesis.

Finally, the independent and interdependent effects of cohesion strands suggests that the more strands a situation has with other situations, the easier the comprehension. Evidence for the Multiple Strands Hypothesis was indeed found in the computational results, with those situations summarised and recalled best having the largest number of cohesion relations. The three hypotheses tested in this chapter provide further support for the Specification Hypothesis.

CHAPTER 5

GRAMMAR-DRIVEN COHESION AND COHERENCE RELATIONS: A PARAMETERISATION

5.1 INTRODUCTION

In the previous chapter we saw that REFERENTIAL, LOCATIONAL, CAUSAL, TEMPORAL (and ADDITIVE) cohesion strands simultaneously affect the comprehension process both independently and interdependently and that the more specified a cohesion relation is, the more it facilitates the comprehension process. However, we have only discussed vocabulary-driven cohesion and coherence relations. In this chapter we turn to grammar-driven cohesion and coherence relations.

As we saw in Chapter 1, the answer to the main research question of how textual cohesion supports representational coherence requires the step of answering the question whether cohesion and coherence relations can be categorised. More precisely, we need to provide an answer to the question what basic categories of grammar-driven cohesion and coherence relations can be distinguished. The aim of this chapter is to provide an overview of taxonomies of grammar-driven cohesion relations, in order to develop a parameterisation of these relations that overcomes the problems in earlier proposals.

Grammar-driven cohesion and coherence relations have been studied from a wide range of disciplines and from various points of view. Linguists have looked at them from a corpus linguistic point of view (e.g. Halliday & Hasan, 1976; Martin, 1992); psychologists and psycholinguists have studied their role in text comprehension (e.g. Sanders, Spooren & Noordman, 1992; 1993), while researchers in artificial intelligence, computer science and cognitive science have studied them from a computational perspective (e.g. Hobbs, 1985; Knott, 1996; Knott & Dale, 1994; Mann & Thompson, 1987). The difference between the literature on vocabulary-driven and grammar-driven cohesion and coherence relations is that studies on grammar-driven cohesion and coherence relations generally concern proposals of taxonomies of these relations, while

such taxonomies have never been proposed for vocabulary-driven ones. We follow the literature on grammar-driven cohesion and coherence relations, discuss several of these taxonomies and propose a parameterisation. We thereby focus on those grammar-driven strands that are commonly marked by conjunctions: TEMPORAL, CAUSAL and ADDITIVE strands¹.

5.2 SIX TAXONOMIES

5.2.1 Halliday & Hasan (1976)

One of the cohesion studies most commonly referred to is Halliday & Hasan (1976). Their analysis of cohesion is limited to the English language and concerns intersentential rather than interclausal cohesion. The authors distinguish five types of textual cohesion: REFERENCE, SUBSTITUTION, ELLIPSIS, LEXICAL COHESION and CONJUNCTION. These cohesive relations make a text-forming component in the linguistic system. REFERENCE is comparable to grammar-driven REFERENTIAL cohesion defined in the introduction and the previous chapter. ELLIPSIS concerns the information that has been left unsaid but does not affect the comprehension of the sentence: it “leaves specific structural slots to be filled from elsewhere” (Halliday & Hasan, 1976: 143). LEXICAL COHESION is what we have called vocabulary-driven cohesion and concerns repetition, synonymy or reiteration of a noun phrase. The two main differences between the first four relations – REFERENCE, SUBSTITUTION, ELLIPSIS, LEXICAL COHESION – and CONJUNCTIONS is that the boundaries of CONJUNCTIONS are much harder to describe than those of the other cohesive relations. Also, CONJUNCTIONS form a different type of SEMANTIC relations, not a search instruction, but a relation that *specifies* the connection of two text units (Halliday & Hasan, 1976: 226). We will here only focus on this type of cohesion and leave the other four cohesion relations undiscussed.

¹ It could be argued that conjunctions are not limited to CAUSAL, TEMPORAL and ADDITIVE strands. Knott & Dale (1994) define the conjunctions *where* and *wherever* for LOCATIONAL strands. Here, we consider these markers deictic rather than conjunctive.

Admitting that different classifications of conjunctions are possible, depending on the perspective of the researcher, Halliday and Hasan propose a scheme of four categories: ADDITIVE, ADVERSATIVE, TEMPORAL and CAUSAL. Examples of these four relations are given in (1)-(4).

- (1) Bill kissed Monica and shook Hillary's hand (ADDITIVE)
- (2) Bill kissed Monica but he didn't really like her (ADVERSATIVE)
- (3) Bill kissed Monica. Then he walked out of the White House (TEMPORAL)
- (4) Bill kissed Monica because he liked her (CAUSAL)

The result of this is a framework of categories that "relegates [the complexity of the facts] to a later, more 'delicate', stage of the analysis" (ibid. 239). The four categories form the rigid structure of the framework, with an additional less rigid subdivision.

Within each of these four categories the distinction is made between EXTERNAL and INTERNAL relations. In EXTERNAL relations the cohesion is interpreted as an experiential language function. That is, the cohesive relation is interpreted with regard to our experience of external reality (ibid. 240). In the case of INTERNAL relations, the cohesion is interpreted as an interpersonal function of language. Here, cohesion is interpreted with regard to the speaker's role in the speech act. In other words, EXTERNAL relations are between the λ -propositional content, INTERNAL relations between the speech acts. Examples (see also ibid. 321) of the distinction in each of the four relations are presented in Table 1.

	EXTERNAL	INTERNAL
ADDITIVE	Bill kissed Monica. And he gave her a ring.	Bill kissed Monica. And only Kenneth found out.
ADVERSATIVE	Bill kissed Monica. Yet he did not like her.	Bill kissed Monica. Yet that can't have happened; he is the President.
CAUSAL	Bill kissed Monica. So they tried to impeach him	Bill kissed Monica. So he knew that he might be impeached.
TEMPORAL	Bill kissed Monica. Then he asked her to marry him.	Bill kissed Monica. Then there was the Paula Jones case.

Table 1 Main categories of Halliday & Hasan's (1976) taxonomy.

Despite the fact that the distinction between EXTERNAL and INTERNAL is a basic component of their taxonomy, it is not always very clearly defined. In an ADDITIVE context for instance it is very hard to decide on either of one of the two (ibid. 245). According to Halliday & Hasan the difference lies in the conjunction *and* as ‘and then’ (EXTERNAL) and an independent ‘and’ (INTERNAL) which invokes the expectation that something more needs to be said. In ADVERSATIVE relations on the other hand, EXTERNAL relations can usually be interpreted as ‘in spite of the fact that’, whereas INTERNAL relations need to be interpreted as ‘in spite of (the state of the argument)’ (ibid. 253). The distinction between INTERNAL and EXTERNAL is not very clear-cut in causality either, as the notion of causality already involves interpretation by the speaker. In general, one could say that in CAUSAL relations INTERNAL relations often imply some reasoning of argument from a premise (ibid. 257). Finally, in TEMPORAL relations INTERNAL relations point out successivity in the communication process (marked by *next* in the course of discussion), while EXTERNAL relations mark successive events (marked by *after that*).

Halliday & Hasan’s taxonomy doesn’t stop at these eight ((ADDITIVE, ADVERSATIVE, CAUSAL, TEMPORAL) x (INTERNAL, EXTERNAL)) categories. Despite the fact that “[a] detailed systematisation of all the possible subclasses would be more complex than is needed for the understanding and analysis of cohesion” (ibid. 239) the authors further subclassify these eight categories into a total of more than 50 relations. They do not define these relations, but mention them, point out their relation to the eight basic categories and illustrate them with examples. Because of the absence of any definitional information and for the purpose of this study, we will not further discuss them, but present them in an overview in Appendix II, Table 1-4. The general categories are presented in Table 2:

	EXTERNAL/ INTERNAL	INTERNAL		
ADDITIVE	ADDITIVE, SIMPLE	-COMPLEX, EMPHATIC -COMPLEX, DE- EMPHATIC	APPOSITION	COMPARISON
ADVERSATIVE	ADVERSATIVE 'PROPER'	CONTRASTIVE	CORRECTION	DISMISSAL
CAUSAL	-CAUSAL, GENERAL -CAUSAL, SPECIFIC	-REVERSED CAUSAL -CAUSAL, SPECIFIC	CONDITIONAL	RESPECTIVE
TEMPORAL	-TEMPORAL, SIMPLE -CONCLUSIVE -CORRELATIVE FORMS	COMPLEX	-INTERNAL TEMPORAL -CORRELATIVE FORMS	-HERE & NOW -SUMMARY

Table 2 Main categories in Halliday & Hasan's (1976) taxonomy

In addition to these conjunctive relations, Halliday & Hasan distinguish an additional subgroup of items in the CONJUNCTIONS-category, which do not express conjunctive relations, but do contribute to the cohesive force of the text (ibid. 267). This group, called CONTINUATIVES, is best to be compared with discourse markers as for instance discussed in Lenk (1998) and Mosegaard-Hansen (1998). We will not further discuss this set of items, as they are particular to discourse rather than text.

Halliday & Hasan's (1976) proposal provides a very detailed description of cohesive devices in English text. It does not theorise about abstract categories, but gives a clear account of the linguistic surface features in the text. They focus their analysis on cohesion across sentence boundaries, simply because intersentential cohesive devices are more obvious (ibid. 9). Although the distinction between intersentential and interclausal cohesion devices seems "overly cautious" (Knott, 1996: 20), from the perspective of a linguistic surface structure approach, it is reasonable to make such a distinction. Furthermore, it restrains the size of the taxonomy. However, this last aim does not apply to the rest of the taxonomy. It is very fine-grained and contains categories that are at least problematic. At the lowest level of the taxonomy the many different categories and their interrelationships are confusing. CAUSAL relations include a reversed causal category (*for, because* versus *so, hence*), but there is not a reversed TEMPORAL category (e.g. *after that* versus *before that*). In ADVERSATIVE relations a distinction is made between correction of meaning (*instead, on the contrary*) and a correction of wording (*at least, I mean*). A similar distinction between meaning and wording is not made for TEMPORAL relations, which do however seem to include

temporal meaning (*an hour later*) and temporal wording (*in conclusion*)². In some cases a distinction is made between 'simple' and 'complex' (ADDITIVE and TEMPORAL), 'general' and 'specific' (CAUSAL) but sometimes the label 'proper' is used instead of 'simple' and 'general' (ADVERSATIVE).

More important problems are found at the highest level of the taxonomy. First, many conjunctions can be used in various classes. ADDITIVE and ADVERSATIVE share conjunctions (*and, I mean*), as do ADVERSATIVE and TEMPORAL (*at the same time*) and CAUSAL and TEMPORAL (*then*). The fact that categories are not clear-cut and that the relation between conjunctions and categories is one-to-many is not too problematic. What is troublesome indeed is the fact that there is no system in these relations, something that seems to be essential in a taxonomy. Related to this, the category ADVERSATIVE remains unclear. Conjunctions like *though, although* and *nevertheless* need to be classified under ADVERSATIVE relations, but are clearly CAUSAL. Similarly, conjunctions like *however* and *but* are ADVERSATIVE, but are similar to ADDITIVE relations (as is suggested by Halliday & Hasan by classifying conjunctions like *and* and *I mean* under ADDITIVE and ADVERSATIVE relations).

Third, probably the largest problem lies in the INTERNAL and EXTERNAL distinction. As pointed out above, the distinction is often difficult to make (at least in two – CAUSAL and ADDITIVE – of the four categories). The summary table of conjunctive relations (*ibid.* 242; Appendix II, Table 1-4) shows that most of the conjunctions can be both INTERNAL and EXTERNAL, but when categorised as such, they can sometimes be EXTERNAL only (e.g. TEMPORAL SIMPLE). Sometimes conjunctions can only be INTERNAL, but when categorised as such they can often be also EXTERNAL (e.g. CAUSAL CONDITIONAL) or only EXTERNAL (e.g. TEMPORAL COMPLEX, ADVERSATIVE CONTRASTIVE).

In sum, Halliday & Hasan's (1976) taxonomy is fine-grained and clarifies many aspects in corpus linguistic data. However, the taxonomy is too fine-grained, leaving categories at the lowest level unexplained. Furthermore, at the highest level it seems that one category (ADVERSATIVE) could be integrated in at least CAUSAL and ADDITIVE relations. Also, the distinction between INTERNAL and EXTERNAL remains vague.

² One could of course argue whether this enumeration is TEMPORAL or ADDITIVE.

5.2.2 Martin (1992)

Based on Halliday & Hasan's (1976) study, Martin (1992) proposes another elaborated taxonomy of the cohesive resources available in the English language. Martin distinguishes four central discourse systems, which constitute the discourse stratum NEGATION, IDENTIFICATION, CONJUNCTION and IDEATION (ibid. 26).

NEGATION considers the discourse semantics of interpersonal meaning, IDENTIFICATION the discourse semantic of textual meaning, CONJUNCTION the discourse semantics of logical meaning, and IDEATION the discourse semantics of experiential meaning. (Martin, 1992: 26)

NEGATION concerns the discourse of dialogue and therefore falls outside the scope of this research. IDENTIFICATION is what Halliday & Hasan (1976) have called REFERENCE and what we have called 'REFERENTIAL grammar-driven cohesion'. IDEATION concerns experiential relations among lexical items, what Halliday & Hasan have called LEXICAL COHESION and what we have called 'vocabulary-driven cohesion'. Finally, as in Halliday & Hasan, CONJUNCTION concerns the logico-semantic relations between messages.

The lion's share of Martin's study is devoted to CONJUNCTION. He distinguishes four types of logico-semantic relations: ADDITIVE, COMPARATIVE, TEMPORAL and CONSEQUENTIAL. Three of these relations – ADDITIVE, TEMPORAL and CONSEQUENTIAL – are identical to Halliday & Hasan's ADDITIVE, TEMPORAL and CAUSAL cohesion. Martin removes ADVERSATIVE relations from his taxonomy and adds a COMPARATIVE relation. Within each of the four relations a distinction is made between DISTINCTIVE INTERNAL relations, EXTERNAL/INTERNAL cohesive relations, PARATACTIC and HYPOTACTIC relations.

The INTERNAL versus EXTERNAL distinction is identical to Halliday & Hasan's distinction. INTERNAL relations concern the organisation of the text, rather than the organisation of the world described by the text. The latter is what EXTERNAL relations are concerned with.

The distinction between PARATACTIC and HYPOTACTIC lies in the status of the conjoined elements. In parataxis the binding of the elements is equal, in hypotaxis they

are unequal. Halliday (1985)³ defines a PARATACTIC relation as symmetrical and transitive and a HYPOTACTIC relation as non-symmetrical and non-transitive (Halliday, 1985: 199). For instance (5)(b) does not imply (5)(a), but (6)(b) does imply (6)(a).

Hypotaxis:

(5)

- (a) Besides undergoing the operation, he also had to pay for it.
- (b) Besides having to pay for it, he also underwent the operation.

Parataxis:

(6)

- (a) I sleep and at the same time I breathe.
- (b) I breathe and at the same time I sleep.

Martin proposes more or less the same test to decide whether we speak of a cohesion relation and to decide which interdependency relation exists. He assumes that coherence relations can always be marked linguistically, but sometimes remain implicit. In those cases where a conjunction can be used⁴, but is not, Martin speaks of an implicit connection. Similarly, the test Martin proposes to determine the category of interdependency relation – DISTINCTIVE INTERNAL, EXTERNAL/INTERNAL, PARATACTIC and HYPOTACTIC – is similar to the EXPLICIT/IMPLICIT test he proposes, namely replacing one relation by another (Martin, 1992: 226).

Like Halliday & Hasan (1976) Martin does not discuss the lower levels of his taxonomy. An overview of the complete taxonomy and examples is presented in Appendix II, Table 5-12. The main categories are presented in Table 3.

³ Halliday & Hasan (1976) only briefly discuss the distinction with regard to clausal substitution and clausal ellipsis.

⁴ Note that Martin claims that coherence relations can always be marked linguistically, but sometimes remain implicit.

ADDITIVE -ADDITION -ALTERNATION	DISTINCTIVE INTERNAL	EXTERNAL/ INTERNAL "COHESIVE"	PARATACTIC	HYPOTACTIC
COMPARATIVE -SIMILARITY -CONTRAST	DISTINCTIVE INTERNAL	EXTERNAL/ INTERNAL "COHESIVE"	PARATACTIC	HYPOTACTIC
TEMPORAL -SIMULTANEOUS -SUCCESSIVE	DISTINCTIVE INTERNAL	EXTERNAL/ INTERNAL "COHESIVE"	PARATACTIC	HYPOTACTIC
CONSEQUENTIAL -PURPOSE -CONDITION -CONSEQUENCE -CONCESSION -MANNER	DISTINCTIVE INTERNAL	EXTERNAL/ INTERNAL "COHESIVE"	PARATACTIC	HYPOTACTIC

Table 3 Main categories of Martin's (1992) taxonomy.

Martin's contribution is valuable in that it combines some earlier taxonomies (among them Halliday & Hasan's, 1976) into an even more elaborated taxonomy. Like Halliday & Hasan (1976), Martin's emphasis lies on explicit linguistic conjunctions, but contrary to Halliday & Hasan's proposal, Martin includes both intersentential and interclausal conjunctions. The biggest problem in Halliday & Hasan's proposal is found in Martin's: the taxonomy is overspecified. In Halliday & Hasan's proposal eight basic categories are distinguished, in Martin's this number is sixteen (4 x 4). The actual taxonomy is even more fine-grained than Halliday & Hasan's 50 categories, with a total of over a 100 categories.

As with Halliday & Hasan's proposal, even at the highest (basic) level of Martin's taxonomy there are problems. Instead of Halliday & Hasan's ADVERSATIVE category, Martin introduces a COMPARATIVE category, including conjunctions like *likewise*, *equally* and *like*. This category seems to show overlap with other categories, for instance TEMPORAL SIMULTANEOUS relations, marked by conjunctions as *at the same time*, *meanwhile* and *while*.

More problematic in Martin's proposal is the following: Martin argues that the context needs to determine whether a relation is DISTINCTIVE INTERNAL,

EXTERNAL/INTERNAL, PARATACTIC or HYPOTACTIC, as many conjunctions are shared by the different categories. Martin states that the distinction between these categories generally is difficult to make, and that only TEMPORAL relations allow a clear difference between INTERNAL and EXTERNAL (ibid. 180). The distinction between INTERNAL and EXTERNAL appears to be difficult for the analyser too. The test Martin proposes to make the distinction between INTERNAL and EXTERNAL relations involves changing the dependency relationship from INTERNAL to EXTERNAL or vice versa (ibid. 226). But earlier (ibid. 184), when Martin provides a test to distinguish between EXPLICIT and IMPLICIT relationships, he states that this test runs into problems because INTERNAL relations can be inserted between any pair of sentences.

In sum, comparing Martin's (1992) taxonomy with Halliday & Hasan's, Martin's proposal is an improvement, as it provides tools to determine to which category a conjunction belongs. It also reduces arbitrary relations, like ADVERSATIVE relations defined in Halliday & Hasan's taxonomy. On the other hand, it has the same problems. It is far too fine-grained to be useful in discourse analysis – let alone to be tested psycholinguistically – because the categories at the lower end of the taxonomy remain unexplained and are far too detailed for an efficient taxonomy. Finally, like in Halliday & Hasan, the distinction between INTERNAL and EXTERNAL in particular proves to be problematic.

5.2.3 Mann & Thompson's RST (1987)

Rather than an account of conjunctions in the English language, Mann & Thompson's Rhetorical Structure Theory (RST) is a descriptive framework for (cross-linguistic) text. More in particular, it describes the relations among the text spans, regardless of whether or not they are marked by conjunctions. This means that contrary to Halliday & Hasan and Martin, RST does not deal with cohesion, but rather with coherence. RST assumes that relations in the text are between text spans, usually but necessarily identical to clauses. Furthermore, it assumes that some rhetorical relations may not have any corresponding linguistic devices (Mann & Thompson, 1987: 45). In RST text spans have variable size. They minimally consist of two clauses, but could also consist of units larger than clauses. RST assumes that multisentential text is relational. In this relational

structure a small set of rhetorical relations is dominant. RST does not exclude other relations – e.g. semantic relations like reference – but assumes they are inferior to the rhetorical relations. The rhetorical relations are described in terms of the effect the writer intends to achieve. The writer decides how to organise and present the text, and in that sense the relations between the text spans are rhetorical. RST can therefore be seen as writer- rather than reader-oriented. This is in sharp contrast with Halliday & Hasan's and Martin's proposals, in which a taxonomy is constructed on the basis of linguistic devices: coherence relations could occur implicitly but all relations in the two taxonomies should be able to be marked by cohesion devices. This is not the case in Mann & Thompson's RST.

An RST analysis of a text starts by dividing the text into functional units, text spans. Independent from one another these text spans are incomprehensible. This means that if one text span is removed, the other is incomprehensible. In RST the two text spans form a nucleus and a satellite (Mann & Thompson, 1987). The distinction between the two text spans can be made on the basis of the asymmetric relationship between them. The nucleus of a text span is the part that is more essential to the writer's purpose than the satellite.

Rhetorical relations hold between two non-overlapping text spans and form an initial arrangement of constituent text spans, called schemas. These schemas are rearranged into larger schema applications. The result of the analysis is a rhetorical structure tree, which is a hierarchical system of schema applications.

The number of relations and the organisation of them differ between the different RST studies. We follow Mann & Thompson (1987), who define a total of 23 rhetorical relations, given below, followed by their intended effect.⁵

⁵ Definitions are directly borrowed from Mann & Thompson (1987).

CIRCUMSTANCE	Relation sets a framework (e.g. spatial or temporal) within which to interpret the nucleus. Satellite presents an unrealised situation.
SOLUTIONHOOD	reader recognises the situation presented in the Nucleus as a solution to the problem presented in the satellite.
ELABORATION	reader recognises the situation presented in the Satellite as a providing additional detail for the nucleus.
BACKGROUND	Readers ability to comprehend the nucleus increases.
ENABLEMENT & MOTIVATION	Satellite provides reader with the information to perform action or increase the reader's desire to perform that action presented in the nucleus.
EVIDENCE & JUSTIFY	Relation influences reader's attitude toward the nucleus.
RELATIONS OF CAUSE	reader recognises the situation presented in the satellite as a cause for the situation presented in the nucleus.
ANTITHESIS & CONCESSION	Relation causes reader to have positive regard for nucleus
CONDITION & OTHERWISE	Relation realises the situation in the nucleus is related to the realisation of the situation in the nucleus.
INTERPRETATION & EVALUATION	reader assesses nuclear material in terms of some frame of reference that is not part of the subject matter of the nucleus itself.
RESTATEMENT & SUMMARY	Relation paraphrases in the satellite of the situation presented in the nucleus.
OTHER NON-NUCLEATED RELATIONS	Reader recognises the succession relationship or the comparability and the difference(s) among the nuclei.

Table 4 Main categories in Mann & Thompson (1987)

For a complete overview of the taxonomy and examples for each of the categories, see Appendix II, Table 13.

With these basic relations defined, other combinatory categories can be created. One of them is for instance the order of spans, in which the nucleus either comes before the satellite or the satellite comes before the nucleus. Because it falls under the independent control of the writer it is not part of the actual taxonomy (ibid. 16). Another combination forms the categories SUBJECT MATTER and PRESENTATIONAL, that is “reminiscent of, but not the same as, Halliday & Hasan’s [and Martin’s] distinction between external and internal relations” (Mann & Thompson, 1987: 18).

The distinction between nucleus and satellite also relates Mann & Thompson’s proposal to Martin’s, as it resembles the HYPOTACTIC-PARATACTIC distinction. The clear difference between proposals like Halliday & Hasan and Martin on the one hand and Mann & Thompson’s proposal on the other is that

relations among parts of a text emanate from the relations among clauses. While all of them acknowledge that these relations might hold among groups of clauses as well, their descriptive modes yield successive combinations of clauses rather than, as in RST, a functional model that asks what the text is doing for the writer. (ibid. 40)

With a focus on the writer rather than on the linguistic realisation of the text, Mann & Thompson argue that some rhetorical relations do not necessarily have corresponding conjunctions. This makes their taxonomy fundamentally different from Halliday & Hasan's and Martin's.

Mann & Thompson (1987: 17) emphasise that other taxonomies are possible, depending on the classifier's interest of grouping the features and dimensions of a taxonomy (like time, writer, reader participation and locus of effect). Their proposal, however, has been extremely influential, particularly in computational linguistics. Many texts have been analysed with RST in a variety of fields, so much that Mann & Thompson can claim that "[i]n our culture, texts that have RST analyses predominate. It is thus typical, but not universal, for texts to be hierarchically structured and functionally organised." (ibid. 20).

Nevertheless, even with the RST proposal as rule of thumb, varieties in analyses are still possible. Because RST does not use strict linguistic boundaries (as in Halliday & Hasan (1976) the sentence; in Martin (1992) the clause) it can be difficult to mark the text spans. Furthermore, it is possible that different analyses are possible of one text, because of an ambiguous text structure. Also, the fact that Mann & Thompson assume that relations often remain unmarked does not facilitate the analyser's task.

In sum, Mann & Thompson's proposal is more coherence-based than cohesion-based. Contrary to the previous proposals it assumes that relations do not have to be signalled. Because for Mann & Thompson there is not a strict one-to-one relation between cohesion and coherence, their taxonomy can easily be applied cross-linguistically. However, in this also lies its main problem. What evidence is there for the relations that have been defined? If they are neither based on linguistic instances nor on cognitive evidence, are the relations then subjective interpretations of the analyser? Furthermore, it seems the case that some RST relations are marked frequently, others sporadically (EVIDENCE, JUSTIFY, INTERPRETATION, RESTATEMENT, LIST), whereas others are never marked linguistically (ELABORATION, BACKGROUND). What

implications does this have for the theory? These questions may be less important for a theoretical computational account of cohesion, but are of great importance for a psycholinguistic account.

5.2.4 Hobbs (1985)

Hobbs integrates a theory of coherence relations in a larger knowledge-based theory of discourse interpretation. In other words, contrary to Halliday & Hasan (1976) and Martin (1992) and like Mann & Thompson (1987), Hobbs considers a theory of coherence relations primarily as a theory of knowledge representation and interpretation. According to Hobbs, coherence relations are text building strategies, inferences the reader uses to make sense of a text. However, contrary to Mann & Thompson's RST, Hobbs emphasises that a theory of discourse interpretation requires information of how knowledge is used in the interpretation process.

Hobbs (1985: 8) defines four classes of coherence relations each corresponding to one of the definitional criteria for discourse:

1. The speaker wants to convey a message;
2. The message is in service of some goal;
3. The speaker must link what he says to what the listener already knows;
4. The speaker should ease the listener's difficulties in comprehension.

One is tempted to make a link between these criteria and Grice's (1975) Cooperative Principle as discussed in Chapter 1, but Hobbs does not make a reference to either Grice (1975) or Searle (1969). Although (the) there is not a one-to-one relationship, criterion 1 seems to refer to the Maxim of Quality and Relevance, 2 to the Maxim of Relevance, 3 to the Maxim of Quantity and 4 to the Maxim of Manner.

The fact that the speaker wants to convey a message means that even if text units do not appear to be cohesive, the reader will try to make the text coherent by asking himself whether any inferred events in the world can help establishing coherence. Hobbs defines the following relations. For a complete overview of the taxonomy, see Appendix II, Table 14.

OCCASION	infer a change of state from an assertion, whose initial or final state can be inferred from another one.
EVALUATION	infer one text segment from another segment so that the inference is a step in a plan for achieving some goal of the discourse.
BACKGROUND	infer that the state or event asserted by a sentence forms the background of the state or event asserted by another one.
EXPLANATION	infer that the state or event asserted by a sentence causes or could cause the state or event asserted by another one.
PARALLEL	infer (a) proposition(s) from the assertion of one sentence and (a) proposition(s) from another assertion so that both propositions are similar.
ELABORATION	Infer the same proposition from the assertions of two sentences.
EXEMPLIFICATION	infer a proposition from the assertion of a sentence and another proposition from another, where the first proposition is a member or subset of the other.
CONTRAST	infer a proposition from the assertion of a sentence and a contrastive proposition from the assertion of another sentence.
VIOLATED EXPECTATION	infer a proposition from the assertion of a sentence and the opposite of that proposition from the assertion of another sentence.

Table 5 Categories of Hobbs' (1985) taxonomy

Hobbs' theory is appealing because of the computational account of coherence relations in a framework of text comprehension. Although references to Van Dijk & Kintsch (1983) or Grice's (1975) Cooperative Principle are lacking, Hobbs' theory can easily be integrated in these theories. Like Mann & Thompson's theory, Hobbs' proposal can be regarded as a cross-linguistic taxonomy of coherence relations. Nevertheless, his theory remains vague in some very important aspects. Hobbs makes an attempt to cluster the relations in larger groups (*ibid.* 14), but does not make a clear attempt to construct a taxonomy. Furthermore, and similar critique has been given on Mann & Thompson's proposal, if coherence relations are cognitive strategies, what cognitive evidence can be given for these strategies? Finally, the attempt to integrate world knowledge in a theory of coherence and structure of discourse is very welcome. But if coherence relations are not primarily related to linguistic markers like conjunctions, one runs the risk that the enormous variety of world knowledge would make a taxonomy of coherence relations a mammoth and impossible task. Contrary to Mann & Thompson and Hobbs, it therefore seems better to start with the textual units, something Knott and colleagues' proposal succeeds in.

5.2.5 Knott & Dale (1994)

The taxonomy proposed by Knott & Dale (1994) and Knott & Mellish (1996) differs from Halliday & Hasan's (1976) and Martin's (1992) proposal in many respects. Not only are the taxonomies different, also – and more importantly – an alternative methodology for the classification of coherence relations is applied. Both the taxonomies by Knott & Dale (1994) and Knott & Mellish (1996) are deduced from a network of semantic relationships between conjunctions, which are the result of a data-driven methodology.

Research on clause and sentence connectives faces a trade-off between what Knott & Mellish (1996: 143) call the 'accuracy' of the theory and its 'scope'. On the scope side of the spectrum, connectives are studied with the aim of being complete, at the cost of theoretical power. On the accuracy side of the spectrum, a strong theoretical framework is developed with the aim of being theoretically rigid at the cost of the number of connectives that can be described. According to Knott & Mellish, in 'accuracy focussed taxonomies' a compromise is often found in the use of intermediate-level categories of connectives, e.g. CAUSAL and TEMPORAL connectives, which can then be further classified. The problem with this is that the question is whether these intermediate-level categories are justified as theoretical constructs. On the other hand, at the scope side of the spectrum these categories often cut through a very large and diverse set of connectives, losing its explanatory power.

Knott (1996), Knott & Dale (1994) and Knott & Mellish (1996) therefore propose to deduce categories for a taxonomy in three stages. The method shows similarities with Martin's (1992) substitution tests for explicit and implicit relations and paratactic and hypotactic relations, and Mann & Thompson's (1987) claim of independency of text spans.⁶

The first step involves the cue phrase test, which tests whether a conjoined clause is a cue phrase, i.e., a relational phrase signalling a discourse relation. This test examines whether the relational function extends beyond a clause. In other words, a cue

⁶ The substitution test proposed by Knott & Dale (1994), Knott (1996) and Knott & Mellish (1996) could be implemented computationally by using Latent Semantic Analysis, briefly outlined in Chapter 2.

phrase is a clause that cannot stand alone, but requires a linguistic context to be understood. Consider the sentence (7):

(7) Bill kissed Monica, because he liked her.

First the phrase and its host clause need to be isolated. Any anaphoric or cataphoric items need to be substituted with their antecedents and any elided items need to be included. If the result of this is an incomplete clause, in which at least one extra clause is needed to make it sensible, Knott et al. speak of a 'cue phrase'. In example (7), the resulting 'because he liked her' is incomplete and hence is a relational phrase. Although this test seems very simple and useful, the decision whether the result is linguistic or not can sometimes be difficult. Knott and Dale (1994) give the following example:

(8) But you can't just leave it there!

It is indeed the case that this discourse can be imagined without previous utterances, and could be seen as an argument against the substitution test. This is not a counterargument though, as the utterance can only be interpreted against a discourse context.

With a resulting corpus of cue phrases, the taxonomy can now be built. Two cue phrases are considered more or less synonymous within the same category if they are inter-substitutable. If one can be replaced by the other but not the other way around, the latter is subordinated to the former. If two cue phrases cannot be substituted in any given context they are exclusive.

after all
(9) Bill kissed Monica ✓because he liked her
on the grounds that

after all
(10) Kenneth sued Bill ✓because he had lied under oath
on the grounds that

The result of the substitution test on a large number of cue phrases is a large web of interrelations between conjunctions. The nodes of these interrelations form the taxonomy. In actual fact it is merely the formation of the categories themselves that is important: Labels for these categories are assigned after the taxonomy has been constructed and not – as was the case with Halliday & Hasan's (1976) and Martin's (1992) taxonomy – a priori. As Knott & Mellish put it:

The taxonomy does not in itself embody a *theory* about the semantics of cue phrases. In any such theory, an independent representation of the relations signalled by cue phrases must be provided, so that predictions can be made about which relations are signalled by which phrases. No such independent level of representation is present in the taxonomy. (Knott & Mellish, 1996: 149)

Two classifications have been constructed by Knott and his colleagues. One taxonomy given in Knott & Dale (1994) come closest to the results of the substitution test and looks – despite its clear differences – similar to Halliday & Hasan's and Martin's proposal. The other, presented in Knott (1996) and Knott & Mellish (1996) concerns a classification of cue phrase definitions which are derived from – and look like an abstraction of – Knott & Dale's taxonomy.

Knott and Dale (1994) propose a 'pre-theoretical' taxonomy, based on the substitution test. It should be seen as a preliminary taxonomy without reference to theories of discourse structure. It is therefore surprising to see similarities between the categories found inductively by Knott & Dale and those found deductively by for instance Halliday & Hsan and Martin. Knott & Dale roughly distinguish between the following main categories: TEMPORAL situation, CAUSAL/PURPOSE relations, SIMILARITY relations, NEGATIVE POLARITY relations, CLARIFICATIONS, INTERRUPTION. Neither this level nor the sublevels of the relations defined are explained in Knott & Dale (1994). The main categories are presented in Table 6. A complete overview of the taxonomy is given in Appendix II, Tables 15-20. It is important to note that contrary to the other proposals, categories are not exhaustive. That is, high-level categories can be filled with conjunctions without the subcategories they govern being filled with the same conjunctions.

TEMPORAL SITUATION	-Previous event -Simultaneous event -Future event -Current circumstances for future event -Past circumstances for current/past event
SPATIAL SITUATION	Spatial proximity
CAUSAL/PURPOSE RELATIONS	-Projected result -Anticipated event acting as volitional cause -Hypothetical cause of lack of event -Realised cause -Temporally/presentationally repeated spans
SIMILARITY RELATIONS	Similarity
NEGATIVE POLARITY RELATIONS	-Contrast/expected preventer of event -Contrast/unexpected event (2 nd item to be presented)
CLARIFICATIONS	-Restatement -Positive Restatement of negative -Exemplification -Additional information -Summary
INTERRUPTION	-Digression -Return to previous point

Table 6 Main categories in Knott & Dale (1994).

In Knott's (1996) research, Knott & Dale's (1994) taxonomy is not mentioned. Instead, another theoretical interpretation is given to the linguistic data and their semantic relations, namely a "set of parameters which are valid right across the space of cue phrases." Knott (1996) and Knott & Mellish (1996) extract the following features from the taxonomy:

1. **SEMANTIC** and **PRAGMATIC** relations, identical to Halliday & Hasan's and Martin's **EXTERNAL** and **INTERNAL** relation. **SEMANTIC** relations link the propositional contents of two clauses, **PRAGMATIC** relations link the illocutions.
2. **POSITIVE** and **NEGATIVE** relations in **CAUSAL** relations. **POSITIVE** relations link the proposition P in the first text span to the proposition Q in the second two text span; **NEGATIVE** relations link the proposition P in the first text span to the negation of Q in the second text span.
3. **UNILATERAL** and **BILATERAL** phrases. In both **UNILATERAL** and **BILATERAL** phrases a premise is presented in the first span which suggests a conclusion in the

second span. Whereas in unilateral phrases the second span presents a negation of the expected conclusion, bilateral phrases suggest an alternative conclusion.

4. **CAUSAL** and **INDUCTIVE** relations are point out the differences between **CAUSAL** relations and relations that can be generalised by inductive rules.
5. **CAUSE** and **RESULT-driven** relations concern the certainty of the proposition. The cause-driven relation relates to the knowledge of the premises, the result-driven relation relates to the desirability of the conclusion.
6. **ANCHOR-BASED** and **COUNTER-PART** based relations specify whether the polarity relation operates on the anchor (in the first part of a clause-pair) or the counterpart of the first part of the clause pair.
7. **PRE-SUPPOSED** and **NON-PRESUPPOSED** relations are related to whether or not the reader already knows the situation expressed in the first part of the clause pair or must accommodate this situation expressed in the text prior to processing the relation.
8. **ACTUAL** and **HYPOTHETICAL** relations defines whether the precondition of the relation is known (actual) or not known (hypothetical) by the protagonist.

Although these relation definitions are certainly useful, they miss the interrelations that were presented in Knott & Dale (1994). This means that the difference between high-level and low-level cue phrases was abandoned and that relations within the parameterisation were left unresolved (see also Knott, 1996: 200). For these reasons we will in the next sections mainly focus on Knott & Dale (1994) instead of Knott & Mellish (1996).

As was stated earlier, Knott & Dale's (1994), Knott's (1996), and Knott & Mellish' (1996) study is particularly useful for its methodology. In contrast to most other taxonomies, e.g. Halliday & Hasan (1976) and Martin (1992), Knott and his colleagues clearly justify their steps. Where other studies have to posit intermediate categories to reconcile the accuracy and scope sides of the spectrum, Knott et al. instead select a large corpus of cohesion relations, and compare these relations in order to create a more objective taxonomy. Categories do not have to be created a priori, like in the taxonomies of Halliday & Hasan (1976) and Martin (1992).

However, this is the case only in theory. In the studies referred to, Knott et al. make the decision themselves about what is acceptable. They recognise that ideally such a taxonomy can only be constructed on the basis of the judgements of others, but that such a project is hardly feasible. An alternative would be to test the intuitions of the researcher (Knott, 1996: 78).

Knott (1996: 58) proposes a “method of psychological constructs” aiming at “the development of a standard set of relations ... taken to model a collection of psychological mechanisms operative during the tasks of reading and writing” (ibid. 2). It remains unclear why a taxonomy of linguistic phenomena has direct psychological implications. In other words, is the use of cohesion relations evidence for psychological constructs (see Knott & Sanders, 1998: 146)? Particularly because the taxonomy is limited to English and because different languages have different sets of cue phrases (Knott, 1996: 60), considering the linguistic phenomena for English as psychological constructs seems problematic. Sanders & Knott (1998) tested whether Dutch and English taxonomies of cue phrases resemble each other. They found that there is no one-to-one mapping between the two sets (ibid. 160) but notice many systematic similarities (ibid. 169), despite the fact that only a small set of cue phrases in both Dutch and English are examined. Differences seem to lie in the “exact meaning of apparent literal translations” (ibid. 169).

In sum, Knott and colleagues’ methodology is an improvement over the other proposals. They deduce the categories after the relations have been made between the cue-phrases resulting in a better account of the actual relations in the text. However, the Knott & Dale (1994) and Knott (1996) taxonomies are not complete as it may be assumed that some conjunctions behave differently in different contexts. Because of this it can be argued that the proposals give linguistic evidence for the cohesion-devices at the surface structure of the text, rather than cognitive evidence for coherence relations marked by cohesion devices.

5.2.6 Sanders, Spooren & Noordman (1992, 1993)

Knott and colleagues addressed the question of being theoretically rigid or complete. Knott & Dale’s taxonomy stayed within both the accuracy and scope side of the

spectrum. Whereas Halliday & Hasan's and Martin's taxonomy were both at the scope side of the spectrum, trying to incorporate a large set of conjunctions, Sanders, Spooren & Noordman's taxonomy – like Mann & Thompson's (1987) and Hobbs' (1985) – lies at the accuracy side. Sanders et al. state that “a satisfying theory of discourse structure should meet: descriptive adequacy and psychological plausibility” (Sanders, Spooren & Noordman, 1992: 3) roughly comparable to scope and accuracy. However, because they claim that coherence relations are cognitive entities rather than analytic tools only, emphasis lies on the psychological plausibility of their proposal (1992: 4; 1993: 102).

The aim of Sanders et al.'s taxonomy is a psychologically plausible theory whose principles apply to all coherence relations, but which generates a limited set of classes of coherence relations (1992: 4). The basis of the taxonomy is the *relational criterion*. This criterion requires that the coherence relation adds an informational surplus to the interpretation of the discourse segments in isolation (Sanders et al., 1992: 5; 1993: 98, 106). Sanders et al.'s taxonomy categorises coherence relations by four cognitive basic primitives (Sanders et al., 1992: 6):

1. BASIC OPERATION: it is assumed that two kinds of relations exist between text spans, a CAUSAL relation or an ADDITIVE relation, e.g. ‘The streets are wet because it rains’ and ‘The streets are wet and the sky looks dark’;
2. SOURCE OF COHERENCE: the coherence relation exists either between the propositions (SEMANTIC relation) or between the illocutions (PRAGMATIC relation), e.g. ‘The streets are wet because it rains’ and ‘It rains because the streets are wet’;
3. ORDER OF SEGMENTS: the text segments can appear in a BASIC (cause precedes effect) or a NON-BASIC order (effect precedes cause). The symmetry in ADDITIVE relations does not yield a BASIC or NON-BASIC order. E.g. ‘Because it rains, the streets are wet’ and ‘The streets are wet because it rains’.
4. POLARITY: the two propositions in the POSITIVE relation correspond to the two text segments, whereas in the NEGATIVE relation they correspond to the negative counterpart of the two text segments. E.g. ‘The streets are wet, because it rains’ and ‘The sun shines, although it rains’.

The four parameters should generate a total of sixteen possible coherence relations. However, because of the symmetric nature of ADDITIVE relations, Order does not apply to this category, so the total number of coherence relations is twelve. Rather than

defining one relation for each of these twelve classes of relations, Sanders, Spooen & Noordman present more than one relation for some classes (1992: 11; 1993: 103). It remains unclear why for some classes more than one relation is defined, as the taxonomy does not aim to be complete (ibid. 102). Defining the subclass of relations next to the four primitives weakens the theoretical rigidity of the proposal. The three categories they have defined – BASIC OPERATION, SOURCE OF COHERENCE, ORDER and POLARITY – are supposed to be cognitive primitives. A further subclassification of some, but not all, categories seems to drift away from the psychological plausibility. More importantly, between the two major studies by the authors (Sanders et al., 1992 and 1993) the combinations of categories resulting in twelve relations remain the same. But the subclassifications differ. This is illustrated in a summary of the relations of Sanders et al. (1992) in Table 7 and Sanders et al. (1993) in Table 8.

BASIC OPERATION	SOURCE OF COHERENCE	ORDER	POLARITY	CLASS	PROTOTYPICAL RELATION
CAUSAL	SEMANTIC	BASIC	POSITIVE	1	CAUSE-CONSEQUENCE
CAUSAL	SEMANTIC	BASIC	POSITIVE	2	CONTRASTIVE CAUSE-CONSEQUENCE
CAUSAL	SEMANTIC	BASIC	NEGATIVE	3	CONSEQUENCE-CAUSE
CAUSAL	SEMANTIC	NON-BASIC	POSITIVE	4	CONTRASTIVE CONSEQUENCE-CAUSE
CAUSAL	SEMANTIC	NON-BASIC	POSITIVE	5a	ARGUMENT-CLAIM
<i>CAUSAL</i>	<i>SEMANTIC</i>	<i>NON-BASIC</i>	<i>NEGATIVE</i>	<i>5b</i>	<i>INSTRUMENT-GOAL</i>
CAUSAL	PRAGMATIC	BASIC	POSITIVE	5c	CONDITION-CONSEQUENCE
CAUSAL	PRAGMATIC	BASIC	POSITIVE	6	CONTRASTIVE ARGUMENT-CLAIM
CAUSAL	PRAGMATIC	BASIC	NEGATIVE	7a	CLAIM-ARGUMENT
<i>CAUSAL</i>	<i>PRAGMATIC</i>	<i>NON-BASIC</i>	<i>POSITIVE</i>	<i>7b</i>	<i>GOAL-INSTRUMENT</i>
CAUSAL	PRAGMATIC	NON-BASIC	POSITIVE	7c	CONSEQUENCE-CONDITION
CAUSAL	PRAGMATIC	NON-BASIC	NEGATIVE	8	CONTRASTIVE CLAIM-ARGUMENT
ADDITIVE	SEMANTIC	_	POSITIVE	9	LIST
ADDITIVE	SEMANTIC	_	NEGATIVE	10a	EXCEPTION
ADDITIVE	SEMANTIC	_	NEGATIVE	10b	OPPOSITION
ADDITIVE	PRAGMATIC	_	POSITIVE	11	ENUMERATION
ADDITIVE	PRAGMATIC	_	NEGATIVE	12	CONCESSION

- italics: the same prototypical relation, but different category between Sanders et al., 1992 vs. 1993.

- italics and bold: a different prototypical relation between Sanders et al., 1992 vs. 1993.

Table 7 Categories in Sanders, Spooren & Noordman's (1992) taxonomy

BASIC OPERATION	SOURCE OF COHERENCE	ORDER	POLARITY	CLASS	PROTOTYPICAL RELATION
CAUSAL	SEMANTIC	BASIC	POSITIVE	1a	CAUSE-CONSEQUENCE
CAUSAL	SEMANTIC	BASIC	POSITIVE	1b	CONDITION-CONSEQUENCE
CAUSAL	SEMANTIC	BASIC	NEGATIVE	2	CONTRASTIVE CAUSE-CONSEQUENCE
CAUSAL	SEMANTIC	NON-BASIC	POSITIVE	3a	CONSEQUENCE-CAUSE
CAUSAL	SEMANTIC	NON-BASIC	POSITIVE	3b	CONSEQUENCE-CONDITION
CAUSAL	SEMANTIC	NON-BASIC	NEGATIVE	4	CONTRASTIVE CONSEQUENCE-CAUSE
CAUSAL	PRAGMATIC	BASIC	POSITIVE	5a	ARGUMENT-CLAIM
<i>CAUSAL</i>	<i>PRAGMATIC</i>	<i>BASIC</i>	<i>POSITIVE</i>	<i>5b</i>	<i>CONDITION-CLAIM</i>
CAUSAL	PRAGMATIC	BASIC	NEGATIVE	6	CONTRASTIVE ARGUMENT- CLAIM
CAUSAL	PRAGMATIC	NON-BASIC	POSITIVE	7a	CLAIM-ARGUMENT
<i>CAUSAL</i>	<i>PRAGMATIC</i>	<i>NON-BASIC</i>	<i>POSITIVE</i>	<i>7b</i>	<i>CLAIM-CONDITION</i>
CAUSAL	PRAGMATIC	NON-BASIC	NEGATIVE	8	CONTRASTIVE CLAIM-ARGUMENT
ADDITIVE	SEMANTIC	_	C	9	LIST
ADDITIVE	SEMANTIC	_	NEGATIVE	10a	OPPOSITION
ADDITIVE	SEMANTIC	_	NEGATIVE	10b	EXCEPTION
ADDITIVE	PRAGMATIC	_	POSITIVE	11	ENUMERATION
ADDITIVE	PRAGMATIC	_	NEGATIVE	12	CONCESSION

- italics: the same prototypical relation, but different category between Sanders et al., 1992 vs. 1993.

- italics and bold: a different prototypical relation between Sanders et al., 1992 vs. 1993.

Table 8 Categories in Sanders, Spooren & Noordman's (1993) taxonomy

When we look at the two taxonomies, the relations GOAL-INSTRUMENT (7b) and INSTRUMENT-GOAL (5b) from the 1992 taxonomy have been replaced by CLAIM-CONDITION (7b) and CONDITION-CLAIM (5b) of the 1993 taxonomy. GOAL-INSTRUMENT relations have a more complex structure than the coherence relations in the taxonomy.⁷ It remains unexplained why the CLAIM-CONDITION relation is added. Furthermore, the comparison between the two studies shows that seven relations have kept their names, but their categories have changed (2, 3, 4, 5c, 7a, 7c in the 1992 taxonomy; 1b, 2, 3a, 3b, 4, 6, 7a in the 1993 taxonomy). Sanders et al. (1993: 104) explain that in the 1992 taxonomy conditional relations were classified as PRAGMATIC, but they can also be SEMANTIC. The fact that conditional relations can be both SEMANTIC and PRAGMATIC does not become clear from the table they present, in which the earlier PRAGMATIC status has now been replaced by a SEMANTIC one. For an overview of the taxonomy and examples of each category, see Appendix II, Table 21. It is important to notice that the cognitive primitives are the same, whereas the theoretically and psychologically weaker categorisation of subclasses differs.

In Sanders et al. (1992) both the success of classification and the psychological plausibility was tested in two experiments. In the first experiment, discourse analysts were asked to find an appropriate label for coherence relations presented in a set of sentence pairs. Prior to the experiment subjects had seen the list of 17 relations in context and their labels. The data were analysed in terms of strict agreement, where the subject chose the correct relation label and class agreement, where the subject chose the correct class label. Both strict agreement and class agreement resulted in low agreement scores, with most confusion among subjects in the SOURCE OF COHERENCE relation. Whereas in all other cases disagreement was only found for a certain class, confusion concerning SOURCE OF COHERENCE was found over the whole range of classes. Least disagreement was found for POLARITY.

In a second experiment Sanders et al. tested whether subjects could infer the coherence relations from sentence pairs and express them by appropriate grammar-

⁷ Sanders et al. (1993: 104) say: "In a classification experiment (Sanders et al., 1992) we found that Goal-Instrument relations were often confused with other causal coherence relations like Argument-Claim, although these relations differ in the *Basic Operation*." [italics added] However, they do not differ in the BASIC OPERATION, but in the SOURCE OF COHERENCE.

driven cohesion devices. Subjects – this time undergraduate students – read sentence pairs without a conjunction and were asked to choose the correct conjunction from a list of conjunctions, each cueing one of the coherence relations. Filler items prevented subjects from establishing a one-to-one relation between sentence pairs and relations. Agreement was again moderate, but agreement on the three classes of primitives was above chance. Least agreement was again found for SOURCE OF COHERENCE.

In a classification experiment reported in Sanders et al., 1993 advanced discourse analysis student were asked to participate in a ‘card sorting task’. Stretches of discourse with explicit and implicit coherence relations were given to subjects and they were asked to make piles of similar relations. A cluster analysis showed that results of groupings of POLARITY and BASIC OPERATION were strong. No evidence was found for the ORDER and only little evidence was found for SOURCE OF COHERENCE. The lack of evidence for ORDER can be explained by the fact that both segments are simultaneously available which “detracts subjects from a left-to-right processing of the relations” (Sanders et al., 1993: 111). This seems a plausible explanation as evidence for ORDER was indeed found in the experiments reported in Sanders et al., 1992. Again, more troublesome was the distinction for SOURCE OF COHERENCE. “If a distinction is made between semantic and pragmatic relations, it is invariably the weakest distinction that turns up” (ibid. 113). Sanders et al. (1993) argue that SOURCE OF COHERENCE probably relies more on context than the other categories and they therefore further investigate this category.

In a follow-up experiment that focussed on SOURCE OF COHERENCE, advanced discourse analysis students were again asked to thoroughly read a series of texts. They then read a paper with the defined coherence relations, their definitions and an example for each of them. Next, subjects were presented with the texts again and had to choose a label for each of the relations. With a relation in a suitable context, the results did give evidence for SOURCE OF COHERENCE.

Sanders et al.’s (1992, 1993) proposal for a taxonomy of coherence relations has been very influential in studies of the phenomena (see e.g. Knott, 1996; Lagerwerf, 1998; Rouchota, 1998). It is particularly an interesting study for the research reported in this thesis as the focus of their proposal lies on cognitive evidence for coherence relations. Furthermore, because the taxonomy is economic – it only has a limited set of

organising principles – it lends itself best to be tested experimentally. However, this is only true for the primitives. It is not entirely clear why Sanders et al. define a subset of coherence relations in addition to their taxonomy of cognitive primitives and test these 17 relations rather than directly testing the primitives. This is particularly of importance, because the coherence relations but not the primitives differ between the two studies.

Cognitive evidence for the primitives comes from four experiments. The overall results of these experiments show that evidence for the BASIC OPERATION and POLARITY is strong. Evidence for the ORDER of the segments is less strong, but lack of evidence can be explained by the experimental design. Evidence for SOURCE OF COHERENCE is generally weak. Evidence was only found for relations with plenty of contextual information.

In sum, Sanders et al.'s proposal is more economical than the other proposals and focuses on cognitive relations. It thus follows Halliday & Hasan's (1976), Martin's (1992) and Knott et al.'s (1994, 1996) proposal, with a cohesion device as a starting point, while it resembles Knott et al.'s (1994, 1996), Mann & Thompson's (1987) and Hobbs' (1985) proposal in trying to describe coherence (rather than solely cohesion) relations. As we have seen, Knott assumes that his theory has a psychological status. For their theory Sanders et al. prove that this is the case. We will come back to Sanders et al.'s proposal later in this chapter.

5.3 A COMPARISON

In discussing the separate taxonomies, we already compared the proposals locally. An overall comparison however is difficult, as some taxonomies are fundamentally different from others. A general division into two groups is relatively easy to make. The taxonomies by Halliday & Hasan, Martin, Knott & Dale and – to a lesser extent – Sanders et al. are all based on conjunctive markers. They all assume that the defined coherence relations can be marked by cohesion markers. This is in contrast to the taxonomies proposed by Mann & Thompson and Hobbs. They argue that coherence relations are often not marked. The result of these assumptions is that the two groups of taxonomies are fundamentally different.

Cohesion-based taxonomies	Coherence-based taxonomies
Halliday & Hasan (1976)	Mann & Thompson (1987)
Martin (1992)	Hobbs (1985)
Knott & Dale (1994)	
Sanders, Spooren & Noordman (1993)	

Table 9 *Division of taxonomies*

The cohesion-based taxonomies can be compared on the basis of their building blocks, conjunctions. For the coherence-based group such a comparison is much more difficult and can only proceed by comparing definitions of the relations.

5.3.1 A comparison of cohesion-based taxonomies

Even a comparison of all four cohesion-based taxonomies – Halliday & Hasan (1976), Martin (1992), Knott & Dale (1994) and Sanders et al. (1992, 1993) – is problematic, as the various categories are not related in a one-to-one relation. Whereas in some cases one different category is used for the same conjunction (e.g. Martin’s CONSEQUENTIAL relations vs. Halliday & Hasan’s ADVERSATIVE relations), in others two or more are used (e.g. Halliday & Hasan’s CAUSAL and ADVERSATIVE relations vs. Martin’s CONSEQUENTIAL, ADDITIVE and TEMPORAL relations). Furthermore, a comparison on the basis of the categories and examples given in Appendix II is feasible, but subjective. We therefore compared the conjunctions that the authors considered prototypical for the categories. The comparison, presented in Appendix II, Table 22-24 was constructed as follows. The categories in the tables presented in Halliday & Hasan (1976), Martin (1992), Knott & Dale (1994) & Sanders, Spooren & Noordman (1993) and their corresponding conjunctions were brought together in one large table. Halliday & Hasan’s (1976) taxonomy was used as starting point. When the conjunctions of a taxonomy corresponded with those of another, the categories were put on one row. Redundant information between categories, because more than one conjunction was shared between categories, was next removed. The obvious disadvantage of this, is that taxonomies may have used different conjunctions and categories were hence compared; if other conjunctions had been used this could have been the case. However, it was reasoned that the taxonomies used the most representative conjunctions for their

categories. Using a method in which different categories were put together regardless of the conjunctions used, would have limited the objectivity of the comparison.

The comparison in Appendix II, Table 22, shows that those conjunctions representative for one taxonomy are not representative for others. About 40% of Halliday & Hasan's conjunctions are not used in the other taxonomies. The same can be said for about 60% of Martin's conjunctions, 70% of Knott & Dale's and 90% of Sanders et al.'s conjunctions. These approximate numbers also indicate the earlier distinction we referred to between taxonomies at the accuracy side and the scope side of the spectrum. The number of conjunctions captured in Halliday & Hasan's 'scope-side' taxonomy appears to be far greater than the number of conjunctions captured in Sanders et al.'s 'accuracy-side' taxonomy.

Despite the obvious differences between the taxonomies some clear similarities can be noted. Generally, by comparing the conjunctions the following categories can be derived, which are shared between the four proposals:

1. CAUSAL, TEMPORAL and ADDITIVE relations: All CAUSAL relations in Halliday & Hasan are marked CAUSAL in Knott and Sanders et al. Only in a few instances Martin marks CAUSAL relations as TEMPORAL. TEMPORAL relations⁸ are shared by Halliday & Hasan, Martin and Knott. In some cases TEMPORAL relations in Halliday & Hasan are CONSEQUENTIAL or CAUSAL in Martin and Knott. For Sanders et al. all TEMPORAL relations in Halliday & Hasan are marked as CAUSAL relations. The label ADDITIVE in Halliday & Hasan, is also used in Martin and Sanders et al. However, in Martin ADDITIVE relations can also be COMPARATIVE and sometimes even CONSEQUENTIAL. Knott & Dale do not use the label ADDITIVE, but the label CLARIFICATIONS and SIMILARITY relations express a similar ADDITIVE feature. As with Martin, some ADDITIVE relations in Halliday & Hasan are CAUSAL in Knott & Dale's taxonomy. The confusion between CAUSAL, TEMPORAL and ADDITIVE could point out that these categories are not very useful, because classifiers cannot agree on how to categorise the conjunctions. It could also suggest that they are very

⁸ It could be argued that 'TEMPORAL relations' should not be considered as a category shared by all taxonomies, as they are absent in Sanders et al. However, the fact that Sanders et al. do not deny a TEMPORAL category (1992: 28) and the striking similarities between the three remaining taxonomies of this category make the prominence of TEMPORAL relations clear.

useful, but that some entailment relation between additivity, temporality and causality makes categorisation difficult. Such an entailment relation will be made clear in the parameterisation we will discuss later in this chapter.

2. **NEGATIVE** relations: all four taxonomies have some kind of **CONTRASTIVE** or **ADVERSATIVE** relations. As we have seen earlier, Halliday & Hasan devote a separate main category to these relations, whereas other subcategorise them under **ADDITIVE**, **CAUSAL** and **TEMPORAL** relations. In Martin, Halliday & Hasan's **ADVERSATIVE** relations are **CONTRASTIVE** or **CONCESSIVE**, while in Knott, like in Sanders et al., they form **NEGATIVE** polarity relations.
3. **SEMANTIC** and **PRAGMATIC** relations. All taxonomies use a distinction between the relations between the propositional content on the one hand, and those between the speech act on the other. Halliday & Hasan and Martin call this **INTERNAL** versus **EXTERNAL**, Sanders et al. **SEMANTIC** versus **PRAGMATIC**. In Knott & Dale this distinction is not made, but it can be found in Knott & Mellish's (1996) **SEMANTIC** versus **PRAGMATIC** distinction. Agreement on whether a relation is **SEMANTIC/EXTERNAL** or **PRAGMATIC/INTERNAL** is hard to find. For instance, Halliday & Hasan's **EXTERNAL/INTERNAL** category is sometimes **EXTERNAL/INTERNAL: COHESIVE**, sometimes **DISTINCTIVE INTERNAL** in Martin's taxonomy. Halliday & Hasan's **INTERNAL** category is mostly **EXTERNAL/INTERNAL** or **DISTINCTIVE INTERNAL** in Martin's taxonomy, but Knott & Mellish (1996) define Halliday & Hasan's **INTERNAL** relations sometimes as **SEMANTIC**, sometimes as **PRAGMATIC**, while Sanders et al. define some of Halliday & Hasan's **INTERNAL** relations as **SEMANTIC**. The problems with this distinction will be discussed into detail later in this chapter.

In sum, despite the fact that some features are not clear between the taxonomies – particularly **ADDITIVE/TEMPORAL/CAUSAL** relations and **INTERNAL/EXTERNAL** – the main categories that are generally shared are **ADDITIVE** relations, **TEMPORAL** relations, **CAUSAL** relations and **CONTRASTIVE** relations.

5.3.2 A comparison of coherence-based taxonomies

The taxonomies proposed by Mann & Thompson and Hobbs do not have the advantage that conjunctions can be compared. We have to rely on the definitions alone, which makes the comparison far more subjective. A comparison between the two taxonomies is presented in Table 10.

Mann & Thompson	Hobbs
Circumstance	Occasion
Solutionhood	Explanation
Elaboration	Elaboration
Background	Background
Enablement	Explanation
Motivation	Explanation, Occasion
Evidence	Explanation, Elaboration
Justify	Occasion, Background, Explanation, Evaluation
Volitional Cause	Explanation, Occasion
Non-Vol. Cause	Explanation, Occasion
Purpose	Background, Evaluation, Explanation
Antithesis	Contrast
Concession	Violated expectation
Condition	Explanation, Background, Occasion, Evaluation
Otherwise	Parallel, Elaboration
Interpretation	Background
Evaluation	Background, Elaboration, Exemplification
Restatement	Parallel, Elaboration
Summary	Parallel
Sequence	Occasion
Contrast	Contrast
Volitional result	Explanation, Occasion
Non-Vol. result	Explanation, Occasion
Means	Background, Occasion
Joint	Parallel, Elaboration

Table 10 Comparison Mann & Thompson (1987) versus Hobbs (1985)

As with the comparison of cohesion-based taxonomies, it immediately becomes clear that there is no one-to-one relationship between the categories. However, what does become apparent is that similar features to the ones are also found in, and are shared with, the cohesion-based comparison are shared between these two coherence-based proposals:

1. CAUSALITY: in both Mann & Thompson's and Hobbs' taxonomy we can find the notion of causality. In Mann & Thompson this falls under RELATIONS OF CAUSE and CONCESSION, which have their equivalents in Hobbs' VIOLATED EXPECTATION and EXPLANATION and OCCASION.
2. TEMPORALITY: although less explicit, temporality also has a place in Mann & Thompson's and Hobbs' proposal in the non-nucleated sequence relation and the Occasion relation respectively.
3. CONTRAST: In Mann & Thompson's proposal contrastive or negative relations can be found in Antithesis, Otherwise and Contrast relations. In Hobbs' they find their equivalents in Parallel, Elaboration and Contrast.

In contrast to the cohesion-based taxonomies, both Mann & Thompson and Hobbs' taxonomy are coherence-based and are particularly concerned with argumentative rather than narrative relations. Despite the difficulty of comparing the two taxonomies objectively, similar common features as the ones found in the cohesion-based proposals were found: temporality, causality and contrast.

5.3.3 Main categories in cohesion- and coherence-based taxonomies

As we have seen, the six taxonomies considerably differ from one another. A general division can be made into cohesion-based and coherence-based taxonomies, which facilitates comparison. However, in both comparisons similar features can be pointed out that play a role in all six taxonomies. These features are most effectively defined by Sanders et al. as the categories BASIC OPERATION (including CAUSAL and ADDITIVE relations), SOURCE OF COHERENCE (including SEMANTIC and PRAGMATIC relations) and POLARITY (including NEGATIVE and POSITIVE relations). In addition all taxonomies, except Sanders et al.'s, define a TEMPORAL relation.

Based on the above discussion, when proposing a taxonomy of coherence relations from a psychological perspective – as our aim is – the following criteria can be given:

1. Assuming that all cohesion relations cue coherence relations, cognitive evidence for coherence relations should at least initially focus on those coherence relations that can be cued by cohesion relations. It might be the case that coherence relations

exist that cannot be linguistically marked, but this option remains to be investigated at a later stage. For now, this enables us to keep an overview on the coherence relations in the taxonomy.

2. For a cognitive account of a taxonomy of coherence relations one should first take the most common and general categories possible, before making more detailed comparisons. There are two options when testing cognitive evidence for a taxonomy: use a small subset of detailed coherence relations or try to find evidence for main categories first. The taxonomies presented so far give theoretical evidence⁹ for these main categories, while there is limited agreement on the subcategories. For a first understanding of coherence relations, an approach focussing on these main categories is hence preferable.

With the above criteria in mind and the fact that the taxonomies discussed so far seem to have a few common categories: ADDITIVE, TEMPORAL and CAUSAL relations, some kind of contrastive relation and the distinction between relations between the speech-act and those between propositions. Sanders et al.'s taxonomy is the most economical and general proposal, is based on cohesion devices, and covers the categories shared by the other proposals, with the exception of TEMPORAL relations. Furthermore, only this taxonomy has already been tested experimentally. Towards achieving the aim of this chapter, proposing a parameterisation of coherence relations, we will therefore focus on Sanders et al.'s proposal in the following sections. In the next section some problems with Sanders et al.'s proposal will be outlined and suggestions for improvements will be made in order to construct a new parameterisation.

5.4 SANDERS, SPOOREN & NOORDMAN (1992, 1993) RECONSIDERED

Sanders et al.'s taxonomy rests on the relational criterion, which states that, to be included in the taxonomy, a cohesion relation should add an informational surplus to the text segments in isolation. However, despite the relational criterion, Sanders et al.'s taxonomy includes unwanted variables and excludes desirable coherence relations.

⁹ Also, some psycholinguistic evidence for the categories is already provided in Sanders et al.'s (1992, 1993) proposal.

5.4.1 The relational criterion

The basis of Sanders et al.'s taxonomy is the relational criterion. "A property of a coherence relation satisfies the relational criterion if it concerns the informational surplus that the coherence relation adds to the interpretation of the discourse segments in isolation" (Sanders et al., 1992: 5). Hence, the coherence relations used in their taxonomy are supposed not be dependent on the semantics of either one of the propositions and to satisfy the relational criterion.

Although it remains unclear what the reason is behind such a strict criterion for a cognition-based taxonomy – Sanders et al. do not present any experimental evidence for it – theoretical arguments could be given. If it is argued that coherence relations can be classified into a taxonomy, these relations should have some informational surplus to what they connect. If not, such a taxonomy and the notion of coherence relation as such, would be meaningless. The relational criterion is thus similar to the criterion of Knott's cue-phrase test: there has to be something in an interclausal relation before it can be called a cohesion/coherence relation. However, the use of the relational criterion has some consequences.

5.4.2 What is excluded: TEMPORAL relations

The most obvious relation missing from Sanders et al.'s proposal is temporality. Although the authors do not deny TEMPORAL relations as such, they place them under the class of ADDITIVE relations (Sanders et al., 1992: 28). They give two main reasons for not including them. The first reason is that temporal information is part of the text segments. Hence, a TEMPORAL coherence relation does not provide an informational surplus. Sanders et al. (1992: 28) say that "the temporal meaning aspect is to a large degree determined by the referential content of the segments, more than, for instance, the causal meaning aspect." This has two consequences: first, "the reader does not have the freedom to ignore the temporal meaning aspect" (ibid.); second, "the order of the segments in a temporal sequence cannot be reversed freely without disturbing the coherence relation" (ibid.) The second reason for not including TEMPORAL relations is

that, according to Sanders et al., TEMPORAL relations are exclusively SEMANTIC and therefore not as resourceful as CAUSAL or ADDITIVE relations.

With regard to the first reason, it is true that tense and aspect constrain TEMPORAL relations. However, if the tense and aspect of the two clauses are the same, a TEMPORAL relation may be necessary to signal the temporal order of the two events (e.g. 'the chicken was born *before/after* the egg was laid'). A TEMPORAL relation can therefore certainly provide an informational surplus.

A second point with regard to the first reason concerns CAUSAL relations. Sanders et al. claim that TEMPORAL relations rely more on the meaning of the segments than CAUSAL relations. This is questionable. Let us look at causality, taking an extreme example of (logical) causality.

(11) John bought the book, because the salesman sold it to him.

Although we would not claim that every situation that could follow from the situation expressed in the first clause is implicit in its representation, the situation in example (11) does include semantic causal information, that makes that the eventuality 'buying' causally refers to an eventuality 'selling'. This extreme example may look rather odd, and the reason for this is exactly that the verb 'buy' implies 'sell' and vice versa. In other words, it is not only the coherence relation expressed by the connective that adds to the interpretation of the two propositions in isolation. Another argument to show that individual events do contain causal information a priori can be found in causatives (cf. Lyons, 1977: 490). A sentence like 'excessive drinking kills Bill' already contains causality, without any coherence relation. Hence, there is some representation of the cause associated within an individual event. In short, two situations linked by a causal coherence relation already contain aspects of causality within these situations.

As we have seen, Sanders et al. gave two consequences of the first reason why to exclude TEMPORAL relations (which was that TEMPORAL relations are determined by the meaning of the discourse segments). The first consequence was that readers often do not have the freedom to ignore the temporal meaning. As we have seen in the case of causatives, readers often do not have the freedom to ignore the causal meaning either.

The second consequence is that the order cannot freely be reversed without disturbing the coherence relation. In fact, in a footnote Sanders et al. claim that “[r]eversal is only possible if the temporality is implied by another relation, such as consequence - cause in (i): (i) He hit his head. He didn’t watch out” (Sanders et al. 1992: 28). But if TEMPORAL relations are sub-classified under ADDITIVE relations, how can it be explained that Sanders et al. reject that all CAUSAL relations imply TEMPORAL relations, but do agree that some CAUSAL relations could imply temporality? Sanders et al. (1992: 28) give examples like the following:

(12) ? John dialled a number. He picked up the phone.

(13)

(a) John has to stand trial. He got a parking ticket.

(b) John got a parking ticket. He has to stand trial.

Indeed, this could be seen as a strong argument for temporal information being part of the segments and not of the coherence relation. But other explanations are possible. Noordman & Vonk (1997) for instance argue that causal relations are fundamental to cognition. If this is the case, one could argue that CAUSAL relations are more flexible than other relations. This flexibility enables reasoning both ‘backward’ (effect – cause) or ‘forward’ (cause – effect) easily. Another explanation would be that temporal reasoning is the default. As we tend to process information in the order past – present – future, it could be argued that processing temporal information overrules all other information in the segments, unless the direction of the TEMPORAL relation is marked by means of a conjunction (e.g. John dialled a number *after* he had picked up the phone).

The second reason why TEMPORAL relations are not included concerned the fact that contrary to ADDITIVE and CAUSAL relations, TEMPORAL relations can only be SEMANTIC and not PRAGMATIC. This claim is rather surprising as Halliday & Hasan (1976) and Martin (1992) claim that the distinction between SEMANTIC and PRAGMATIC (i.e., EXTERNAL and INTERNAL) in TEMPORAL relations are clearest of all. Moreover, Knott (in press) gives a detailed analysis of SEMANTIC and PRAGMATIC readings of TEMPORAL relations. The decision to exclude TEMPORAL relations because they are not

as resourceful as the other relations can thus not be upheld. First, TEMPORAL relations do seem to allow a SEMANTIC and a PRAGMATIC reading. Second, TEMPORAL relations should not be excluded for being not resourceful if there only were semantic readings, while ADDITIVE relations which are not resourceful either because of the lack of a non-basic component are included.

In sum, TEMPORAL relations are excluded because there is already temporal meaning within the discourse segments. The consequence of an implicit temporal meaning is that readers cannot ignore temporality and the order of the segments cannot be reversed freely. The same, however, can be said for CAUSAL relations. Readers cannot ignore causality and CAUSAL relations cannot be reversed. This argument can be made, because we have assumed that CAUSAL relations imply TEMPORAL relations. Sanders et al. who ascribe an important status to SOURCE OF COHERENCE dispute that all CAUSAL relations imply TEMPORAL relations, as in PRAGMATIC CAUSAL relations it is often not the case that the cause precedes the effect. However, the distinction between SEMANTIC and PRAGMATIC (SOURCE OF COHERENCE) is highly problematic in the first place, because it does not correspond to the relational criterion, as will be argued in more detail next.

5.4.3 What is included: SEMANTIC versus PRAGMATIC

In all four cohesion-based taxonomies introduced here, a distinction was made between SEMANTIC and PRAGMATIC relations (or INTERNAL and EXTERNAL) and Mann & Thompson too provided a division of their relations into Subject matter (SEMANTIC) and Presentational (PRAGMATIC). Hence, this seems to be a category that cannot be neglected in a taxonomy of coherence relations. However, the distinction causes some problems.

Martin (1992) describes the difficulty with a distinction between SEMANTIC and PRAGMATIC relations as follows:

The distinction between internal and external relations, although clear in principle, is in some cases hard to draw, either because it does not matter ... or because certain relations, such as the concessive, are themselves interpersonal enough in orientation that they fudge the distinction being drawn between organising text and constructing field. (ibid. 183)

As we have seen earlier, even with the distinction between SEMANTIC and PRAGMATIC large differences occur between the taxonomies. Halliday and Hasan (1976) point out that "many though not all of the conjunctions occur in both types of relation (ibid. 244). More specifically, they state that "[i]n the additive context, in fact, there may be no clear difference between the two [i.e. external and internal type of conjunction relation]" (ibid. 245) Similarly, this "distinction tends to be less clear-cut in the context of causal relations than it is in the other contexts, probably because the notion of cause already involves some degree of interpretation by the speaker" (ibid. 257). On the other hand, "[i]n temporal cohesion it is fairly easy to identify and interpret the distinction" (ibid. 263). However, for Sanders et al. (1992, 1993) the distinction between SEMANTIC and PRAGMATIC is easy to make for ADDITIVE and CAUSAL relations, while for TEMPORAL relations it cannot be made (Sanders et al., 1992: 28). Agreement on SEMANTIC versus PRAGMATIC readings is thus hard to find.

But there is a more fundamental problem with the distinction between SEMANTIC and PRAGMATIC with respect to the relational criterion. We emphasise again that according to Sanders et al. (1992, 1993) the relational criterion is met when the property of a coherence relation concerns the informational surplus added to the interpretation of the text segments in isolation. In the first experiment reported in Sanders et al (1992) experts in discourse studies agreed least on SOURCE OF COHERENCE when trying to find labels for relations in a series of texts. In the second experiment (ibid.) students again agreed least on SOURCE OF COHERENCE. In a card-sorting test in which subjects were asked to cluster relations found in the texts only little evidence was found for SOURCE OF COHERENCE. The explanation Sanders et al. (1993) provide for the subjects' disagreement on SOURCE OF COHERENCE is that "this primitive depends more strongly on the context than the others" (ibid.113). In a follow-up experiment subjects were asked to give labels for relations in the text, but this time more context was given. This experiment looking at SEMANTIC versus PRAGMATIC relations in a suitable communicative context did provide evidence for the distinction. In an

experiment reported in Sanders (1997) subjects were asked to give paraphrases of linguistically unmarked relations in the texts. Although the agreement with the theoretical classification was high, Sanders found a strong effect for context when the relation was ambiguous. Sanders et al. (1992, 1993) did not find substantial experimental evidence for the category SOURCE OF COHERENCE and concluded that this was due to the contextual effects of the category.¹⁰ Sanders (1997) concluded something similar. The results and the conclusions of the three studies thus undermine the very foundation of Sanders et al.'s taxonomy, the relational criterion. The distinction between SEMANTIC and PRAGMATIC does not lie in the relation, but in the segments.

On the basis of the discussion of the taxonomies discussed in this chapter and the difficulties experts and students, classifying relations into SEMANTIC and PRAGMATIC in Sanders et al.'s (1992, 1993) and Sanders' (1997) experiments, we can conclude that the distinction between SEMANTIC and PRAGMATIC is not entirely clear.

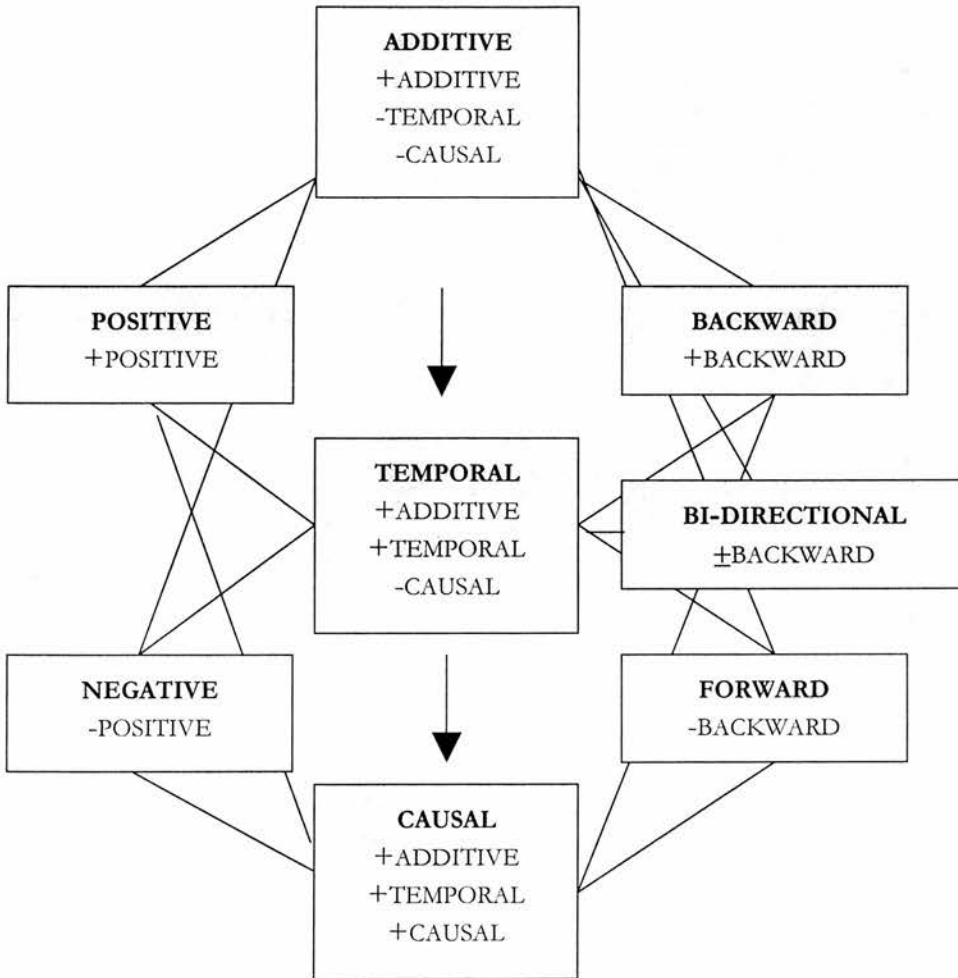
5.5 PROPOSED PARAMETERISATION

On the basis of the taxonomies, and in particular on the basis of Sanders et al. (1992, 1993) proposal, we will now propose a parameterisation that will play a central role in the remainder of this thesis. The aim of the parameterisation to be proposed is a basic economical theory of grammar-driven cohesion and coherence. Aiming at an economical theory, we necessarily have to place the taxonomy at – what Knott & Mellish (1996: 143) call – the accuracy side of the spectrum. In other words, we will not aim at describing all conjunctions available, but settle for a parameterisation for which cognitive evidence can be found. Because we want to test the proposed parameterisation experimentally, it needs to be cohesion-based. That is, testing a taxonomy like the ones proposed by Mann & Thompson (1987) or Hobbs (1985) is problematic for the same reasons as a comparison of these taxonomies is problematic.

¹⁰ The fact that SOURCE OF COHERENCE is a rather problematic category can also be illustrated by the comparison of the taxonomy in Sanders et al. (1992) and Sanders et al. (1993) made earlier in the decision of the authors to treat connectives belonging to classes 6 (CAUSAL, PRAGMATIC, BASIC, NEGATIVE) and 12 (ADDITIVE, PRAGMATIC, -, NEGATIVE) as Class 2 (CAUSAL, SEMANTIC, BASIC, POSITIVE). See also 5.2.6 of this chapter.

Furthermore, the relations in these taxonomies are highly composite, which would make testing difficult and cognitive evidence for categories unlikely (Knott & Sanders 1998: 140).

Three categories are used in the proposed parameterisation, *TYPE*, *POLARITY* and *DIRECTION*. *TYPE* contains the parameters ADDITIVE, TEMPORAL and CAUSAL. The category *POLARITY* contains the parameter POSITIVE. A third category in the taxonomy, *DIRECTION*, consists of the parameter BACKWARD. The proposed parameterisation looks



as follows (Figure 1):

POLARITY

TYPE

DIRECTION

Figure 1 Overview parameterisation

The following cognitive strategies can be defined for all categories:

TYPE

ADDITIVE

parameters: [+ADDITIVE, -TEMPORAL, -CAUSAL]

map the two clauses onto the same mental structure, so that the situation expressed by the succeeding/preceding clause extends, or ceases to extend¹¹, the situation expressed by the preceding/succeeding clause without reference to time or causality (marked by conjunctions like *and, but, what's more, however*).

TEMPORAL

parameters: [+ADDITIVE, +TEMPORAL, -CAUSAL]

map the two clauses onto the same mental structure, so that the situation expressed by the succeeding/preceding clause extends, or ceases to extend, the situation expressed by the preceding/succeeding clause with reference to time but not to causality (marked by conjunctions like *later, before, until, after*).

CAUSAL

parameters: [+ADDITIVE, +TEMPORAL, +CAUSAL]

map the two clauses onto the same mental structure, so that the situation expressed by the succeeding/preceding clause extends, or ceases to extend, the situation expressed by the preceding/succeeding clause with reference to time and causality (marked by conjunctions like *because, although, so, nevertheless*).

¹¹ With “extends” we mean that the situation presented first is continued in the related situation. With “ceases to extend” we mean that the expected related situation does not take place. We will return to this issue later in this chapter.

POLARITY

POSITIVE

parameter: [+POSITIVE]

map the two clauses onto the same mental structure, so that the situation expressed by the succeeding/preceding clause extends the situation expressed by the preceding/succeeding clause (marked by conjunctions like *and, what's more, because, later*).

NEGATIVE

parameter: [-POSITIVE]

map the two clauses onto the same mental structure, so that the situation expressed by the succeeding/preceding clause ceases to extend the situation expressed by the preceding/succeeding clause (marked by conjunctions like *but, until, however*).

DIRECTION

FORWARD

parameter: [-BACKWARD]

map the two clauses onto the same mental structure, so that the situation expressed by the succeeding clause extends, or ceases to extend, the situation expressed by the preceding clause (marked by conjunctions like *because, although, until*).

BACKWARD

parameter: [+BACKWARD]

map the two clauses onto the same mental representation, so that the situation expressed by the preceding clause extends, or ceases to extend, the situation expressed by the succeeding clause (marked by conjunctions like *so, nevertheless, later*).

BI-DIRECTIONAL

parameter: [\pm BACKWARD]

map the two clauses onto the same mental representation, so that the situation expressed by the preceding/succeeding clause extends, or ceases to extend, the situation

expressed by the succeeding/preceding clause, and the two clauses can be reversed without significantly changing the meaning of the clause pair (marked by conjunctions like *while, whereas, or*).

The three categories TYPE, POLARITY and DIRECTION generate a total of eighteen (3 x 2 x 3) cohesion and coherence relations. However, because no instances exist of BI-DIRECTIONAL CAUSAL and NEGATIVE TEMPORAL relations and because ADDITIVE relations only occur FORWARD a total of thirteen relations are actually marked in English (and as far as we know in other European languages). Examples for each of the relations are given in Table 11.

TYPE	POLARITY	DIRECTION	examples
CAUSAL	POSITIVE	BACKWARD	x because y
		FORWARD	x so y ; because x, y
		BI-DIRECTIONAL	-
	NEGATIVE	BACKWARD	x although y
		FORWARD	x nevertheless y ; although x, y
		BI-DIRECTIONAL	-
TEMPORAL	POSITIVE	BACKWARD	x before y , after x, y
		FORWARD	x after y ; before x, y
		BI-DIRECTIONAL	x while y ; y while x
	NEGATIVE	BACKWARD	x until y
		FORWARD	until x, y
		BI-DIRECTIONAL	-
ADDITIVE	POSITIVE	BACKWARD	-
		FORWARD	x moreover y
		BI-DIRECTIONAL	x and y ; y and x
	NEGATIVE	BACKWARD	-
		FORWARD	x however y
		BI-DIRECTIONAL	x but y ; y but x

Table 11 Categories of parameterisation

This parameterisation differs from Sanders et al.'s in two respects:

1. TEMPORAL relations are included. There are three reasons why, contrary to Sanders et al.'s taxonomy, TEMPORAL relations have been included. First, many conjunctions in (at least European) languages mark temporality (e.g. *after, before, later, until, afterwards, earlier*, etc.). A cohesion-based taxonomy should account for this large group of conjunctions. Secondly, as we have seen, all six taxonomies discussed here use the notion of a TEMPORAL category in one way or another. Temporality seems to be one of the common features. It is also the source for disagreement, as TEMPORAL relations in one taxonomy were categorised as ADDITIVE or CAUSAL in another. This brings us back to the relation between additivity, temporality and causality, we mentioned earlier. As can be seen in Figure 1, this relation can be explained by the entailment relation between CAUSAL, TEMPORAL and ADDITIVE relations. We assume that CAUSAL relations imply TEMPORAL relations. Sanders et al. could not make this claim, because of SOURCE OF COHERENCE. They assumed TEMPORAL relations as a subcategory of ADDITIVE relations. As SEMANTIC CAUSAL relations clearly do imply temporality, this claim is hard to uphold.
2. The distinction between SEMANTIC and PRAGMATIC is excluded. Despite the fact that almost all taxonomies (Halliday & Hasan (1976), Martin (1992), Knott & Mellish (1996), Sanders et al. (1992, 1993), Mann & Thompson (1987) discussed in this chapter use the distinction between SEMANTIC and PRAGMATIC relations, this feature has been left out of the proposed taxonomy. Three reasons can be given for this decision. First, the distinction is not as fundamental to a psychologically based parameterisation of coherence relations as the other categories. This claim is supported by the experimental results of the Sanders et al. (1992, 1993) experiments, in which least evidence for SOURCE OF COHERENCE was found. Second, the discussion of the taxonomies showed that although SEMANTIC versus PRAGMATIC can be considered as a common feature, it is also the feature with the least agreement among the taxonomies. Third, it seems that a SEMANTIC or PRAGMATIC reading depends on context rather than the coherence relation. This is concluded by Sanders et al (1992, 1993) and Sanders (1997) and would explain the disagreement among the taxonomies. If SEMANTIC versus PRAGMATIC heavily depends on the

context, it should not be considered as a basic, psychologically valid, category in an economical parameterisation of coherence relations.

The first point is least controversial, as all taxonomies, except Sanders et al.'s, include TEMPORAL relations. The second point is rather controversial, as all taxonomies include the distinction between SEMANTIC and PRAGMATIC relations. The question of course is whether the category SOURCE OF COHERENCE can be eliminated from the parameterisation. If it is, how do we explain semantic and pragmatic readings of sentences? Clearly, excluding the category from the parameterisation does not mean that we would argue that the distinction cannot be made in the text, only that it should not be part of a basic cognitive theory.

Consider the following two sentences, whose clauses are conjoined by a BACKWARD POSITIVE CAUSAL coherence relation:

(14)

(a) the streets are wet, because it is raining,

[event 1] [event 2]

(b) It is raining, because the streets are wet

[event 1] [event 2]

We assume here that we process both sentences according to the strategy we defined:

parameters:

[+ADDITIVE, +TEMPORAL, +CAUSAL, +POSITIVE, +BACKWARD]

map the two clauses onto the same mental representation, so that the situation expressed by the succeeding/preceding clause extends the situation expressed by the preceding/succeeding clause with reference to causality and time.

This strategy succeeds for sentence (14)(a) where event 2 [it is raining] is causally (and therefore temporally) prior to event 1 [the streets are wet]. This is not the case for sentence (14)(b). If we try to apply the POSITIVE CAUSAL strategy, this fails. The conjunction 'because' cues an interpretation where event 2 is prior to event 1. From our

general knowledge however we know that event 2 is prior to event 1. Hence there is a conflict. We solve this conflict by a pragmatic reading of the sentence where – in a process called ‘abduction’ – we reverse the cause and effect and interpret the conclusion of event 1 as causally prior to the fact in event 2 (cf. Lagerwerf, 1998: 47). This means that the actual relation between the two events is SEMANTIC. However, it is established through pragmatic reasoning. A similar argument is given by Traxler, Sanford, Aked, Moxey (1997: 96), who also argue that a postulation of two types of relations specified by the conjunction ‘because’ is not necessary. In a series of experiments they found that diagnostic statements (pragmatic readings) take longer to read than causal statements (semantic readings). This is what we would expect on the basis of the conflict that arises when we read a sentence like (14)(b).

The claim that extra processing time is attributable to the use of context rather than to the coherence relation is supported by other cognitive theories, something which was concluded in Sanders et al. (1992, 1993) and Sanders (1997). If it is context rather than the coherence relation that dictates a pragmatic or semantic reading, we would expect that the conflict between a semantic or pragmatic reading in the case of sentences like (14)(b) could be avoided. We could say that a pragmatic reading is imposed only if there is sufficient reason to believe that the event denoted by the main clause precedes the event denoted by the subordinate clause (irrespective of the linear order of the two clauses).¹²

In sum, the proposed parameterisation is based on Sanders et al.’s proposal, but does not use the SEMANTIC - PRAGMATIC distinction, and includes TEMPORAL relations. We have argued that not using the SEMANTIC - PRAGMATIC distinction does not cause any problems, because this distinction refers to the context of the clauses, rather than the cohesion/coherence relation between the clauses.

¹² The idea that pragmatic relations occur when clearly imposed by the (con)text or when semantic relations are frustrated can even be seen in the flow-chart Sanders et al. (1993: 121) showing how coherence relations are cognitively assigned to text segments. Only when a semantic interpretation fails, is a pragmatic interpretation attempted.

5.6 TYPE, POLARITY AND DIRECTION

5.6.1 TYPE: CAUSAL, TEMPORAL and ADDITIVE

According to the proposed parameterisation ADDITIVE relations are equivalent to TEMPORAL relations, except for their reference to temporality, and the latter are equivalent to CAUSAL relations except for their reference to causality. Furthermore, it was argued that CAUSAL relations imply TEMPORAL relations and TEMPORAL relations imply ADDITIVE relations.

This idea is not new. Sanders et al. (1992, 1993) say about the relation between CAUSAL and ADDITIVE relations:

Because a causal relation implies an additive relation, one has to be as specific as possible in identifying the relation. The first question in identifying the relation is therefore: Is the relation between P and Q a causal relation? If it is not, the relation is an additive one" (Sanders et al., 1992: 6)

As we have seen in Chapter 3, CAUSAL relations 'benefit' from temporal contiguity (see also Michotte, 1963; Schultz & Mendelson, 1975; Dittrich & Lea, 1994), that is, temporality is a prerequisite for causality. Furthermore, both causality and temporality require two situations that need to be connected (either temporally or causally) and hence it can be argued that causality and temporality require additivity.

ADDITIVE, TEMPORAL and CAUSAL relations thus more or less lie on the same axis, with ADDITIVE relations being [+ADDITIVE], TEMPORAL relations being [+ADDITIVE and +TEMPORAL], and CAUSAL relations being [+ADDITIVE, +TEMPORAL and +CAUSAL]. Hence, CAUSAL relations are more specified than TEMPORAL and ADDITIVE relations, and TEMPORAL relations are more specified than ADDITIVE relations.

5.6.2 POLARITY: POSITIVE and NEGATIVE

Presuppositions

Earlier we defined the NEGATIVE relations as those relations in which a situation “ceases to extend.” It is tempting to consider NEGATIVE relations as negated POSITIVE relations. The conjunctions *because* and *although* would then be duals, and so would *before* and *until* or *and* and *but* be. For instance, $\text{not}(\text{because}, P, Q)$ would then be similar to *although* P, Q . Such a view on duality of *because* and *although* is proposed by König (1989). König claims that *although* is the dual of *because*, so (15)(a) is equivalent to (b)¹³:

(15)

(a) *Although* x, y

(b) $\neg(\text{Because } X, \neg Y)$

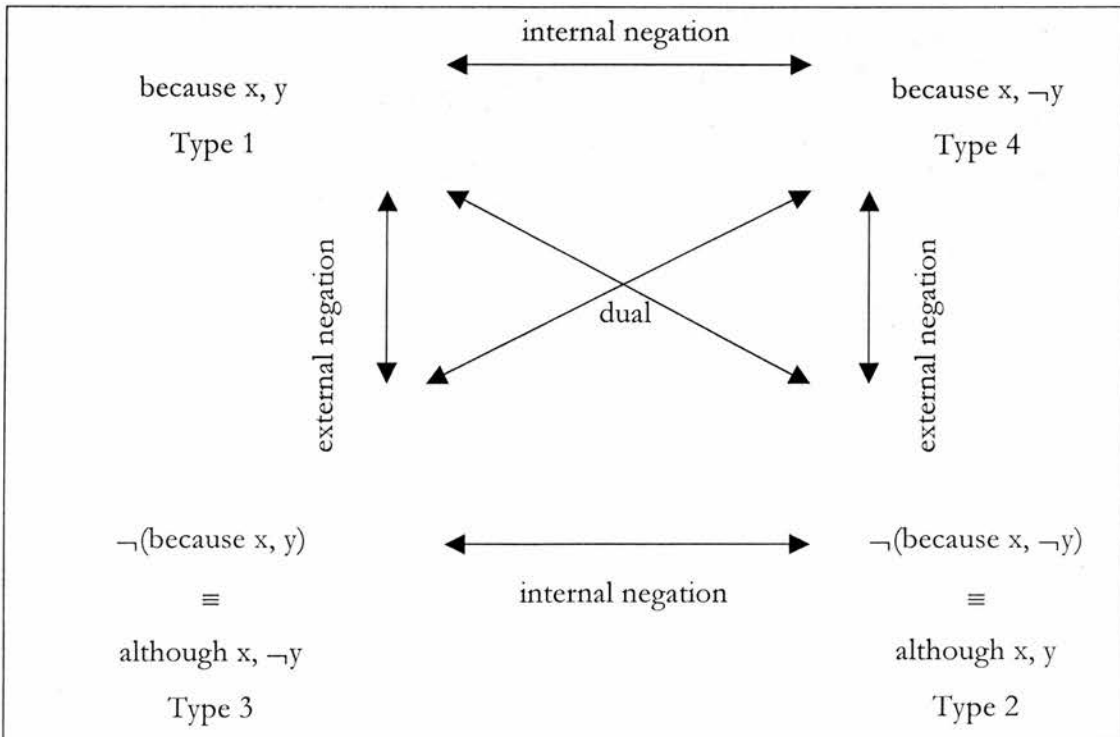


Figure 2 König's duality square

¹³ Note that: $\neg y$ *although* $x \equiv$ *Although* $x, \neg y$
 $\neg(y$ *because* $x) \equiv \neg(\text{Because } x, y)$

Now consider the following two texts:

(16)

- (a) My neighbour played saxophone. I did not like it, because he practised every day.
- (b) My neighbour played saxophone. I liked it, because he practised every day.

Text (a) is internally negated in (b) and (a) can be seen as a Type 1 sentence, while (b) can be seen as a Type 4 sentence. According to König's schema, the following four types can be presented.

Type 1: I liked it, because he practised every day

Type 2: It is not the case that (I liked it because he did not practise every day)

≡ I didn't like it although he practised every day

Type 3: It is not the case that (I liked it because he practised every day)

≡ I liked it although he practised every day

Type 4: I did not like it because he practised every day

König uses the following two Type 3 sentences and concludes that they are equivalent in meaning (1989: 196).

(17)

- (a) This house is no less comfortable because it dispenses with air conditioning.
- (b) This house is no less comfortable although it dispenses with air conditioning.

Both (17)(a) and (b) have the same truth conditions, but do they really mean the same? Similarly, is the rather unnatural "It is not the case that (I liked it because he did not practise every day)" semantically equivalent to "I didn't like it although he practised every day"? The same can be asked for sentences (16)(a) and (b).

Lagerwerf (1998) argues that *although* is not a negation of *because*, but that both CAUSAL relations share a presupposition, the first being explicitly stated, the latter

implicitly. He shows this by performing two kinds of presupposition tests, embedding tests and discourse oriented tests. The embedding tests are aimed at finding out whether an implied proposition is a presupposition. In other words, in cases where it is not clear whether a proposition is a presupposition – like in complex sentences – the tests can be useful. The embedding test consists of a test of negative context, of interrogative context and of conditional context. It needs to be noted that embedding tests are developed for single clauses, whereas we use conjoined clauses (ibid. 68). We follow Lagerwerf's arguments.

Negation test

The most classical test for determining presuppositions is the use of the negation test. Lagerwerf (1998: 63), following Strawson (1950) and Levinson (1983), states: if assertion A implies proposition B then the negation of assertion A implies the same proposition B. Or, more formally:

A statement P presupposes another statement Q iff
in all situations where P is true, Q is true
in all situations where P is false, Q is true.

This means that (18)(a) and (b) presuppose (c):

(18)

- (a) Bill stopped kissing Monica
- (b) Bill did not stop kissing Monica
- (c) Bill kissed Monica

The same test can now be performed for a sentence conjoined by *although*, with the alleged presupposition in (c)

(19)

- (a) Bill kissed Monica although he did not like her
- (b) It is not the case that Bill kissed Monica although he did not like her
- (c) If you kiss somebody, you like the person.

Lagerwerf (1998: 64) rightly argues that (19)(b) looks rather unnatural. However, he proves that there is no logical inconsistency by assuming that *although* behaves like a logical conjunction in a semantic representation. With this assumption, the negation in *although* can be broken down by using De Morgan's law, which reads "the negation of a conjunction is equivalent with the negation of the disjuncts of a disjunction" (ibid. 64).

De Morgan's law

$$\neg(\phi \wedge \psi) \leftrightarrow \neg\phi \vee \neg\psi$$

This means that (19)(b) represented here as (20)(a) can be paraphrased as (b), which is equivalent to the implication in (c).

(20)

- (a) It is not the case that Bill kissed Monica although he did not like her
- (b) Bill did not kiss Monica or he liked her
- (c) If Bill kisses Monica, he likes her.

An obvious objection to this analysis is that the presupposition is neither (19)(c) nor (20)(c), as both contradict assertion (19)(b) and (20)(b). Lagerwerf's solution is the following:

The formulation of the presupposition, using *normally*, prevents contradiction: the defeasibility of the implication contained in the presupposition makes it possible to deny its consequence, while the implication itself is not denied. (ibid. 64)

Thus, the presupposition of a sentence like (21)(a) is (c).

(21)

- (a) Bill kissed Monica although he did not like her
- (b) It is not the case that Bill kissed Monica although he did not like her
- (c) Normally, if you kiss somebody, you like the person.

It seems that the *although*-sentence survives the negation test and that the presupposition projects in negation contexts.

Modality test

Similar to the negation contexts, Lagerwerf argues that a presupposition should project in possibility contexts too. Consider the following sentences. Sentence (22)(a) is put in a possibility context in (b). Sentence (c) is then the presupposition of (22)(a).

(22)

- (a) Bill stopped kissing Monica
- (b) Perhaps Bill stopped kissing Monica
- (c) Bill kissed Monica

In the possibility context sentence (22)(b) does *not* imply that the event of “stopping kissing” happened. However, the presupposition does need to be factual and assumes an event of kissing. Similarly, we can present the *although*-sentence in a possibility context.

(23)

- (a) Bill kissed Monica although he did not like her
- (b) Perhaps Bill kissed Monica although he did not like her
- (c) Normally, if you kiss somebody, you like the person

The modality too shows the presupposition of *although*-sentences.

Interrogative test

Like the modality context, a presupposition should stand an interrogative test.

(24)

- (a) Bill kissed Monica although he did not like her
- (b) Did Bill kiss Monica, although he didn't like her?
- (c) Normally, if you kiss somebody, you like the person

Imperative test

Finally, a presupposition should not be affected by imperative sentences

(25)

- (a) Bill kissed Monica although he did not like her
- (b) Make Bill kiss Monica, although he doesn't like her
- (c) Normally, if you kiss somebody, you like the person

The second tests Lagerwerf proposes, concern *discourse oriented tests*. Whereas the embedding tests looked at the survival of presuppositions by manipulating sentences, discourse oriented tests look at the well-formedness of sentences with regard to the presupposition in discourse.

Presuppositions need to be anchored in context, in other words, they behave like anaphora or – in the absence of an explicitly mentioned presupposition – could behave like anaphora when inserted in the text.

(26)

- (a) Bill often kissed Monica. Bill stopped kissing Monica.
- (b) ? Bill never kissed Monica. Bill stopped kissing Monica.
- (c) Bill kissed Monica.

- (a) Normally, people kiss if they like each other. Bill kissed Monica although he did not like her
- (b) ? Normally, people kiss if they dislike each other. Bill kissed Monica although he did not like her
- (c) Normally, people kiss if they like each other.

Having shown that *although* bears a presupposition as it survived the presupposition tests, Lagerwerf continues his argument claiming that *because* has a presupposition analogous to *although*. In other words, CAUSAL relations in general tend to bear presuppositions. A sentence like “Bill kissed Monica, because he liked her” bears the presupposition “Normally, if somebody kisses a person, he/she likes him/her” because like *although* it stands all presupposition tests. However: “The utterance is now acknowledging the presupposition, instead of denying it, as in the case of *although*. This makes the presupposition less visible, but not less important: the presupposition serves as a warrant” (Lagerwerf, 1998: 94). Lagerwerf thus concludes that the similarity between *because* and *although* is “that typically causal conjunctions are presuppositional” (ibid. 93).

Although it may be the case that CAUSAL relations bear presuppositions, the clear difference between *because* and *although* is that in the former the presupposition is explicitly stated, whereas in the *although*-sentence it remains implicit. The question is whether that what makes *although* so special, is shared by all NEGATIVE relations. As in Lagerwerf’s (1998) study, the answer to this question forces us to make a trade-off between logical semantics and pragmatics. Lagerwerf’s negation test showed us the presupposition of *although* clauses and how to solve the unnaturalness by De Morgan’s Law. In sum, for causal relations it is not the meaning that is the same, but the presupposition. Something that is expected in the *because* is negated in the *although* clauses. When we look at the other NEGATIVE relations, something similar can be said. This can be proved by applying Lagerwerf’s discourse test, as is shown in Table 12.

	CAUSAL	TEMPORAL	ADDITIVE
Original sentence:	Bill kicked Kenneth, although he liked him.	Bill runs until Kenneth told him to stop.	Bill liked peanut butter, but he doesn't like jam.
Expectation	One expects that: because Bill likes Kenneth, he does not kick him.	One expects that: when Kenneth does not tell Bill to stop, Bill runs.	One expects that: Bill likes peanut butter, and he likes jam
Discourse test:	Because somebody likes somebody else, they do not kick that person. Bill kicked Kenneth, although he liked him.	When nobody tells you to stop, one continues run. Bill ran until Kenneth told him to stop.	Many people like both peanut butter and jam. Bill liked peanut butter, but he doesn't like jam.

Table 12 Expectations per TYPE category

In all three NEGATIVE TYPE relations, the expected situation is negated. The situation is expected to be extended, but the NEGATIVE cohesion relation cues the comprehender that this expectation is negated and hence ceases to extend.

Until: *the odd one out?*

As we have seen the proposed parameterisation does not deviate much from other proposals discussed, except for the distinction between SEMANTIC and PRAGMATIC that has been excluded. However, one other category cannot be found in other taxonomies, NEGATIVE TEMPORAL relations. The fact that this category has not been defined before can easily be explained as several reasons can be brought forward why this category is the odd one out:

1. Contrary to the other categories, there seems to be only one conjunction that marks this category, *until* (or *till*). Whereas all other categories have a relatively large set of

cues marking the corresponding relation, it seems peculiar that NEGATIVE TEMPORAL relations have only one cue.

2. It is hard, if not impossible to have a NEGATIVE TEMPORAL coherence relation that is not marked by a cohesion device. NEGATIVE TEMPORAL relations always need to be marked. It is true that the same can be said for NEGATIVE relations in general. However, conjunctions like *although* or *however* can in some instances be left out, whereas this cannot be said for a conjunction like *until*.
3. The conjunction *until* can often be replaced by the conjunction *before*. For example: "You won't get your dessert *until/before* you have eaten your spinach." However, *before* would be marked as a POSITIVE TEMPORAL category. Contrary to the TYPE category where ADDITIVE relations can be TEMPORAL for instance, POLARITY is expected to be exclusive (i.e. POSITIVE relations can never be NEGATIVE, NEGATIVE relations can never be POSITIVE).
4. Contrary to POSITIVE ADDITIVE and TEMPORAL relations and NEGATIVE ADDITIVE relations, NEGATIVE TEMPORAL can neither be interpreted as a NEGATIVE CAUSAL relation, nor can NEGATIVE ADDITIVE relations be interpreted as NEGATIVE TEMPORAL relations.

So why are NEGATIVE TEMPORAL relations introduced here? Several answers can be given. First, the proposed parameterisation lies at the accuracy side of Knott & Mellish' (1996) spectrum. In other words, the theory generates the categories even if they are not necessarily filled linguistically. This is the reason that we have for instance empty cells for BACKWARD ADDITIVE relations, and BI-DIRECTIONAL CAUSAL relations. In the case of NEGATIVE TEMPORAL relations, however, the cell can be filled with the conjunction *until*. Second, as we have seen, *until* behaves more or less the same as the other NEGATIVE relations in the presupposition/expectation tests. Clearly, in NEGATIVE TEMPORAL relations an anticipated TEMPORAL relation ceases to extend. Third there is cross-linguistic evidence. In languages like Italian, Classical Greek, Russian conjunctions like *until* are characterised by the occurrence of some kind of negation in the sentence. Classical Greek *until*-clauses for instance don't have a negative but they contain the particle *an* which in all its other uses signals that a situation is presented as an irrealis. Furthermore, in both Russian and Italian a negation is used to mark the conjunction

until. Sentence (27)(b) is the Russian translation (a), with the negation *poka*. Sentences (c) is the Italian translation of (a) with the negation *non*.¹⁴

(27)

- (a) Bill kissed Monica until the phone rang
- (b) Bill celoval Moniku poka ne pozvonil telefon.
- (c) Bill bacio' Monica finche' non suono' il telefono

In sum, both in Italian and in Russian the interpretation of a NEGATIVE TEMPORAL relation in which the situation ceases to extend is accompanied by a negation.

These definitional, theoretical and cross-linguistic arguments support the category of NEGATIVE TEMPORAL relations.

5.6.4 DIRECTION

In several of the taxonomies discussed earlier, a notion of order of the texts segments was defined. For instance, in Halliday & Hasan (1976) a feature like 'reversed causal effect' was defined; in Mann & Thompson (1987) relations were classified in 'satellite before nucleus' versus 'nucleus before satellite' and in Sanders et al. (1992, 1993) the distinction BASIC versus NON-BASIC was used. To describe the difference between conjunctions like *because* and *although* on the one hand and *so* and *nevertheless* on the other (in the first the text segment describing the effect precedes the segment describing the cause, in the latter vice versa), we have used the notions of FORWARD and BACKWARD. The question is what we do with relations Martin (1992) called 'comparative' and Knott & Dale (1994) called 'similarity'. In those cases where the order of the text segments can be reversed without changing the meaning, we speak of BI-DIRECTIONAL.

Although the DIRECTION parameter is important, it differs from the TYPE and POLARITY parameter. Where the TYPE and POLARITY parameters concern the semantics of the cohesion relation, DIRECTION only concerns its presentation.

¹⁴ Another translation of (27)(a) in Italian is also possible (Bill bacio' Monica finche' suono' il telefono) but is less preferred. Without the negation the sentence is ambiguous. It could mean that Bill kissed Monica while the phone was ringing (and when the phone stopped ringing, he stopped kissing her), or Bill stopped to kiss her when the phone rang).

5.7 CONCLUSION

In this chapter six leading taxonomies of cohesion and coherence relations – Halliday & Hasan (1976), Hobbs (1992), Mann & Thompson (1987), Hobbs (1985), Knott & Dale (1994), Sanders et al. (1992) – have been discussed and compared with each other. To make a comparison possible, a division into cohesion-based and coherence-based taxonomies had to be made. Although the taxonomies differed considerably from each other several categories appeared to be consistent in all (or most) taxonomies. These categories were more or less summarised in Sanders et al.'s primitives: ADDITIVE, TEMPORAL and CAUSAL relations, which were either POSITIVE or NEGATIVE and invited either a SEMANTIC or PRAGMATIC reading. Because Sanders et al.'s showed to be the most general and economical proposal and because it has already psychologically been tested, Sanders et al.'s taxonomy formed the basis for the proposed parameterisation. However, contrary to Sanders et al.'s taxonomy, in the parameterisation the distinction between SEMANTIC versus PRAGMATIC was excluded and TEMPORAL relations were included. The reason for this was that TEMPORAL relations appeared in all taxonomies and can be considered fundamental in both language and cognition. The linguistic distinction between a SEMANTIC versus PRAGMATIC reading does not belong to a basic, cognition based taxonomy of coherence relations and was therefore left out. The arguments for this were that there is no strong psychological evidence for this distinction in a taxonomy of coherence relations and that processing coherence relations in a pragmatic reading amounts to SEMANTIC coherence relations. Because a cognitive framework of coherence relations should not initially focus too much on minor linguistic differences that may obscure the more apparent ones, one should apply Occam's razor. A cognitive approach to a taxonomy of coherence relations should therefore – at least initially – concentrate on basic cognitive categories.

The proposed parameterisation contains the categories TYPE (CAUSAL, TEMPORAL, ADDITIVE), POLARITY (POSITIVE, NEGATIVE), and DIRECTION (FORWARD, BACKWARD). It was argued that CAUSAL relations imply TEMPORAL relations, which imply ADDITIVE relations. Furthermore, it is argued that in NEGATIVE relations the anticipated situation (be it presupposition or expectation) is frustrated.

The aim of this chapter was to answer the question formulated in Chapter 1: what basic categories of grammar-driven cohesion and coherence relations can be distinguished. We have answered this question by proposing a parameterisation of grammar-driven cohesion and coherence relations based on existing taxonomies. We are now able to answer the research question whether coherence develop (on-line) throughout the comprehension process, whether it comes about (off-line) in a final wrapping-up stage of the comprehension process, or both. This question will be answered in the next chapter.

CHAPTER 6

GRAMMAR-DRIVEN COHESION AND COHERENCE RELATIONS: BEHAVIOURAL EVIDENCE FOR THE PARAMETERISATION

6.1 INTRODUCTION

In the previous chapter we discussed and compared several taxonomies in order to propose an economic and elementary parameterisation of cohesion and coherence relations. This chapter moves from theory to practice and tests the proposed parameterisation.

In Chapter 1 we presented the question how textual cohesion supports representational coherence in terms of this parameterisation and formulated two research questions:

1. To what extent is each of the types of cohesion independent of the others in its effects on the comprehender?
2. Does coherence develop (on-line) throughout the comprehension process and does it come about (off-line) in a final wrapping-up stage of the comprehension process or both?

In Chapter 4 we looked at the Cohesion Question, the Interdependency Question and the Multiple Strands Question. The Cohesion Question looked at whether the presence of a vocabulary-driven cohesion relation facilitates comprehension, the Interdependency Question at whether multiple vocabulary-driven strands interact, and the Multiple Strands Question at whether multiple vocabulary-driven cohesion strands facilitate comprehension. We tested three hypotheses – the Cohesion, the Interdependency and the Multiple Strands Hypothesis – directly derived from the three questions in a computational model. These hypotheses relate to the main hypothesis defined in Chapter 2, the Specification Hypothesis.

In this Chapter we will look at similar questions as those in Chapter 4, except that we now look at grammar-driven relations and that the behavioural evidence comes from experimental data rather than a computational model. Despite the seemingly vast amount of literature on grammar-driven cohesion, studies investigating both

taxonomies of cohesion/coherence relations and the effects of their categories in text comprehension are rare. To our knowledge, only Sanders et al. (1992, 1993) have attempted such an enterprise. However, their aim was to find behavioural evidence for the classification. Our aims are threefold:

- a. to provide an answer to the question whether the presence of grammar-driven cohesion relations affects the comprehension process;
- b. to provide behavioural evidence for the parameters by determining the effects of the different categories on the comprehension process;
- c. to provide an answer to the second research question: where establishing of coherence takes place in the comprehension process.

The experimental literature on grammar-driven cohesion and coherence provides behavioural evidence for the presence of cohesion relations (Cohesion Question), for the proposed parameterisation (Parameterisation Question) and for the position of integration in the comprehension process (Integration Question). Clearly, the three questions are related: studies investigating the Integration Question may also address the Cohesion Question, the Parameterisation Question, or both.

The chapter begins by reviewing and comparing the experimental literature on grammar-driven cohesion and coherence in the light of these aims.

6.2 EXPERIMENTAL STUDIES ON GRAMMAR-DRIVEN COHESION AND COHERENCE

6.2.1 An overview

Because the three questions are interrelated and because one study may address more than one question, it would be futile to divide the studies on grammar-driven cohesion and coherence by each of the questions they answer. We therefore give an overall discussion of each study first and give a brief overview of its answer to each of the three questions, before comparing all studies with each other and generalise their results.

In a series of experiments Deaton & Gernsbacher (in press) investigate the effects of the conjunction *because* on the total reading time and cued recall of two clauses. Subjects participated in a self-paced reading time task, followed by a cued recall task, with the first clause used as a cue. In a within-subjects design subjects read sentences like (1):

(1)

- (a) Susan called the doctor for help
- (b) *because* / *then* / *and* the baby cried in his playpen

These conjunctions can be translated in terms of the parameterisation as POSITIVE CAUSAL, POSITIVE TEMPORAL and POSITIVE ADDITIVE.

The results showed that the different conjunctions did not affect the reading times for the first clause. Reading times for the second clause were lower when the conjunction was *because* than when it was *then* or *and*. Recall scores showed that second clauses were more likely to be recalled when the conjunction was *because* than when it was *then* or *and*. In an additional experiment clauses were conjoined by either *because* or *after*, to account for the order of the clause (What is called DIRECTION in our parameterisation). The procedure was identical to the one used in the first experiment. Reading times showed that clauses conjoined by *because* were read faster than those conjoined by *after*, and recall was better for *because*-clauses than for *after*-clauses.

However, the advantage in processing for the CAUSAL relations was also found for the first clause in those cases where three groups of subjects were assigned to different conjunctions (between-subjects design). In these cases subjects read the first clause in the *because*-sentences faster than in the *then*- and *and*-sentences, prior to having seen the conjunction. Deaton & Gernsbacher explained this by an anticipation effect: if comprehenders expect a CAUSAL relation, they will read faster than if they expect a TEMPORAL or ADDITIVE relation.

In an additional experiment Deaton and Gernsbacher showed that the effect for *because* depends on the CAUSAL relatedness of the clauses. They tested two-clause sentence that were either highly or moderately causally related or causally unrelated, like in the examples in (2):

(2)

- (a) Susan called the doctor for help
- (b) *because/and/then* the baby played in his playpen. (*causally unrelated*)
- (c) *because/and/then* the baby cried in his playpen. (*moderately causally related*)
- (d) *because/and/then* the baby choked in his playpen. (*highly causally related*)

Highly causally related clauses were read faster than causally unrelated clauses. Reading times showed that when clauses were unrelated there was no effect of the conjunction in either reading time or recall. When the clauses were highly related, *because*-clauses were read faster and recalled better than *and*-clauses.

Deaton and Gernsbacher concluded that comprehenders build mental representations of the sentences they read using two kinds of cues: linguistic cues and predictable cues. When moderately or highly causally related clauses are conjoined by the conjunction *because* reading times are lower and recall scores are better than when the clauses are conjoined by conjunctions like *and*, *then* or *after*. However, even if a conjunction is not present, if comprehenders expect a relation cued by *because* the reading times are lower prior to the comprehender having read the actual conjunction.

Deaton & Gernsbacher's experiments give us an insight into how we process different grammar-driven cohesion devices in a vocabulary-driven cohesive context. If the vocabulary-driven context does not support the comprehender in anticipating a coherence relation, no effect for the conjunction is found. If the vocabulary-driven context supports the comprehender in anticipating a CAUSAL relationship, the clauses with the conjunction *because* are read faster than those with the conjunctions *then*, *after* and *and*. The results can be translated into answers to one of the three questions, as presented in Table 1.

question	Deaton & Gernsbacher's (in press) results
<i>Cohesion Question</i>	n/a
<i>Parameterisation Question</i>	POSITIVE CAUSAL < POSITIVE TEMPORAL < POSITIVE ADDITIVE
<i>Integration Question</i>	n/a

Table 1 Deaton & Gernsbacher (in press)

However, Deaton & Gernsbacher's experiments do not allow us to draw far reaching conclusions about the processing of coherence relations cued by *because*, *then*, *and*, and *after* (POSITIVE CAUSAL, POSITIVE TEMPORAL, POSITIVE ADDITIVE, POSITIVE TEMPORAL RELATIONS), because all experimental sentences already contained some kind of vocabulary-driven cohesive relationship. Although Deaton & Gernsbacher also tested causally unrelated clauses, these appeared to be rather unnatural in all three conditions:

(3)

- (a) ? The mother called the doctor for help.
- (b) Then the baby played in his playpen. (unnatural sequence of events)

(4)

- (a) ? The mother called the doctor for help,
- (b) because the baby played in his playpen. (unnatural cause for calling a doctor);

(5)

- (a) The mother called the doctor for help
- (b) and the baby played in his playpen. (acceptable, but unspecified).

Regardless of the unnaturalness, the clauses were not pretested for their naturalness to allow drawing any conclusions on the processing of causally unrelated clauses. Such a comparison of conjunctions and the effect of their presence were investigated in Caron, Micko & Thuring (1988).

Caron, Micko & Thuring (1988)

Caron, Micko and Thuring carried out two German experiments and one French. The first experiment in German tested sentences like the translated one in (6), either not conjoined by a conjunction or conjoined by the German conjunctions *und* (*and*) or *denn* (*because*).

- (6) The priest was able to build the new church. / The computer had made a serious error.

Subjects saw a booklet with pairs of sentences in one of the three conditions (not conjoined, conjoined by *and*, conjoined by *because*) and were asked to study each of them either for 7.5, 15 or 30 seconds. Next, they were given an interpolated task for 10 minutes, presented with the first clause and asked to write down as much as they could remember of the second. More propositions were correctly recalled for clauses conjoined by *because* at all three exposure times, with an increase in recall between 7.5 and 15 seconds only. No significant difference was found between *and*-clauses and unconnected clauses. It is important to note that the superiority effect for *because* apparently appeared at the shortest study period.

Caron et al.'s second experiment was a free recall experiment. This time all subjects studied the sentences in the booklet for 15 seconds. Sentences were either unconnected, connected by *because*, connected by *and* or had 'some relationship'. The latter condition was the same as the unconnected condition, except that subjects were told that if they read a relationship between sentences, recall would be easier. Tests following an interpolated task showed that the proportion of sentences recalled did not differ between the conditions. However, if the first clause was recalled, the second clause was often recalled with *because*-clauses, again showing a superiority effect for clauses conjoined by *because*. The proportion of times both clauses were recalled was lowest for clauses conjoined by *and*, with the related (hinted) clauses and unrelated clauses in between *because*- and *and*-clauses. There was no effect of telling subjects to relate the clauses.

A third experiment replicated the first, but in French and with an additional conjunction. Subjects read sentences which were either unconnected, or were conjoined either by *et* (*and*), *parce que* (*because*) or *mais* (*but*). Cued recall for *because* sentences was consistently better than that for *and* and *but* clauses, whose scores were almost similar, with the unrelated condition in between.

Caron et al.'s results showed that recall for POSITIVE CAUSAL sentences was better than for POSITIVE and NEGATIVE ADDITIVE sentences. Furthermore, recall for sentences conjoined by a POSITIVE CAUSAL cohesion relation was better than for sentences in which no cohesion relation was used. For POSITIVE ADDITIVE relations the opposite effect was found, with a recall advantage for clauses where no cohesion

relation was used. A summary of Caron et al.'s results translated into answers to two of the three questions is presented in Table 2.

question	Caron et al.'s (1988) results
<i>Cohesion Question</i>	POSITIVE CAUSAL < implicit < POSITIVE ADDITIVE
<i>Parameterisation Question</i>	POSITIVE CAUSAL < POSITIVE ADDITIVE POSITIVE CAUSAL < NEGATIVE ADDITIVE
<i>Integration Question</i>	n/a

Table 2 Caron et al. (1988)

Caron et al.'s experiments offer insights into the processing of various conjunctions. The advantage over Deaton & Gernsbacher's experiments is that the texts are neutral rather than causally related a priori. However, contrary to Deaton & Gernsbacher's experiments, no information is provided about on-line processing. It could be argued that Caron et al.'s results show how various conjunctions are integrated in a mental representation *after* a two-clause sentence is read. A study that investigated both on- and off-line processing is Sanders & Noordman (2000).

Sanders & Noordman (2000)

Sanders and Noordman examined both on-line and off-line effects of cohesion and coherence relations. Unlike most studies, which use simple narrative texts, Sanders & Noordman used expository texts. They used a reading time task, a verification task and a free recall task to investigate the effects of cohesion devices on different stages of text processing. Dutch texts were presented either in a Problem-Solution version or List-version (in terms of Sanders et al.'s (1992, 1993) taxonomy). CAUSAL, PRAGMATIC, BASIC, POSITIVE; or ADDITIVE, BASIC, POSITIVE¹) in either a condition marked by a vocabulary-driven cohesion device (translated from Dutch e.g. *A solution is in sight now* or *A third project is situated nearby*) or unmarked. The (marked/unmarked) coherence relation was between the text and a target sentence. Subjects were asked to read a series of texts – one sentence at a time, followed by verification statements. Reading times of target sentences were recorded, followed by a cued free recall experiment. In the next part of

the experiment subjects read another series of texts in each of the four conditions and were asked to recall what they could remember after being cued by words from each of the original texts.

Reading times for the (CAUSAL) Problem-Solution condition were faster than for the (ADDITIVE) List condition, while the reading times for the marked condition were faster than the unmarked condition. Verification scores also showed a processing benefit for Problem-Solution relations compared to List relations. Linguistic marking only showed a marginal effect on verification latencies, only for Problem-Solution relations. Recall scores were better for Problem-Solution structures than for List-structures, with no effect for linguistic marking.

In sum, linguistic marking facilitated on-line (reading time) processing, but not off-line (recall) processing. Verification data confirmed this, showing that there is an effect of linguistic marking only right after on-line processing. Furthermore, Problem-Solution relations resulted in faster processing, more accurate and faster verification and better recall than List relations.

Sanders & Noordman showed what the processing benefit effect is for POSITIVE CAUSAL compared to POSITIVE ADDITIVE cohesion and coherence relations on text processing, both on-line and off-line. They argued that CAUSAL relations are more informative or relate more to our schematic knowledge than ADDITIVE relations in naturally occurring discourse.

question	Sanders and Noordman's (in press) results
<i>Cohesion Question</i>	n/a
<i>Parameterisation Question</i>	POSITIVE CAUSAL < POSITIVE ADDITIVE
<i>Integration Question</i>	n/a

Table 3 Sanders & Noordman's (in press)

Sanders and Noordman controlled for a bias in the material – the problem in Deaton & Gernsbacher's experiments – by using the same passages for both conditions and only using a different target clause. Nevertheless, it may be the case that the results are influenced by text length of one relation or by the fact that vocabulary-driven coherence

¹ But see Sanders et al. (1993: 104-105), who consider Problem-Solution a complex relation with

may have come about in the passage preceding the target sentence. A pre-test of the materials would have been desirable. Furthermore, one could argue that this study does not investigate grammar-driven cohesion, but vocabulary-driven cohesion. However, the vocabulary-driven cohesion devices Sanders and Noordman use can be replaced by grammar-driven relations marking the POSITIVE CAUSAL and POSITIVE ADDITIVE relations.

Townsend & Bever (1978)

Contrary to Sanders & Noordman, Townsend & Bever (1978) tested the effect of cohesion markers at different stages in the comprehension process. This study had several follow-up studies (e.g. Townsend & Bever (1978), Townsend & Bever (1982), Townsend (1983), Townsend & Ravelo (1980)),² all showing similar findings.

Townsend & Bever (1978) tested the processing of conjunctions like *if*, *since*, *when*, *while* and *though*. They classified the semantic relations between subordinate and main clauses marked by these conjunctions as follows (Townsend & Bever 1978: 510)³:

	cause	+prior	simultaneous	-prior	adversative
<i>If</i>	√				
<i>Since</i>	√	√			
<i>When</i>	√	√	√		
<i>While</i>			√	√	√
<i>Though</i>					√

Table 4 Cohesion relations Townsend & Bever (1978)

In the first experiment subjects listened to sentence fragments, and were asked whether a verb-object phrase was similar in meaning to the sentence fragment. Subjects saw one of the following conditions of one sentence, like (7):

two Basic operations.

² For a brief overview of their work, see Townsend (1997).

³ As we cannot really speak of a taxonomy of relations, their classification was not discussed in the Chapter 5.

(7)

- (a) Good jobs are quite scarce now in most large ... (*initial main*)
- (b) Though good jobs are quite scarce now in most large ... (*initial subordinate*)
- (c) Though there is little danger of a major depression, good jobs are quite scarce now in most large ... (*final main*)
- (d) There is little danger of a major depression, though good jobs are quite scarce now in most large ... (*final subordinate*)

Response times for clauses with the conjunction *If* in initial subordinate condition were significantly faster than those for *Though*-fragments. The opposite effect was found for final subordinate clause fragments. Here, response times for *if*-clauses were significantly higher than those for *though* clauses.

A second experiment was identical to the first, except that this time not verb-object phrases were used as a probe, but probe words actually used in the sentence pairs. The difference between the two experiments thus lay in the tapping into associative processing (Experiment 1) and structural processing (Experiment 2). This distinction seems identical to the distinction we made in earlier chapters between cohesion-based and coherence-based processing.

Because Townsend and Bever expected that when comprehenders focus more on the structure (cohesion-based) than on the meaning (coherence-based) in this experiment, they predicted that the difference in early and late target position (the difference between (8)(a)-(b)) would be greater for ADVERSATIVE than for CAUSAL and TEMPORAL relations.

(8)

- (a) Good jobs are quite scarce *now* in most large ... (*initial main – late probe*)
- (b) Good jobs are *now* quite scarce in most large ... (*initial main – early probe*)

The effects of the target position in subordinate clauses relative to its effect in the corresponding main clauses, showed that response times for *if* clauses are higher to the late targets than to the early targets, while response times for *though* clauses were lower for the late targets than for the early targets.

In sum, in the two experiments similar results were found for the different conjunctions: relative accessibility for meaning was best in the initial clause condition and the early target condition, whereas for accessibility of the literal form was best in the final clause condition and the late target condition. (POSITIVE CAUSAL) *If*-clauses seem to be processed fastest in semantic accessibility, (NEGATIVE CAUSAL) *though*-clauses best in literal accessibility, with the remaining conjunctions falling between the *if* and *though* sides of the spectrum and following the CAUSAL-TEMPORAL dimension.

Figure 1 and Figure 2 present the results in Townsend & Bever (1978). Figure 1 shows the difference of mean response times between subordinate and main clauses on probes related to meaning. The figure should be read as follows: when *If* occurs in the initial subordinate clause (e.g. [*conjunction*] *x*, *y*) the general accessibility of *If*-clauses is lower than accessibility for *though* clauses. On the other hand, accessibility for *though*-clauses is lower than for *if*-clauses, when the conjunction occurs in the final clause (e.g. *x*, [*conjunction*] *y*). Figure 2 is the same as Figure 1, except that response times to structural probes rather than to associative probes are given here. Mean response times for the subordinate clause are subtracted from those for the main clause and the response times for the early target are subtracted from the late target times. It shows the difference between the response times of the late versus the early target words of the subordinate clause was subtracted from the difference between early and late probe times for the main clause. Highly positive response times are higher for the late targets than the early targets and highly negative response times higher for the early targets than the late targets.

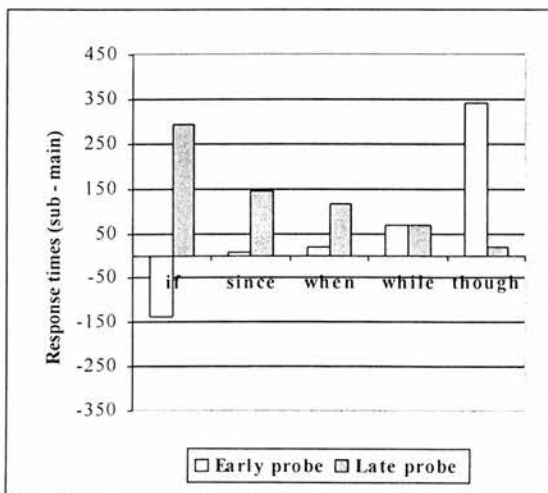


Figure 1 Response times meaning-probe

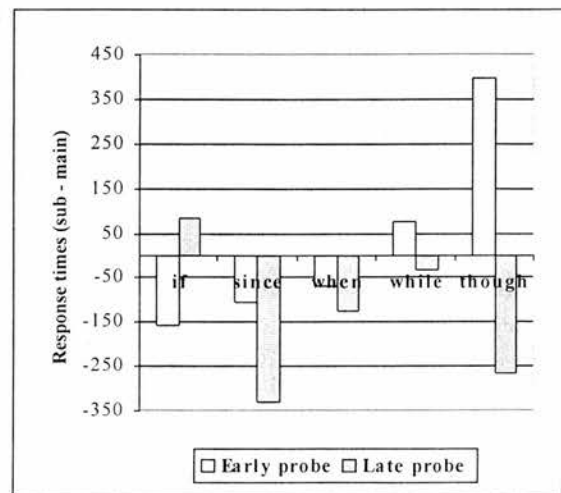


Figure 2 Response times structure-probe

These results can be translated in the answers to the three questions and are presented in Table 5.

question	Townsend & Bever's (1978) results
<i>Cohesion Question</i>	n/a
<i>Parameterisation Question</i>	POSITIVE CAUSAL < POSITIVE TEMPORAL (early probe) POSITIVE CAUSAL < NEGATIVE CAUSAL (early probe) NEGATIVE CAUSAL < POSITIVE TEMPORAL (early probe) POSITIVE TEMPORAL < POSITIVE CAUSAL (late probe) NEGATIVE CAUSAL < POSITIVE CAUSAL (late probe) POSITIVE TEMPORAL < NEGATIVE CAUSAL (late probe)
<i>Integration Question</i>	late for POSITIVE CAUSAL early for NEGATIVE CAUSAL

Table 5 Townsend & Bever (1978)

Townsend & Bever's experiments show us that the answer to the Integration Question is dependent on the answer to the Parameterisation Question. Townsend (1983) replicated these results.

Townsend (1983)

In the discussion of Townsend & Bever (1978), we have already outlined the resemblance between their associative processing and structural processing on the one hand and our cohesion-based and coherence-based processing on the other. Like Townsend & Bever (1978), Townsend (1983) distinguishes between these processes and calls them 'propositional' (cohesion-based) and 'thematic' (coherence-based):

Thematic processing determines the relation of incoming propositions to previously processed propositions by applying patterns that had been established earlier in the text and in similar texts, etc. Thematic processing integrates just-apprehended propositions into a thematic representation of the text; for example, in the case of narratives, it determines the causal/temporal relations of incoming propositions. Propositional processing retains hypotheses about syntactic structure and literal meaning until the proposition has been integrated in the preceding text. (Townsend, 1983: 225)

Townsend (1983) carried out various experiments to investigate the role of conjunctions on 'thematic' and 'propositional' processing. The first experiment involved a post-sentence meaning task, a fragment-meaning task and a fragment-word task. The latter two tasks were similar to the ones in Townsend & Bever (1978), discussed above. Subjects listened to clauses like in (9).

(9)

- (a) Since Tom has *poured* the red wine and served the iced tea, the guests are waiting to be seated for dinner.
- (b) Since Tom has served the red wine and *poured* the iced tea, the guests are waiting to be seated for dinner.

Subjects in the fragment tasks heard all but the last word of the subordinate clause and those in the post-sentence meaning task heard the complete two clauses. Subjects in the fragment word task then heard a word (the word in italics in the example). They were asked to decide whether or not the word had occurred in the fragment. The subjects in the fragment meaning task and the post-sentence meaning task saw a 2-4 word predicate phrase and were asked whether the phrase was consistent with the meaning in the fragment. Sentences were either conjoined by the (POSITIVE TEMPORAL) conjunction *while* or (the POSITIVE CAUSAL) *since*.

Response times for the meaning tasks for the *while*-clauses were lower when the whole sentence rather than only the sentence fragment was heard. This difference was not found in *since* clauses. In fact, the increase of accessibility to meaning after the whole sentence was heard – indicated by lower response times – compared to the sentence fragment was significantly larger for *while* sentences than for *since* sentences. This suggests that processing *while*-clauses is not fully thematic. A similar result was found in the fragment word task. Recognition times in the early target condition were higher for *since* than for *while*, whereas in the late target condition this was the other way around. The results showed a similar pattern as the ones found in Townsend & Bever (1978): response times for (POSITIVE TEMPORAL) *while*-clauses are lower for late targets than to early targets, and those for (POSITIVE CAUSAL) *since*-clauses are lower for early targets than to late targets.

A second experiment involved a question-answering task. Subjects listened to clauses introduced by (POSITIVE CAUSAL) *since* or (NEGATIVE CAUSAL) *though* and followed

by a main clause in either an active or passive form. Aim of the experiment was to test the effect of a syntactic variable (active versus passive) on the main clause following either a clause introduced by a CAUSAL or by a non-CAUSAL conjunction. The procedure was identical to the one in Experiment 1, except that the sentences were now followed by an active question instead of a probe word. Response times were higher for the active than for the passive clauses when *though* preceded the clause, but higher for the passive than the active clause when *since* preceded the clause. According to Townsend, processing a final clause preceded by a *since*-clause occurs independently, while this is not the case for *though*-clauses. An alternative interpretation not provided in Townsend (1983) is that structural features (like syntax) affect (NEGATIVE CAUSAL) *though*-clauses more than (POSITIVE CAUSAL) *since*-clauses, as the difference between the active and passive sentence is smaller for *since*- than *although*-clauses.

In a post-sentence synonymy judgement experiment, subjects read two long stories sentence by sentence and were occasionally interrupted after a two-clause sentence and subjects were asked to indicate whether or not a 2-4 words verb-object phrase had a similar meaning to the sentence the subject had read. For each narrative a large set of verb-object phrases was constructed that were either synonymous or non-synonymous with the final verb-object phrase in the sentence. Six conditions were used: sentences were modified in such a way that subordinate clauses were introduced by one of the following conjunctions: *because*, *after*, *when*, *and*, *before* and *although*. Results showed that response times were highest (accessibility for meaning was poorest) for the conjunctions (POSITIVE TEMPORAL) *before* and (NEGATIVE CAUSAL) *although*, with almost equal scores for *because*, *after*, *when* and *and*.

In another experiment, subjects were asked to study 72 noun-sentence pairs like example (10) for 10 seconds.

(10) The canary. It sung the song because it ate the seed.

Half of the sentence started with a subordinate clause followed by the main clause, and half started with the main clause followed by the subordinate clause. After studying six pairs, the subject saw the noun cue and was asked to write down the sentence as accurately as possible. Clauses were conjoined by *because*, *since*, *after*, *when*, *while* and *before*.

Recall scores were generally higher for the main clause – subordinate clause order than the subordinate clause – main clause order, but this effect interacted with the

conjunction. Scores for initial main clauses were higher when the subordinate clause was introduced by *while*, *before* or *when*. On the other hand, scores for initial subordinate clauses were higher for *because* and *after* clauses. When the structure of the two-clause sentence was main clause followed by a subordinate clause, an advantage was found for *while*, *before* and *then* conjunctions, but when the structure was subordinate followed by a main clause, advantage was found for (POSITIVE CAUSAL) *because* and (POSITIVE TEMPORAL) *after*.

In another experiment, subjects read sentences like (11) from the computer screen:

(11)

- (a) Harry began raising snakes on his farm
- (b) Therefore, kids visited the farm everyday.

The second clause was either introduced by *therefore*, *afterward*, no connective, *meanwhile* or *previously*. After having read the second clause, subjects were asked to write down a sentence that would be a reasonable continuation of the story. The crucial variable was the time subjects looked at the second clause to figure out which continuation sentence to write. Continuation times were lowest for (POSITIVE CAUSAL) *therefore* followed by (POSITIVE TEMPORAL) *afterward*, no connective⁴, (POSITIVE TEMPORAL) *meanwhile*, (POSITIVE TEMPORAL) *previously*, and (NEGATIVE ADDITIVE) *however* respectively.

The final experiment reported in Townsend (1983), investigated thematic integration of a sentence with a context. Subjects read context sentences like those in (12)(a)-(d), and pressed a button when they were ready to read the target sentence (e)-(f). They read the target sentence constructed a continuation sentence, pressed a button and reported this sentence. The time between the start and end of the target sentence during which the subject thought of a continuation sentence was recorded. Target sentences were introduced by *because*, *while* or *although*.

(12)

Context sentences:

- (a) Harry takes care of reptiles in his house. (*direct paraphrase of subordinate clause*)
- (b) Children are always hanging around Harry's place. (*direct paraphrase of main clause*)

⁴ An adjustment was made for 'no connective' as these sentences lacked one word.

- (c) Harry is fascinated by exotic animals. (*indirect paraphrase of subordinate clause*)
- (d) Harry is popular with children. (*indirect paraphrase of main clause*)

Target sentences:

- (e) Although he raises snakes, kids often visit Harry.
- (f) Kids often visit Harry, although he raises snakes.

Results showed that response times were lower for the subordinate + main clause order (12)(e) in the (POSITIVE CAUSAL) *because*- and (POSITIVE TEMPORAL) *while*-condition, but not in the (NEGATIVE CAUSAL) *although*-condition. This suggests that integration is easier when the cause occurs in the beginning of the sentence in *because*-condition and the unexpected effect is in the beginning of the sentence in *although*-condition. Furthermore, response times were lower when the context paraphrased the subordinate clause rather than the main in the *because*-condition, but for the *although*-condition (and marginally for the *while*-condition) response times were lower when the context paraphrased the main clause rather than the subordinate clause. This suggests that particularly in *although* clauses thematic processing uses the context to determine its presupposition. However, this can only be done after the unexpected effect is processed.

As with Townsend & Bever (1978), the results can be summarised as in Table 6.

question	Townsend's (1983) results
<i>Cohesion Question</i>	POSITIVE CAUSAL < implicit POSITIVE TEMPORAL < implicit
<i>Parameterisation Question</i>	POSITIVE CAUSAL < POSITIVE TEMPORAL (final subordinate) POSITIVE CAUSAL < NEGATIVE CAUSAL (final subordinate) POSITIVE TEMPORAL < NEGATIVE ADDITIVE (final subordinate) POSITIVE TEMPORAL < POSITIVE CAUSAL (initial subordinate) NEGATIVE CAUSAL < POSITIVE CAUSAL (initial subordinate) NEGATIVE ADDITIVE < POSITIVE TEMPORAL (initial subordinate)
<i>Integration Question</i>	late for POSITIVE CAUSAL early for POSITIVE TEMPORAL

Table 6 Townsend (1983)

Townsend's experiments show how similar effects for conjunctions can be found between isolated sentences and in short narratives. Results in all experiments replicate those found in Townsend & Bever (1978), Townsend & Ravelo (1980) and Townsend & Bever (1982).

Ziti & Champagnol (1992)

More or less following Townsend & Bever's (1978) and Townsend's (1983) methodology, Ziti and Champagnol examined the effect of four conjunctions on processing two-clause sentences in two French experiments. Each experiment contained a reading time task for the first clause, a recognition time task for a word related to the clause in structure or meaning, and a reading time task for the final clause. In the first experiment, subjects were asked to read the first clause of sentences like (13) and (14) to decide whether the word had occurred in the clause. Next the second clause was presented and the subjects were asked to respond as quickly as possible whether the second clause would make a coherent whole with the first clause. Clauses were conjoined by the following conjunctions: *parce que* (because), *puisque* (since), *quoique* (albeit) and *bien que* (although). The following structures were used in the conditions with sentences like (13) and (14):

Structure:

Parce que / *Puisque* / \emptyset clause 1, clause 2

Clause 2 *parce que* / *puisque* / \emptyset clause 1

(13)

- (a) La neige avait rendu le piste du circuit très difficile, /
- (b) les coureurs ont tous abandonné la course bien avant l'arrivée.

- (a) (The snow has made the circuit very hard, /
- (b) all drivers had to abandon the race well before the finish)

Structure:

Bien que / *Quoique* / \emptyset clause 1, clause 2

Clause 2, *bien que* / *quoique* / \emptyset clause 1

(14)

- (a) La chaleur avait séché toutes les terres agricoles l'an dernier, /
- (b) les paysans ont tous recueilli des moissons très satisfaisantes.

- (a) (Last year, the heat dried up all farm land, /
- (b) the farmers reaped a satisfactory harvest.)

In the reading times of the first clause no difference was found between clauses conjoined by *parce que* and those conjoined by *puisque*. However, between the reading times of *bien que*- and *quoique*-clauses a significant difference was found, with higher reading times for the *bien que*-clauses. Furthermore, the reading times for the clauses not conjoined by a conjunction were processed faster than those conjoined by any of the conjunctions when the first clause was expressing the cause, but not when it was expressing the effect of a CAUSAL relationship. Recognition times for clauses conjoined by concessive conjunctions were lower than those for CAUSAL conjunctions. Finally, in the concessive condition, reading times for the final clauses not conjoined by a conjunction were higher than those for the final clause conjoined by any of the conjunctions, but this effect was not found in the CAUSAL condition.

In the second experiment the word recognition task did not use a word taken from the first clause, but a semantically related word (e.g. *complication des passages* and *délaissement de l'épreuve* for the examples given above). Results were identical as those obtained in the first experiment, with one exception. While in the first experiment the CAUSAL recognition times were higher than the concessive, with a structural probe, in the second experiment with a semantic probe, recognition times were the lower. This result replicates the results reported in Townsend (1983) and Townsend & Bever (1978). Again, the results can be summarised as presented in Table 7.

question	Ziti & Champagnol's (1992) results
<i>Cohesion Question</i>	n/a
<i>Parameterisation Question</i>	< POSITIVE TEMPORAL (early probe, meaning) < POSITIVE CAUSAL (early probe, structure)
<i>Integration Question</i>	meaning integration for POSITIVE CAUSAL structure integration for POSITIVE TEMPORAL

Table 7 Ziti & Champagnol (1992)

Although Ziti and Champagnol mainly focussed on the semantic versus pragmatic distinction, their results are in the line of the results found in Townsend & Bever (1978) and Townsend (1983), with a processing advantage for *parce que/puis que*-clauses when semantic resources were activated and an advantage for *bien que/quoique*-clauses when structural resources were activated.

So far, we have looked at studies in which the materials seem rather natural in all conditions. But what happens when something goes wrong in the comprehension process? What happens if the text is not so natural? It could be argued that particularly in the cases of disruptive interclausal relationships behavioural evidence can be obtained about the impact of conjunctions on processing. Murray (1997) investigated this question.

Murray (1997)

Murray formulated the so-called 'continuity hypothesis', stating that "connectives differentially facilitate on-line processing to the extent they inform the comprehender about an upcoming discontinuity" (1997: 229). Murray defines discontinuity as breaks in the anticipated continuity cued by adversative conjunctions, or breaks in linear continuity.⁵ According to the hypothesis, CAUSAL and ADDITIVE relations should lead to less facilitation than ADVERSATIVE relations.

Murray conducted three experiments to test this hypothesis. In the first experiment he tested to what extent different conjunctions signal continuous or discontinuous events. Subjects were given a set of single clauses and were asked to

⁵ This is partly what Halliday & Hasan (1976) and Martin (1992) have called 'adversative relations' and what has been called NEGATIVE and BACKWARD relations respectively in the proposed parameterisation.

generate a second clause for each first clause that would be a sensible continuation. The first word of the second clause was given and consisted of an ADDITIVE conjunction like *moreover, furthermore, also* and *and*; a CAUSAL conjunction like *therefore, so, thus, consequently*; or an ADVERSATIVE (i.e. NEGATIVE in our parameterisation) conjunction like *yet, nevertheless, however, but*. The subjects' continuation clauses (without conjunctions) were next classified by independent judges as ADDITIVE, CAUSAL or ADVERSATIVE. Subjects' responses more often corresponded to the ADVERSATIVE conjunctions than to the ADDITIVE and CAUSAL conjunctions. No difference was found between ADDITIVE and CAUSAL conjunctions. Furthermore, ADVERSATIVE conjunctions elicited discontinuity and ADDITIVE and CAUSAL conjunction continuity. Murray (ibid. 230) concludes that this shows that ADVERSATIVE conjunctions are more salient in the relations they signal. Of course, an alternative explanation is that (unmarked) ADVERSATIVE relations are unnatural. It could then be argued that ADDITIVE and CAUSAL relations are more natural when unsignalled and that this is the reason that a difference between the two could not be found.

In the next two experiments Murray tested the discontinuity hypothesis with respect to on-line processing, using clause pairs like in (15) (Murray, 1997: 231). Subjects rated the sensibility of each of the clause pairs with different conjunctions on how sensible the combination seemed.

(15)

- (a) Ronny cleaned up the house for his girlfriend's visit.
- (b) Ronny wanted to arrange a surprise for his girlfriend's visit.
- (c) Ronny had little time to arrange a surprise for his girlfriend's visit.
- (d) [conjunction] H/he bought her a beautiful bouquet of flowers. (*target*)

Having established the most likely coherence relation, Murray now asked subjects to read a series of clause pairs that contained an ADDITIVE, CAUSAL or ADVERSATIVE relation. However, 66% of the clause-pairs contained a conjunction that was inconsistent with the expected relation (e.g. *nevertheless* instead of *so* in (15)(b)-(d)), 33% of the pairs did not contain a conjunction. This reading task was followed by a comprehension task and a cued recall task. Reading times for the target clause were shorter with no conjunctions than with inappropriate ADDITIVE conjunctions or

ADVERSATIVE conjunctions. As predicted, inappropriately placed ADVERSATIVE conjunctions caused greater disruption to reading times than the two continuous (ADDITIVE and CAUSAL) conjunctions.

The final experiment reported in Murray (1997) tested to what extent the findings of the previous experiment were conscious perceptions of subjects. In other words, the reading times showed that an inappropriate conjunction makes a clausal relationship less sensible than no conjunction and this effect was stronger in ADVERSATIVE conjunctions than in the other two relations. The question now is whether the (unconscious) reading time results can be extended to (conscious) ratings of clauses by subjects. Incorrect conjunctions yielded lower ratings, but this effect was weaker for continuous (ADDITIVE and CAUSAL) than discontinuous (ADVERSATIVE) conjunctions. Similar to the results in the reading time experiment, ADVERSATIVE conjunctions led to lower ratings than the no-conjunction condition.

A summarisation of Murray's results shows that the disruptive effect for NEGATIVE relations is greater than for POSITIVE relations, both in CAUSAL and ADDITIVE relations. Also the disruptive effect for sentences with inappropriate NEGATIVE CAUSAL and ADDITIVE conjunctions and for POSITIVE ADDITIVE conjunctions was greater than for the sentences where no cohesion relations were used. Although we have to be careful translating the disruption results into continuation results, they are presented in Table 8.

question	Murray's (1997) results
<i>Cohesion Question</i>	POSITIVE ADDITIVE < implicit NEGATIVE ADDITIVE < implicit
<i>Parameterisation Question</i>	NEGATIVE CAUSAL < POSITIVE CAUSAL NEGATIVE ADDITIVE < POSITIVE CAUSAL NEGATIVE ADDITIVE < POSITIVE ADDITIVE
<i>Integration Question</i>	n/a

Table 8 Murray (1997)

Murray's study shows that readers assume continuity in a sequence of events presented in the clauses of a text. Those conjunctions marking discontinuity in text showed they have most impact on on-line processing. However, Murray shows the general impact of

ADVERSATIVE conjunctions and the important supporting role they have in text processing by turning the world upside-down. Murray's initial assumption that if ADVERSATIVE conjunctions are causing the greatest processing disruption when used inappropriately (by using the wrong conjunction in the wrong context) they result in the greatest degree of processing facilitation if applied appropriately may simply be wrong.

Millis & Just (1994)

Like Murray, Millis & Just (1994) looked at the effect of cohesion markers in the text compared to the absence of these markers. They used a non-cumulative self-paced reading time experiment and a recognition and comprehension task to investigate the effect of the (POSITIVE CAUSAL) conjunction *because* (and NEGATIVE CAUSAL *although*) on sentence comprehension. Subjects read two-clause sentences like (16):

(16)

- (a) The elderly parents toasted their only daughter at the party (because)
- (b) Jill had finally passed the exams at the prestigious university.

In addition to this, the experiment also contained a concurrent load condition to test how the processing of conjunction versus non-conjunction affects working memory resources. In the 'load condition', the two-clause sentence was preceded by a sentence unrelated to the content of the test sentence. Immediately after the second clause a probe word appeared on the screen and subjects were asked to respond whether or not the word had appeared in the clause-pair. Two questions followed on the content of the first and second clause. One word of this sentence appeared in capitals and subjects in this condition were asked to remember this word. After the recognition probe they were asked to recall this word.

The presence of the connective *because* facilitated the response time of the probe for the first clause in both the load and the no-load conditions. No significant difference between conjunction and no-conjunction condition was found for the probe for the second clause. Generally, subjects needed more response time for the probe word for the first clause than the second clause and – not surprisingly – probe times were higher for the load than the no-load condition.

The word reading times showed the following pattern: reading times went up to a greater extent for the last word of the first clause without the conjunction than with the conjunction, suggesting that the presence of the conjunction delayed the full integration of the first clause. Reading times for the second clause were lower for the clauses introduced by a conjunction than the no-conjunction clauses. The load versus no-load conditions only had a small effect in the beginning of the second clause, but a large effect (increasing reading times) at the end of the clause. Finally, the accuracy of the answers was better and the answer times were lower for the clauses conjoined by *because* than the no-conjunction clauses.

The question Millis & Just (1994) wanted to answer next was when the integration occurred. They formulated two competing hypotheses (ibid.135).

1. Immediate Reactivation Hypothesis: the conjunction causes the contents of the first clause to remain activated in working memory throughout the comprehension of the second clause.
2. Delayed Reactivation Hypothesis: the conjunction causes a reactivation of the contents of the first clause at the end of the second clause.

The two hypotheses were tested in an early and late probe recognition experiment with a procedure similar to the previous experiment. Again, sentences were used with the conjunction *because* and without a conjunction. Response times for early probes should be similar to those for late probe recognition, according to the Immediate Reactivation Hypothesis, whereas response times for late probes should be higher than for early probes, according to the Delayed Reactivation Hypothesis.

Results showed a reactivation effect at the late response times, as predicted by both hypotheses. However, at an early probe this effect was not obtained, thus suggesting support for the Delayed Reactivation Hypothesis. However, rather surprisingly, response times were higher for clauses conjoined by (POSITIVE CAUSAL) *because* than no-conjunction clauses in the early probe condition. One explanation Millis & Just (1994) provide for this result is that comprehenders try to make a meaningful

relation between the clauses while the second clause is read, thus reading the first clause faster⁶.

The third experiment investigated the effects of CAUSAL relatedness on reactivation. CAUSAL relatedness was a factor in Deaton & Gernsbacher (in press) and was extensively discussed in Chapter 4. In that chapter we also discussed the studies by Myers et al. (1987), who showed that moderate CAUSAL relatedness facilitates processing compared to extremely high or low levels of CAUSAL relatedness, and that comprehenders are more likely to generate elaboration for causally moderately related than for causally low related clause pairs.

Subjects read moderately causally related and low-related clause-pairs and they were asked to respond to a probe that appeared after they had read the second clause. Clauses were either conjoined by *because* or were not conjoined. Results showed that when clauses were moderately causally related, response times to the probe were lower for the conjunction condition than the no-conjunction condition.

The reading times of the last word of the second clause showed that in the moderately related clauses the presence of the conjunction reduced the reading time significantly, whereas in the low-related clauses the reading time increased when a conjunction was present. This makes sense, as in the case where clauses hardly have a CAUSAL relation, the reader is still cued to make a CAUSAL relation, which requires time. When the CAUSAL relation can be established without too much difficulty, the conjunction facilitates processing. Note that in the marginally related condition the reading times for the second clause *minus* the last word (!) were lower than those for the first clause. Apparently, comprehenders tried to establish a relationship announced by *because*, which they could only establish at the end of the second clause.

In another probe recognition task, the negation marker *not* in combination with the conjunction *although* was investigated. Subjects saw sentences like (17), either without either

⁶ But note that the conjunction was placed at the end of the first line and not at the beginning of the second line. Processing of the conjunction could take place while the subject was processing the first clause.

negation or conjunction, without negation but with conjunction, or without conjunction but with negation.

(17)

- (a) The young architect had (*not*) yelled at the new secretary (*although*)
- (b) the poorly typed manuscript was not handed to the meticulous boss.

The probe word was either related to the first or the second clause. Results showed that the presence of the conjunction decreased probe recognition times. However, this facilitating function of the conjunction did not affect the interaction of probe times for the probe related to the clause (first or second) and the presence or absence of the negation. Furthermore, negation in one clause raised the probe times for that clause, and also for the other clause. The experiment showed that the reactivation effect also applies to *although*, with one important difference. Unlike *because*, *although* also increased the activation of the second clause. Reading times for (NEGATIVE CAUSAL) *although*-clauses were slightly higher than for (POSITIVE CAUSAL) *because*-clauses, while comprehension accuracy scores were lower.

In sum, Millis & Just showed that cued recall was better and reading times lower for those clauses conjoined by a POSITIVE or NEGATIVE CAUSAL conjunction than for clauses that are not conjoined by a conjunction. However, this is only true for the first clause. Probes in, and reading times for, the second clause show the opposite effect. Furthermore, whether or not the clause is moderately causally related influences these effects with a processing advantage for the presence of the conjunctions in the second clause of moderately causally related sentences, and a processing disadvantage for unrelated clauses. With respect to the Integration Question, Millis and Just claim that conjunctions cue the comprehender to reactivate the first clause while and after having read the second clause and not when first encountering the second clause.

question	Millis & Just's (1994) results
<i>Cohesion Question</i>	POSITIVE CAUSAL < implicit (early) NEGATIVE CAUSAL < implicit (early) implicit < NEGATIVE CAUSAL (late)
<i>Parameterisation Question</i>	n/a
<i>Integration Question</i>	late integration for POSITIVE CAUSAL

Table 9 Millis & Just (1994)

It should be noted that Millis & Just's results come from probe word data. It could be argued that actual on-line data – like those obtained in reading time and eye-tracking experiments might give different results. Furthermore, it should be noted that the only conjunctions tested by Millis & Just are *because* and *although*. It may very well be possible that different conjunctions relate differently to the Connective Integration Model. Finally, Millis and Just tested the reading time for clauses with the conjunction at a somewhat peculiar position, at the end of the first line. This allows comprehenders to process the relationship even before the second clause starts to be processed.

Traxler, Bybee & Pickering. (1997b)

Traxler et al. (1997b) disagree with Millis & Just's (1994) conclusion. They argue that the Delayed Integration Hypothesis does not hold and propose an Incremental Interpretation Hypothesis which states that comprehenders integrate the semantic representation of incoming information on an almost word-by-word basis. This means that when two conjoined clauses are processed, integration of the two clauses does not occur at the end of the second clause, as is stated in the Delayed Integration Hypothesis, but immediately after the conjunction is encountered. Traxler et al. test their alternative hypothesis in an experiment similar to Traxler et al.'s (1997a) reported in Chapter 5. Subjects read sentences like (18)(a) and (b), the first a CAUSAL sentence, the second a diagnostic one.

(18)

- (a) Jeff got angry at his neighbours, because they played the stereo too loud
(semantic)
- (b) Jeff had inconsiderate neighbours, because they played the stereo too loud
(pragmatic)
- (c) because / they played / the stereo / too loud

Subjects read sentences like (18)(a) or (b) and (c) on two lines, one line for each clause. Eye-tracker results showed no significant difference between the semantic and diagnostic condition in the first clause. If, according to Traxler et al (1997b), the delayed Integration Hypothesis is true, a difference in fixation times would only be noticed at the end of the processing of the second clause, i.e. in region 4, shown in (18)(c). Raised fixation times in any other region would provide evidence for the incremental interpretation hypothesis. Readers in fact reflected the disruption in the CAUSAL relationship in PRAGMATIC sentences, before they reached the end of the second clause. Comprehenders thus try to construct a coherent mental representation as soon as possible.

But how can Millis & Just's evidence for the delayed Integration Hypothesis then be explained? According to Traxler et al. (1997b) the most likely reason for the differences is the method. Millis and Just used two probes, one right after the conjunction and one at the end of the text. This method provides us with a rather static picture of language processing, whereas the eye movement study gives a more dynamic continuous picture.

Against Traxler et al., however, recall we have seen in Chapter 5 that the difference between semantic and pragmatic reading of a sentence is peculiar in that the comprehender needs to switch the order of the events, despite the fact that the conjunction does *not* cue for such an inversion. It may therefore very well be the case that the conflict in processing that occurs in pragmatic reading occurs earlier or later than general processing of conjunctions. Related to this, and more importantly, Traxler et al. only use causally related clauses. This means that subjects may have particularly looked for semantic or pragmatic CAUSAL relations (see Deaton & Gernsbacher's (in press) anticipation effect), and the results therefore do not reflect a natural processing of discourse. That is, the results may show where comprehenders start determining

whether a clause requires a semantic or pragmatic reading and not where integration of coherence takes place.

6.2.2 A comparison

The studies we have discussed so far provide us with answers to the three questions we formulated at the beginning of this chapter. The Cohesion Question concerns the effect of the presence versus the absence of cohesion markers on the comprehension process; the Parameterisation Question concerns the effect of the various parameters on the comprehension process; and the Integration Question concerns the position in the comprehension process where integration of coherence takes place. We will next compare the answers the studies give on these questions.

Cohesion Question

If we compare the studies discussed above on their answers on the Cohesion Question, the picture emerges that is presented in Table 10.

task (other conditions)	CAUSAL		TEMPORAL	ADDITIVE	
	POS CAUS < Ø	NEG CAUS < Ø		POS ADD < Ø	NEG ADD < Ø
cued recall	CM&T88		T83		
cued recall (load; clause 1)	M&J94			M97	M97
cued recall (no load; clause 1)	M&J94	M&J94			
cued recall (moderately causally rel.)	M&J94				
free recall (strength)	CM&T88				
RT (clause 1; last word)	M&J94				
RT (clause 1; effect + cause)	Z&C92				
RT (clause 2; last word; mod.rel.)	M&J94				
RT (clause 2; last word; mod. rel.)	M&J94				
RT for continuation	T83				
disruption RT					
cued recall (early probe)	POS CAUS > Ø	NEG CAUS > Ø	POS TEMP > Ø	POS ADD > Ø	NEG ADD > Ø
free recall (strength)	M&J94				
RT (clause 1; cause + effect)	Z&C92			CM&T88	
RT (clause 2; last word; load)	M&J94				
RT (clause 2; last word; no load)	M&J94				
RT (clause 2; last word; low caus.)	M&J94				

CM&T88 = Caron, Micko & Thuring (1988) T&B78 = Townsend & Bever (1978)
 M&J94 = Millis & Just (1994) T83 = Townsend (1983)
 M97 = Murray (1997) Z&C92 = Ziti & Champagnol (1992)
 Ø = absence of cohesion marker (i.e. those conditions where no conjunction was used).

Table 10 Overview of Cohesion Question

As we can see, most evidence for the effects of the presence of cohesion relations on the comprehension process comes from POSITIVE CAUSAL relations. There is some evidence for NEGATIVE CAUSAL and POSITIVE TEMPORAL relations, and for POSITIVE and NEGATIVE ADDITIVE relations.

Both the presence of NEGATIVE CAUSAL relations and POSITIVE TEMPORAL relations seem to facilitate the comprehension process compared to the unmarked relations. Two recall-studies (Millis & Just, 1994 and Townsend, 1983) point this out. For POSITIVE and NEGATIVE ADDITIVE relations this is less clear. Evidence from discontinuation studies points toward a processing benefit (Murray, 1997). But at least POSITIVE ADDITIVE relations may have a processing disadvantage, according to a free-recall study (Caron et al., 1988). However, Murray's experiments investigate discontinuation. We could question whether Murray's results can be extended to continuation studies. On the other hand, Caron et al.'s experiments investigate the strength of a relation once it is recalled. This means that the effect that is found comes from production rather than comprehension data. Without any further evidence it may thus be hard to generalise the results of these studies to text comprehension.

In general, POSITIVE CAUSAL cohesion relations seem to facilitate the comprehension process, when compared with the absence of cohesion markers (top part of the table). However, in several cases, the opposite result is found: more processing effort is needed for POSITIVE CAUSAL cohesion than for unmarked cases. How can these contradicting results be explained? Evidence for the opposite results mainly come from reading time studies (Millis & Just, 1994; Ziti & Champagnol, 1992). The presence of the POSITIVE CAUSAL relation has a processing advantage over sentences where such a cohesion is absent in the last word of the first clause (Millis & Just, 1994) and for the second clause without the last word. On the other hand, a disadvantage for the cohesion relation is found for the last word of the second clause (Millis & Just, 1994) and of the last word of the second clause. It thus seems that towards the end of the comprehension process, processing effort is needed for POSITIVE CAUSAL relations, while initially they offer a processing advantage, compared to unmarked cases. This conclusion answers the Integration Question, to which we will return later. For now we can conclude that on the basis of various cued recall and

reading time studies, cohesion markers seem to have a processing advantage over unmarked cases, at least for CAUSAL relations and very likely for TEMPORAL relations too.

Parameterisation Question

As with the Cohesion Question, we have put the studies in one table to compare the answers on the Parameterisation Question (Table 11).

task (other conditions)	TYPE				POLARITY				TYPE+POLARITY			
	POS < POS CAUS TEMP	POS < POS CAUS ADD	POS < POS TEMP ADD	POS < NEG ADD ADD	POS < NEG CAUS CAUS	POS < NEG CAUS TEMP	POS < NEG TEMP ADD	POS < NEG CAUS ADD	POS < NEG CAUS ADD	POS < NEG CAUS ADD	POS < NEG CAUS ADD	
cued recall		CM&T88										CM&T88
cued recall (main + sub)	T83							T83				
cued recall (meaning)	T83							T83				
cued recall (meaning; early probe)	T&B78, T83							T&B78				
cued recall (structure; early probe)	T&B78, T83							T&B78		T&B78		
cued recall (meaning; clause 1)	Z&C92											
cued recall (high causal; inferential)	D&G00											
cued recall (high causal; partial)	D&G00											
cued recall (high causal; verbatim)	D&G00											
cued recall (mod. causal; inferential)	D&G00											
cued recall (mod. causal; verbatim)	D&G00											
free recall		S&N00										
free recall (strength)		CM&T88										
RT		S&N00										
RT for continuation		S&N00						T83		T83		T83
RT (high causally related)	D&G00			D&G00								
RT (moderately causally related)	D&G00											
verification		S&N00										
	POS > POS CAUS TEMP	POS > POS CAUS ADD	POS > POS TEMP ADD	POS > NEG ADD ADD	POS > NEG CAUS CAUS	NEG > POS CAUS TEMP	POS > NEG TEMP ADD	POS > NEG CAUS ADD	POS > NEG CAUS ADD			
cued recall (sub + main)	T83				T83							
cued recall (meaning; late probe)	T&B78, T83							T&B78		T&B78		
cued recall (structure; late probe)	T&B78, T83							T&B78		T&B78		
cued recall (structural; clause 1)	Z&C92											
disruption RT				M97								M97

CM&T88 = Caron, Micko & Thuring (1988) M97 = Murray (1997) T&B78 = Townsend & Bever (1978) Z&C92 = Ziti & Champagnol (1992)
D&G00 = Deaton & Gernsbacher (2000) T83 = Townsend (1983) M&J94 = Millis & Just (1994) S&N00 = Sanders & Noordman (2000)

Table 11 Overview Parameterisation Question

Most studies have investigated the effect of POSITIVE CAUSAL cohesion relations compared to other cohesion relations. The table shows convincing evidence for a processing advantage for POSITIVE CAUSAL over NEGATIVE CAUSAL, POSITIVE TEMPORAL, POSITIVE ADDITIVE and NEGATIVE ADDITIVE. This effect can be found in cued recall (Townsend & Bever, 1978; Townsend, 1983; Deaton & Gernsbacher, in press), free recall studies (Sanders & Noordman, 2000; Caron et al., 1988) and reading time studies (Deaton & Gernsbacher, in press; Sanders & Noordman, 2000). Similarly, NEGATIVE CAUSAL relations have a processing advantage over POSITIVE TEMPORAL relations (Townsend & Bever, 1978).

However, the bottom part of the table shows opposite results. When the structure of the sentence is such that the main clause is presented last (Townsend, 1983), or when the cued recall task uses a late probe (Townsend & Bever, 1978; Townsend, 1983) POSITIVE CAUSAL relations require more processing time than NEGATIVE CAUSAL or POSITIVE TEMPORAL relations. Again, these findings are related to the Integration Question: only when the emphasis in a task lies on the end of the comprehension process, POSITIVE CAUSAL relations seem to be disadvantaged. But disruption studies (Murray, 1997) also show a processing disadvantage for POSITIVE CAUSAL relations and POSITIVE ADDITIVE relations, compared to NEGATIVE ADDITIVE relations. Murray's results are not shared by any of the other experiments. As with the Cohesion Question, it seems that Murray is wrong to assume that the disruption of inappropriately used conjunctions tells us something about the continuity of appropriately used conjunctions.

If we focus on the upper part of the table, where most evidence comes from, a clear picture emerges of how the parameters behave in the comprehension process:

POSITIVE CAUSAL < NEGATIVE CAUSAL < POSITIVE TEMPORAL < POSITIVE ADDITIVE.

It shows us that

1. within the TYPE relations, CAUSAL < TEMPORAL < ADDITIVE;
2. within the POLARITY relations, POSITIVE < NEGATIVE;
3. that apparently TYPE relations are more influential than POLARITY relations, as NEGATIVE CAUSAL relations are processed faster than POSITIVE TEMPORAL relations.

Integration Question

In particular Millis & Just (1994) and Traxler et al. (1997b) address the Integration Question. Millis & Just argue that integration of the information in the clause occurs toward the end of the clause. Traxler et al., on the other hand, argue that the comprehender starts processing at the earliest possible point.

What do the other studies say about the point of processing? In the discussion of the Cohesion and Parameterisation Question we already briefly touched upon the Integration Question. Answering this question is rather complicated. We have seen that in answering the Cohesion Question and the Parameterisation Question, the interfering variable was the position of integration (opposite results to the most common ones were found towards the end of the comprehension process). In answering the Integration Question, the interfering variable is the cohesion relation. For instance, in a cued recall task with an early probe (e.g. Townsend, 1983) POSITIVE CAUSAL relations are processed faster than POSITIVE TEMPORAL relations, while with a late probe the opposite result is found. From this, we cannot conclude that POSITIVE CAUSAL relations are processed toward the beginning of the comprehension process. This conclusion could only be drawn from a comparison of early and late targets of one cohesion relation. Three studies give evidence for the position of integration, as presented in Table 12.

	integration stage	
	early	late
Millis & Just, 1994	-	POSITIVE CAUSAL
Traxler et al., 1997b	POSITIVE CAUSAL	-
Townsend & Bever, 1978	NEGATIVE CAUSAL	POSITIVE CAUSAL
Townsend, 1983	POSITIVE TEMPORAL	POSITIVE CAUSAL

Table 12 Overview Integration Question

There is clear evidence by all three studies that POSITIVE CAUSAL relations are processed towards the end of the comprehension process. Other relations, like NEGATIVE CAUSAL and POSITIVE TEMPORAL are processed more towards the beginning. Also, if no cohesion relation is present, processing takes place in the beginning of the comprehension process.

Conclusions from the overview

The overview of studies shows us several other important things. Although we have to be careful with making generalisations, some general observations can be made:

1. *methodology*: different methods (reading time, probe, recall, etc.) yield a consistent picture;
2. *cross-linguistic results*: the results found for English do not contradict those for Dutch (Sanders & Noordman, 2000), French (Caron, Micko & Thuring (1988), Ziti & Champagnol (1992)) or German (Caron, Micko & Thuring (1988));
3. *text length*: The results have shown that the length of the text does not affect the consistency in the processing effects. Townsend (1983) conducted experiments with the same methodology on narrative texts and two-clause sentences and found identical results. Furthermore, Sanders & Noordman (2000) used relatively large texts and found results that confirmed those in the other experiments;
4. *text type*: Apparently text type does not affect the general findings. Sanders & Noordman (2000) used expository texts rather than the generally used narrative texts and found similar results.

6.3 HYPOTHESES

In the experiments to be reported below, we want to examine the presence of cohesion relations on the comprehension process, the behavioural evidence for the proposed parameterisation and the processing effects of its parameters, and the position where integration of coherence takes place. In other words, we want to address the Cohesion Question, the Parameterisation Question and the Integration Question. In the previous sections, the literature on grammar-driven cohesion and coherence relations was discussed around these three questions. The literature suggests the following:

1. *Cohesion Question*: the presence of cohesion relations in the text generally facilitates the comprehension process. This means that if comprehenders read a clause with a cohesion relation, they can process that clause faster than if they read a clause without such a cue.
2. *Parameterisation Question*: the presence of a parameter of the proposed parameterisation, shows that TYPE relations are more influential than POLARITY

relations. Within the TYPE category, there is a processing advantage for CAUSAL relations over TEMPORAL relations and for TEMPORAL relations over ADDITIVE relations. Within the POLARITY category POSITIVE relations seem to have a processing advantage over NEGATIVE relations. This means that if comprehenders for instance read a clause with a POSITIVE CAUSAL relation marked by the conjunction *because*, they process that clause faster than if they read a clause with a NEGATIVE ADDITIVE relation marked by the conjunction *however*.

3. *Integration Question*: there are two integration theories, one arguing that the integration of coherence takes place incrementally (Traxler et al. 1997b), the other that it takes place at the end of the comprehension process in a wrapping up stage (Millis & Just, 1994). However, in studies that are less concerned with the integration studies we have seen that the Integration Question may be dependent on both the Cohesion Question and the Parameterisation Question. This means that with one cohesion relation comprehenders process the first part of the sentence faster than the final part, whereas with another cohesion relation this is the other way around.

In Chapter 2 we introduced the Specification Hypothesis, which predicts that cohesion-relations that are less specific direct the comprehenders' resources toward cohesion-based information, whereas those relations that are more specific direct the comprehenders' resources toward coherence-based information.

For the Cohesion Question this means that a text with cohesion relations will hence be processed faster than a text without these relations.

For the Parameterisation Question it means that those relations that are most specific will be processed fastest. In terms of our parameterisation, this means that CAUSAL relations will be processed faster than TEMPORAL relations (CAUSAL coherence implies TEMPORAL and ADDITIVE coherence), which will be processed faster than ADDITIVE relations (TEMPORAL coherence implies ADDITIVE coherence). Furthermore, POSITIVE relations will be processed faster than NEGATIVE relations, as for the latter are less specific because of the explicitness of implicatures.

For the Integration Question this means that comprehension of clauses with less specific relations develop incrementally throughout the comprehension process, that is, processing times are slower toward the beginning of the clause than toward the end of the clause. Comprehension of clauses with specific relations comes about in a final

wrapping-up stage of the comprehension process, that is, processing times are slower toward the end of the clause than toward the beginning of the clause.

To distinguish the three questions in the Specification Hypothesis, we formulate the following hypotheses to be tested in a series of experiments.

I. Cohesion Hypothesis

Clauses containing a grammar-driven cohesion relation are processed faster than clauses without a grammar-driven cohesion relation.

II. Parameterisation Hypothesis

Clauses conjoined by different combinations of the parameters have different processing times between the TYPE-parameters and between the POLARITY-parameters.

IIA. TYPE Hypothesis

CAUSAL cohesion relations are processed faster than TEMPORAL relations, which are processed faster than ADDITIVE relations.

IIB. POLARITY Hypothesis

POSITIVE cohesion relations are processed faster than NEGATIVE relations.

III. Coherence Integration Hypothesis

More specific relations are processed toward the end, less specific relations are processed toward the beginning of the clause. Hence, CAUSAL relations are processed toward the end of a clause, ADDITIVE relations incrementally throughout the clause, with TEMPORAL relations in between. NEGATIVE relations are processed incrementally, POSITIVE relations toward the end of the clause.

A summary of these hypotheses is given in Table 13.

Question	Name of hypothesis	Prediction for reading times
<i>Cohesion Question</i>	<i>Cohesion Hypothesis</i>	cohesion relations < implicit
<i>Parameterisation Question</i>	<i>Parameterisation Hypothesis</i>	TYPE and POLARITY effects
	<i>TYPE Hypothesis</i>	CAUSAL < TEMPORAL < ADDITIVE
	<i>POLARITY Hypothesis</i>	POSITIVE < NEGATIVE
<i>Integration Question</i>	<i>Coherence Integration Hypothesis</i>	<i>beginning of clause:</i> CAUSAL < ADDITIVE POSITIVE < NEGATIVE cohesion relations < implicit <i>end of clause:</i> ADDITIVE < CAUSAL NEGATIVE < POSITIVE implicit < cohesion relations

Table 13 Hypotheses for grammar-driven cohesion relations

These five hypotheses were tested in five experiments. First an eye-tracking experiment was carried out to test the Parameterisation- and the TYPE- and POLARITY-Hypotheses. This was followed by a series of non-cumulative self-paced reading time experiments to also test the other hypotheses.

6.4 EXPERIMENT 1

In this explorative study, an eye-tracking experiment was carried out to test the hypotheses for the Parameterisation Question. Because this method is precise, it is particularly suitable for testing this question. Furthermore, we used a part of a novel for the materials to ensure the material would be natural.

The experiment investigated behavioural evidence for the parameterisation proposed in the previous chapter and the effects on processing for the various parameters. The effects were measured by examining the regression and fixation times for interclausal conjunctions. The experiment investigated the reading process in its

most natural form, that is, with subjects reading a piece of naturally occurring rather than manipulated text.

We predicted to find an effect for both TYPE and POLARITY (Parameterisation Hypothesis), to find a processing advantage for CAUSAL relations over TEMPORAL and TEMPORAL over ADDITIVE relations (TYPE Hypothesis) and to find that POSITIVE relations are processed faster than NEGATIVE relations (POLARITY Hypothesis).

Method

Subjects

Ten subjects taken from the Glasgow University eye tracker list participated in the experiment. All subjects were native speakers of English and had normal (uncorrected) vision. Some subjects had participated in other eye-tracking experiments.

Materials

Subjects read an extract of the novel *An Awfully Big Adventure* by Beryl Bainbridge, drawn from the British National Corpus⁷. This text was also used for the analysis in Chapter 1. Subjects read ten to thirty screens of text, depending on their reading speed. The text contained uppercase and lowercase letters and the paragraph layout was removed. Each screen did not exceed 10 lines in length or 65 characters in width. The end of a screen and beginning of a new screen were separated by sentence and – where possible – paragraph boundaries.

A total of 89 interclausal conjunctions occurred in the material. They were classified in one of the six cohesion and coherence relations POSITIVE CAUSAL, NEGATIVE CAUSAL, POSITIVE TEMPORAL, NEGATIVE TEMPORAL, POSITIVE ADDITIVE, NEGATIVE ADDITIVE. Only conjunctions considered as prototypical for a category were used. The categorisation of conjunctions – based on the definitions of the categories given in Chapter 5 – was checked by an independent judge, who agreed on the classification.

conjunction	TYPE	POLARITY
although	CAUSAL	NEGATIVE
and	ADDITIVE	POSITIVE
because	CAUSAL	POSITIVE
before	TEMPORAL	POSITIVE
besides	ADDITIVE	POSITIVE
but	ADDITIVE	NEGATIVE
for	CAUSAL	POSITIVE
however	ADDITIVE	NEGATIVE
if	CAUSAL	POSITIVE
though	CAUSAL	NEGATIVE
until	TEMPORAL	NEGATIVE
when	TEMPORAL	POSITIVE
whenever	TEMPORAL	POSITIVE

Table 14 Conjunctions in Bainbridge (1989)

Procedure

The eye movements of each subject were recorded using a SRI Dual Purkinje 5.5. eye-tracker. The tracker had an angular resolution of 10'. The tracker monitored only the subjects' right eye's gaze location. The text was presented on a computer screen 70 cm from the subjects' eyes.

The accuracy of the eye tracker was verified before the subject started reading the passage. Each fixation was represented by an x and y screen co-ordinate, a starting time and an ending time. This eye tracker output was converted to gazes on each word. Fixations less than 80 ms where two fixations were within one character space were assimilated to the next fixation. Other very short fixations (less than 40 ms and within three character spaces of the nearest word) were deleted. Fixations on interword spaces were attributed to the right, due to the right centred perceptual span.

Subjects were seated in front of a computer screen and were asked to read naturally and to make sure they understood the text. First, a calibration procedure was carried out. The accuracy of the eye tracker was verified before the subject read each passage. The subject fixated on a number of screen positions. It was then determined

⁷ I am very grateful to Padraic Monaghan, Richard Schillcock and Louise Kelly for allowing me to use these eye movement data.

whether each position was within one character space of the fixation point. If necessary, the eye tracker was realigned.

To initiate the reading of the passage, the reader had to look at a fixation point. This point was located at the position where the first word of the new screen would appear. The position of the gaze was indicated by a small pixel moving across the screen. When the experimenter judged that this pixel was in line with the fixation point, a button was pressed and a screen of text was presented on the monitor. The screen of text was presented on the monitor until the subject pressed a response button indicating he/she had finished reading the screen.

Results

Mean reading times were computed after outliers were removed. Outliers were those reading times exceeding 2.5 SD from the mean. A total of 1.9% of all fixated words was accordingly removed from the analysis. The average fixation time on all words was 247 ms (SD 75.03), with a range from 16 to 551 ms. With 35% of the words not fixated and 24% of the words regressed twice or more, subjects averaged 270 words per minute on the text. Subjects regressed a maximum of 5 times to one word. 21.19% of the first pass fixations were regressed, of these second fixations 17.09% were regressed. These results correspond to the results generally found in other eye-tracking experiments (see Rayner & Pollatsek, 1989).

As not all subjects read all screens, a total of 765 encounters of the conjunctions classified in terms of the parameterisation were used for the analysis. Outliers of the conjunctions were removed from the analysis (2.6% of the data), using the same method as for general fixations. The average fixation time on conjunctions was 253 ms (SD 94.48), with a range from 57 to 789 ms.

Regressions to previously fixated words

Regressions to previously fixated conjunctions show that certain categories of conjunctions require more processing time than others. According to the TYPE- and POLARITY-hypotheses, we would expect that ADDITIVE relations receive more

regressions than TEMPORAL relations, and TEMPORAL more than CAUSAL relations, while POSITIVE require fewer regressions than NEGATIVE relations. Figure 3 shows the percentages of regressions per category (e.g. 7% of all POSITIVE CAUSAL relations is regressed twice or more), indicating that NEGATIVE relations are regressed more than POSITIVE relations ($T=0$, $z = -2.805$, $p = .005$, $N=10$). Furthermore, CAUSAL and TEMPORAL relations received more regressions than ADDITIVE relations ($\chi^2_F = 13.474$, $df = 2$, $p = .001$).

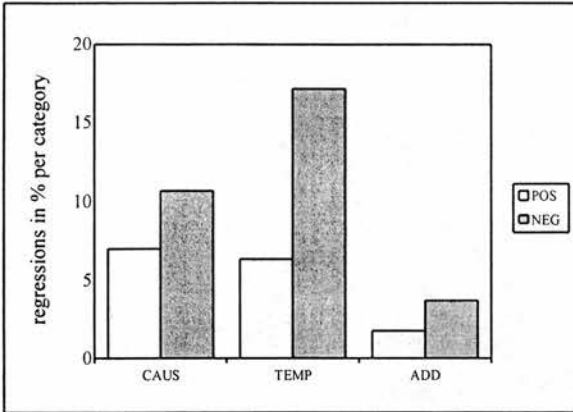


Figure 3 Percentage of words being regressed twice or more

POLARITY	TYPE			Total
	CAUSAL	TEMPORAL	ADDITIVE	
POSITIVE	6.99 (10)	6.33 (19)	1.78 (3)	5.24 (32)
NEGATIVE	10.71 (3)	17.14 (6)	1.70 (3)	8.33 (12)
total	7.60 (13)	7.46 (25)	2.41 (6)	

Note: real numbers in brackets

Table 15 Percentage of words being regressed twice or more

Non-fixations

The number of conjunctions not fixated on by subjects gave another source of information. Differences are not as clear as in the regressions (Figure 4). NEGATIVE relations are skipped less often than POSITIVE relations ($T=0$, $z=-2.536$, $p=.011$, $N=10$). This is evidence for the POLARITY Hypothesis, which predicts that NEGATIVE relations

are harder to process than their POSITIVE counterparts. Although the difference between the three TYPE categories also reached the significance level ($\chi^2_F = 6.741$, $df = 2$, $p = .034$), the differences are not as predicted by the TYPE hypothesis, with TEMPORAL relations being skipped most. However, the cell-sizes differ too much to draw definite conclusions.

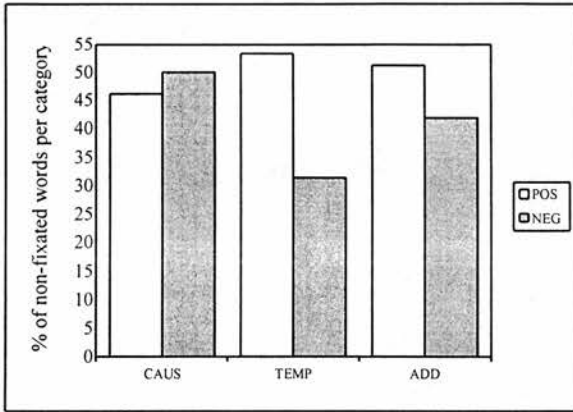


Figure 4 Percentage of non-fixated words

POLARITY	TYPE			total
	CAUSAL	TEMPORAL	ADDITIVE	
POSITIVE	46.15 (66)	53.33 (160)	51.19 (86)	51.06 (312)
NEGATIVE	50.00 (14)	31.43 (11)	41.98 (34)	40.97 (59)
total	46.78 (80)	51.04 (171)	48.19 (120)	

Note: real numbers in brackets

Table 16 Percentage of non-fixated words per category

Fixation times

To analyse the first pass fixation times of the conjunctions, a residual correction was carried out on the unadjusted reading times using the method proposed in Ferreira & Clifton (1986) and Trueswell, Tanenhaus & Garnsey (1994), in order to account for differences in word length, word frequency and the position of the conjunction. The best linear fit between the selected independent variables and the first pass fixation time was calculated for each subject. All linear variance related to these variables was removed by subtracting the predicted fixation time from the actual fixation time. A multiple regression analysis was carried out on the first pass fixation times of the cohesion relations with word

frequency, word length, position on line (beginning or end) and position on screen (beginning or end) as independent variables. Significant effects ($p < .01$) were attributed to word frequency, last position on the line and first position on the screen ($R_2 = .119$, $F(5,345) = 9.327$, $p < 0.01$)⁸. Residuals of the mean of the first pass fixation times (linear variance that cannot be explained by these independent variables) were saved as the dependent variable for further analysis. An analysis of variance was carried out on the reading times with items (conjunctions) as random factors. Because of the heterogeneity of the material, no analysis could be carried out with items as a random factor.

According to the Parameterisation Hypothesis, we expected effects for both TYPE and POLARITY. Effects of the first pass fixations on conjunctions were only found for TYPE ($F(2, 18) = 3.938$, $MS_e = 610.371$, $p = .038$). However, contrary to the TYPE Hypothesis – which predicts that CAUSAL relations are processed fastest and ADDITIVE relations slowest. A planned comparison showed that this effect came from ADDITIVE relations versus CAUSAL and TEMPORAL relations ($F(1, 9) = 6.665$, $MS_e = 442.930$, $p = .013$), with CAUSAL and TEMPORAL relations having the highest fixation times (see Figure 5).

POLARITY	TYPE			Mean
	CAUSAL	TEMPORAL	ADDITIVE	
POSITIVE	8.386 (11.963)	-4.030 (8.511)	-6.687 (12.502)	-.777 (10.597)
NEGATIVE	-2.268 (10.945)	16.785 (16.060)	-21.416 (12.411)	-2.300 (10.248)
Mean	3.059 (7.738)	6.377 (11.751)	-14.052 (11.778)	

Note: Error rates in parentheses; times in milliseconds.

Table 17 Mean residuals of fixation times

⁸ Note that no generalisations can be made about the other variables (e.g. first position on line). First position on line generally does have an effect, but not for the current text with the current conjunctions at various positions.

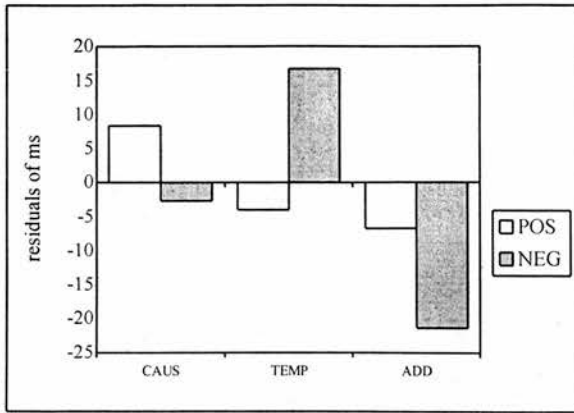


Figure 5 Mean residuals of first pass fixation times

We need to be careful with the above results, as they contain only the fixations on conjunctions. First, the first pass fixation times may need to be seen in the light of second and third pass fixations. It is possible that a subject shortly fixates on a conjunction the first time and spends more time on second (and third) regressions. This would mean that low first pass fixation times may have to be interpreted as high processing load because of subsequent fixations. Second, conjunctions are often not fixated on at all. This would mean that low first pass fixation times may have to be interpreted as high processing load compared to other conjunctions not fixated on.

More importantly, the above analysis of variance is questionable for two reasons. First of all, the analysis was only carried out with subjects as a random factor. In any language experiment particularly an analysis with items as random factors is desirable. However, the heterogeneity of the materials – the text was chosen at random and sentences in which the cohesion relations occurred were not manipulated – does not allow for such an analysis. A second crucial point making these ANOVA-results unreliable is the number of missing cases and the variable number of conjunctions in each cell. Unequal cell sizes alter the analysis in some way. In an ANOVA generally unweighted means are compared, whereas ideally we would like to compare weighted means, in which the sample size for each parameter is taken into account. The unweighted means in Table 17 could thus be replaced by weighted means, in which the frequency of the conjunction is also taken into account in the calculation, like in Figure 6 and Table 18.

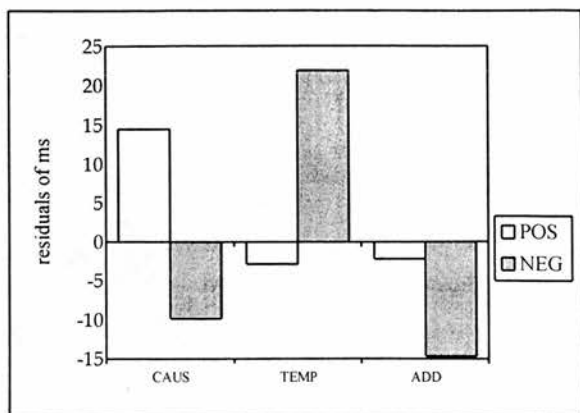


Figure 6 Mean residuals of first pass fixation times (weighted)

POLARITY	TYPE			Mean
	CAUSAL	TEMPORAL	ADDITIVE	
POSITIVE	14.503 (7.009)	-2.863 (3.534)	-2.169 (5.124)	3.157 (5.222)
NEGATIVE	-9.970 (9.561)	21.588 (17.037)	-14.711 (6.337)	-1.031 (10.979)
Mean	2.266 (8.285)	9.362 (10.286)	-8.440 (5.731)	

Note: Error rates in parentheses; times in milliseconds.

Table 18 Mean residuals of fixation times (weighted means)

It can easily be seen that the unweighted means resemble the weighted means. Because of this similarity, and with other statistical tests equally inappropriate for an analysis (an often suggested alternative, a t-test, for instance does not allow for cross-comparisons), we therefore prefer the analysis of variance, treating the results with great caution⁹.

Discussion

We found some evidence for the Parameterisation Hypothesis, with effects for both TYPE and POLARITY parameters. More specifically, as predicted by the POLARITY Hypothesis, POSITIVE relations have a facilitating effect on processing coherence relations. They tend to be regressed less than NEGATIVE relations and they are skipped

⁹ To avoid the problem of unequal cell sizes, we also carried out a more conservative non-parametric test. As with the analysis of variance, a significant difference was found for TYPE relations ($\chi^2_F = 7.800$, $df = 2$, $p = .02$, $N = 10$), while no effect was found for POLARITY.

more often than NEGATIVE relations. However, no significant POLARITY-effect was found for fixation times.

Although TYPE effects were found, the TYPE Hypothesis was falsified: CAUSAL and TEMPORAL relations had higher reading times than ADDITIVE relations. Furthermore, CAUSAL relations also appear to be regressed more often than TEMPORAL or ADDITIVE relations. Both the fixation times and regressions show that CAUSAL and TEMPORAL relations are processed more or less similarly, both requiring more regressions and higher fixation times than ADDITIVE relations. Not only does this falsify the TYPE hypothesis, it also falsifies the Coherence Integration Hypothesis, which predicts that less specific cohesion relations require more processing time than specific relations, particularly at the beginning of the clause. A possible explanation is that many ADDITIVE relations in the text are marked by the conjunctions *and* and *but*. It may be the case that processing time for these frequent conjunctions is less than for any other conjunction, thus explaining the lower number of regression and lower fixation times.

However, we need to be careful with drawing these conclusions, as the data only comes from conjunctions. Further general evidence for these hypotheses needs to come from words after the conjunctions. The main conclusion that can be drawn from this study is that evidence is found for the Parameterisation Hypothesis. More in particular, we did find some evidence for the POLARITY Hypothesis, but not for the TYPE Hypothesis. Because of unknown processing effects (comprehenders quickly read the first conjunction and spend more time on regressions), missing values (comprehenders construct grammar-driven cohesion on the basis of vocabulary-driven cohesion) and unequal numbers per conjunction (some conjunctions occur more frequently than others) these conclusions need to be treated with caution. What is needed are carefully controlled experiments, which we will discuss next.

6.5 COHESION AND COHERENCE EXPERIMENTS

In the following sections we report a series of related experiments that tested all five hypotheses: the Cohesion-, Parameterisation-, TYPE-, POLARITY- and Coherence Integration Hypothesis. In a data collection for the subsequent reading time experiments, a corpus of three-clause texts was collected and tested on their naturalness when the second

and third clause were conjoined by one of the six cohesion relations. All texts were identical among the six conditions and were reasonably natural in these conditions. The texts considered most natural by subjects were selected for the reading time experiments. All four experiments were self-paced non-cumulative experiments, in which the reading times of three-clause texts were tested. The cohesion/coherence relation occurred between the second and third clause; hence the sentence structure was of the type main + subordinate clause.

There are four reasons to use a method like this. The discussion of the literature on grammar-driven cohesion relations showed us some problematic issues, which our experiments try to eliminate.

1. It seems that discontinuation studies like Murray (1997) give results that are opposed to those of other studies. If we want to look at cohesion and coherence, we cannot draw conclusions from the disruption of cohesion or coherence, but have to look at their presence.
2. In the discussion we have seen in both the Cohesion Question and the Parameterisation Question how the position in the comprehension process influences the effects. Similarly, an answer to the Integration Question depends on the cohesion/coherence relations that are used. In other words, we need to test all parameters, at different points in the comprehension process, to provide an unequivocal answer to the three questions.
3. Deaton & Gernsbacher's study showed an anticipation effect. Comprehenders are soon aware of the coherence relation they can expect and process succeeding texts accordingly. This means that a within-subjects design or – better – Latin Square design is preferred over a between-subjects design to overcome any order effects.
4. In Caron et al. (1988) and Deaton & Gernsbacher (in press), we noted that the materials might be biased. Sanders & Noordman (2000) overcame this problem by using identical texts and different target sentences, but again the question could be asked to what extent text length affects different cohesion and coherence relations. Most importantly, we can conclude that materials need to be pre-tested. Furthermore, it may be desirable to use identical materials and only change the cohesion relation.

We have overcome these problems by carrying out Latin-Square designed self-paced non-cumulative experiments using three-clause texts whose second and third clause can be conjoined by any combination of the parameters.

6.6 DATA COLLECTION

The aim of the data collection was primarily to collect a number of texts that were generally considered natural in each of the conditions POSITIVE CAUSAL, NEGATIVE CAUSAL, POSITIVE TEMPORAL, NEGATIVE TEMPORAL, POSITIVE ADDITIVE and NEGATIVE ADDITIVE.

Method

Subjects

48 Undergraduate students from the Faculty of Arts of the University of Edinburgh participated in this experiment on a voluntary basis or to fulfil their course requirement. They received refreshments for participation. All subjects were native speakers of English.

Materials

The materials consisted of 86 three-line texts. The second and third clause of each text was conjoined by either a POSITIVE CAUSAL, NEGATIVE CAUSAL, POSITIVE TEMPORAL, NEGATIVE TEMPORAL, POSITIVE ADDITIVE, or NEGATIVE ADDITIVE relation. The choice of the conjunctions was determined by commonness of the word in daily use and non-ambiguity of the word, i.e., the conjunction should minimally interfere with other coherence relations. Taking into account these two conditions, the following conjunctions were selected as representative for each of the categories:

	CAUSAL	TEMPORAL	ADDITIVE
POSITIVE	<i>because</i>	<i>Later</i>	<i>What's more</i>
NEGATIVE	<i>although</i>	<i>until</i>	<i>However</i>

Table 19 Conjunctions used in data collection

The materials were constructed in such a way that very long and uncommon words were avoided. Although the Latin Square design we used would control for these confounds, it was argued that they would make general processing more difficult, eventually resulting in unwanted carry-over effects into other texts. Furthermore, many different scenarios were used, so that the subject could not anticipate a relation based on the previous scenario.

The following text is an example of the texts used in this experiment where *[conjunction]* is a placeholder for each of the six conjunctions.

(19)

- (a) My neighbour played saxophone
- (b) I didn't like it
- (c) *[conjunction]* he practised every day

The interpretation of text (19) with each of the conjunctions is thus as follows:

POSITIVE CAUSAL: *because*

My neighbour played saxophone every day. His daily practice annoyed me.

NEGATIVE CAUSAL: *although*

Despite his daily practice, my neighbour's saxophone playing annoyed me.

POSITIVE TEMPORAL: *Later*

I did not like the saxophone playing of my neighbour at time *t*. At time $>t$ he practised every day.

NEGATIVE TEMPORAL: *until*

I did not like the saxophone playing of my neighbour at time *t*. But at time $>t$ he practised every day and from that moment on I appreciated it.

POSITIVE ADDITIVE: *What's more*

I did not like the saxophone playing of my neighbour. To make things worse, he also practised every day.

NEGATIVE ADDITIVE *However*

I did not like the saxophone playing of my neighbour, but at least he practised every day.

Each clause in the text contained an average of seven words, with an average of five characters per word. Eight fillers were used. They were constructed so that they would not be considered natural in any of the conditions. As all texts were constructed with the intention of natural interpretations in all conditions, these fillers were needed to ensure occurrences of sentences that would definitely be interpreted as unnatural.

Two independent judges helped to adjust grammaticality and plausibility. Examples of the text are given in Appendix III.

A Latin-Square design was used to allow each item to be judged in each cohesion and coherence relation by a different group, while each group encountered all conjunctions with equal frequency. The order of the texts was carefully randomised.

Procedure

Subjects reported their age, sex, degree registered for, hometown and place where they had spent most of their childhood. They were then asked to show how naturally the third line of a three-line paragraph went with the previous two lines by circling one option on a seven- point scale. They were asked to follow their initial reaction as there were no wrong answers. Although there was no time constraint, they were encouraged to proceed without backtracking. Two examples were given, followed by two practice texts.

Results and discussion

The main aim of the data collection experiment was to select those texts that were considered natural in all six conditions. A prerequisite for the selection was an agreement among subjects. All agreement scores among raters were significant at a .001-level, which

shows that all texts were indeed natural. The actual scores show that clauses conjoined by CAUSAL relations are generally considered more natural than TEMPORAL or ADDITIVE relations. This can be seen in Table 20 and particularly in Table 21.

	CAUSAL	TEMPORAL	ADDITIVE
POSITIVE	5 (2-7)	4 (2-6)	4 (1-6)
NEGATIVE	5 (1-7)	5 (2-7)	4 (1-6)

Table 20 Scores in data collection experiment (median and range per category)

It may in fact be illustrative to look at the agreement difference, as presented in Table 21 and Figure 7. According to the TYPE Hypothesis, processing CAUSAL relations is easiest, processing ADDITIVE relations hardest, with TEMPORAL relations in between. This pattern can also be found in the agreement scores: comprehenders agree most on the naturalness of CAUSAL relations and least on the naturalness of ADDITIVE relations. For the POLARITY parameters this is even stronger, with more agreement on POSITIVE than on NEGATIVE relations, as predicted by the POLARITY Hypothesis.

Coherence Relation	Kendall's W ($p < .0001$)
POSITIVE CAUSAL	.128
POSITIVE TEMPORAL	.115
POSITIVE ADDITIVE	.112
NEGATIVE CAUSAL	.080
NEGATIVE TEMPORAL	.068
NEGATIVE ADDITIVE	.072

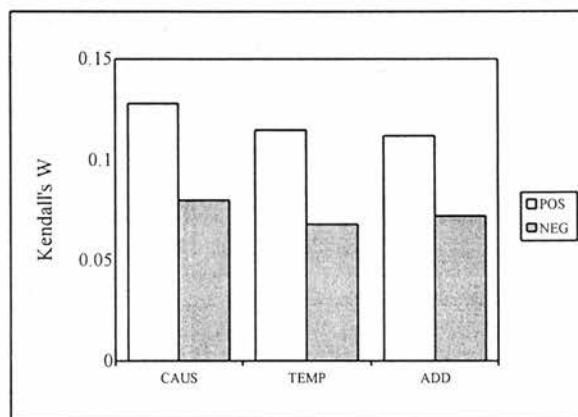


Table 21 Agreement on Coherence Relations

Figure 7 Agreement on Coherence Relations

6.7 EXPERIMENT 2

To test the Cohesion Hypothesis, which states that the presence of cohesion markers in texts facilitates the comprehension process, we carried out a self-paced reading time

experiment with the texts selected for high agreement in the data collection exercise. Furthermore, we tested the Coherence Integration Hypothesis. One group of subjects read the texts with the conjunctions we used in the data collection exercise (explicit condition), the other group read the texts without the conjunctions (implicit condition).¹⁰

Method

Subjects

24 Students from the University of Edinburgh participated in this experiment. They either fulfilled their course requirement or received £2,- for participation. All subjects were native speakers of English and had normal or corrected-to-normal vision.

Materials

36 Texts that were considered most natural in all six conditions of the data collection exercise were selected (see Appendix III). However, one group of subjects saw the texts with the conjunctions and the other group saw the texts without the conjunctions. Clauses were either followed by a question, or by a series of randomly ordered conjunctions, to ensure the subject had read and understood the clauses. In the explicit-condition, the following conjunctions were used between the second and the third clause (Table 22). In the implicit-condition subjects could choose from this set of conjunctions, to express which coherence relation they had used in processing the third clause.

	CAUSAL	TEMPORAL	ADDITIVE
POSITIVE	<i>because</i>	<i>Later</i>	<i>What's more</i>
NEGATIVE	<i>although</i>	<i>until</i>	<i>However</i>

Table 22 Conjunctions used in the third reading time experiment

¹⁰ Earlier in this chapter we argued that a between-subjects design needs to be avoided, as subjects might anticipate the expected relations (see Deaton & Gernsbacher, in press). However, in this experiment relations cannot be anticipated: in the explicit-condition various conjunctions are used, in the implicit condition the subject can choose from several options.

Procedure

The experiment was carried out on Apple Macintosh computers running the *PsyScope* package (Cohen, MacWhinney, Flatt & Provost, 1993). Reading times were measured by a standard Carnegie Mellon button box.

Subjects were seated in front of a computer screen in separate booths. First, subjects were asked to fill out some personal details: town and country of residence, town and country where they had spent most of their childhood, language of community between the age 1-10. These questions were to ensure that the subject was a native speaker of English. Subjects were told to use a button press to make each new word appear. In the explicit condition, the button press after the last word of the third line brought up a question about the text that subjects had just read. To answer the question subjects had to press a 'yes' or 'no' button. In the implicit condition, subjects were asked to choose whichever conjunction they had supplied in processing the text. Conjunctions were given in a random order. In both the explicit and implicit conditions the time to read through the text was, but the time to respond was not recorded. The experiment began with 3 practice texts followed by 36 experimental texts. After the practice texts and after 12 experimental texts there was a short break. A Latin Square design was used to eliminate any confounding effects from the items or subjects.

Results

For the explicit-condition, only those texts were used whose questions were correctly answered by subjects. For both conditions outliers (2.5 SD from the mean) were removed and replaced by the mean. To ensure equal cell sizes, it was decided not to classify the data into the categories of the coherence relations in the implicit-condition, but to solely look at the presence or the absence of the conjunction.

Two analyses of variance were carried out on the reading times for clauses and words within the third clause, with subjects (F_1) and texts (F_2) as random factors respectively.

Contrary to what was expected by the Cohesion Hypothesis, which predicted a processing advantage for clauses with cohesion relations, no effects were found for the

differences between the implicit and explicit condition in total reading time for the third clause.

Analyses were then run for the first, second and final word of the third (post-conjunction) clause, as only these could be found in all texts. To facilitate the comparison, we compared the first word after the conjunction in the explicit condition with the first word clause in the implicit condition. The first word of the clause showed a processing benefit for the explicit condition ($F_1(1, 46) = 19.061, MS_e = 13103.904, p < .0001; F_2(1, 70) = 92.125, MS_e = 4066.785, p < .0001$). This processing advantage disappeared for the reading times of the second word of the clause with no effects for explicitness. No effect was found for the last word of the clause. As in the discussion of the literature, here too we see that the Cohesion Question is related to the Integration Question. Because of the different words in a clause, word position cannot be considered as an effect. However, the interaction between position and the presence of cohesion relations can. As predicted by a combination of the Cohesion- and the Coherence Integration Hypotheses, this interaction showed a significant effect ($F_1(1.883, 86.633) = 70.049, MS_e = 9112.643, p < .0001; F_2(2.148) = 244.972, MS_e = 3001.233, p < .0001$). This means that whereas there is a processing advantage for cohesion in the beginning of the clause, this disappears toward the end of the clause. For clauses with a cohesion relation, processing lies toward the end of the clause.

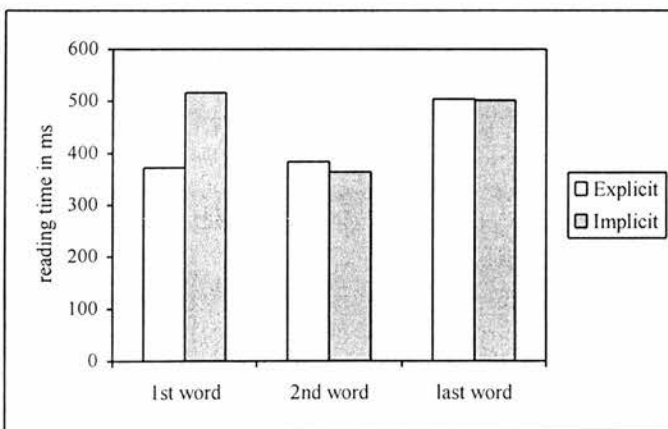


Figure 8 Explicit versus implicit in third clause

Discussion

In the discussion of the grammar-driven cohesion studies, we concluded that there was strong evidence that implicit coherence relations require more processing time than explicit coherence relations (Caron et al., 1988; Millis & Just, 1994). In this experiment we did not find conclusive evidence for this claim. Only at the beginning of the clause evidence was found for the Cohesion Hypothesis. Toward the end of the third clause no effect was found. This suggests that the answer to the Cohesion Question is related to the Integration Question. The Coherence Integration Hypothesis predicted that clauses without cohesion markers require more processing time toward the beginning of the third clause, while clauses with cohesion relations require more time toward the end of the third clause. This was exactly what the interaction of position and explicitness showed. Answering whether cohesion facilitates the comprehension process hence depends on the position in the clause: the Cohesion Hypothesis is dependent on the Coherence Integration Hypothesis. Similarly, the answer to the Integration Question depends on the cohesion relations in the text: the Integration Hypotheses are dependent on the Cohesion hypothesis. Whether they are also dependent on the Parameterisation Hypotheses will be investigated next.

6.8 EXPERIMENT 3

In the previous experiment we investigated the Cohesion Question and the Integration Question. In this experiment, we will turn to the Parameterisation Question.

In the eye tracking experiment we falsified the TYPE Hypothesis, which predicted that CAUSAL relations require less processing time than TEMPORAL relations, which require less processing time than ADDITIVE relations. We did find some evidence for the POLARITY Hypothesis, which predicts that POSITIVE relations need less processing time than NEGATIVE relations. However, we pointed out that there are some serious limitations in the eye movement study. In this study we therefore reconsider evidence for the Parameterisation-, TYPE-, POLARITY- and Coherence Integration Hypothesis.

Method

Subjects

48 students from the University of Edinburgh participated in this experiment. Half of them participated on either a voluntary basis or for course credit. The other half were paid £2,- for their participation. The three groups were divided equally over the conditions in the experiment. All subjects were native speakers of English and had normal or corrected-to-normal vision.

Materials and Procedure

The same materials were used as the ones in the explicit-condition of the previous experiment. Subjects read a total of 36 experimental texts distributed over the six conditions. The non-cumulative self-paced reading method was identical to the one in the previous experiment.

Results

Like in the previous experiment, the data was first filtered by removing wrong answers to questions – which were again equally distributed over all conditions, all text and all subjects – and outliers (values above or below 2.5 SD from the mean). Less than 3% of the data was accordingly removed. Missing values occurring because of the elimination of wrong answers and outliers were replaced by the mean values for each of the six cells of the filtered data.

As expected no effects were found for the reading times of the first and second clause (all $F_s > .1$). Contrary to what was predicted by the Parameterisation Hypothesis, no effects were found for the total reading time of the third clause.

For the word-by-word analyses, a series of ANOVAs were carried out on the reading times for the words of the third clause. First, to allow for a comparison between conjunctions, a multiple regression was carried out on the residuals of reading times on the conjunction, by using the independent variables word length and frequency ($R_2 = .027$, $F(2, 2301) = 7.245$, $p = .001$), following the method proposed in Ferreira & Clifton (1986) and Trueswell, Tanenhaus & Garnsey (1994). No effects were found for the

reading time on the conjunction. Analyses were then run for the first, second and final words of the third (post-conjunction) clause, as only these could be found in all texts.

The reading times for the first word showed a marginally significant effect for TYPE ($F_1 (2, 94) = 6.60$, $MS_e = 754.89$, $p = .002$; $F_2 (2, 70) = 2.96$, $MS_e = 1260.85$, $p = .058$), showing only an effect for ADDITIVE relations in the planned comparison ($F_1 (1, 47) = 8.515$, $MS_e = 924.220$, $p = .005$; $F_2 (1, 35) = 5.45$, $MS_e = 1082.516$, $p = .025$) (Mean CAUSAL = 352 (5.315), TEMPORAL = 352 (5.050), ADDITIVE = 365 (5.817)).

The reading times of the second word showed a similar pattern, but now with a marginal significant effect for TYPE ($F_1 (2, 94)$, $MS_e = 1389.671$, $p = .034$; $F_2 (2, 70) = 2.75$, $MS_e = 1329.95$, $p = .071$) and a significant effect for POLARITY ($F_1 (1, 47) = 4.64$, $MS_e = 1977.73$, $p = .036$; $F_2 (1, 35) = 6.21$, $MS_e = 1107.06$, $p = .018$) with an interaction effect, significant for the by-subjects only ($F_1 (2, 94) = 3.79$, $MS_e = 1260.753$, $p = .026$; $F_2 (2, 70) = 2.55$, $MS_e = 1406.76$, $p = .086$)).

The final word of the third clause showed an effect for TYPE ($F_1 (2, 94) = 6.17$, $MS_e = 2847.01$, $p = .003$; $F_2 (2, 70) = 3.79$, $MS_e = 3480.13$, $p = .027$), for POLARITY ($F_1 (1, 47) = 12.93$, $MS_e = 2452.44$, $p = .001$; $F_2 (1, 35) = 7.47$, $MS_e = 3184.11$, $p = .01$), and for the interaction between TYPE and POLARITY ($F_1 (2, 94) = 3.10$, $MS_e = 2935.82$, $p = .05$; $F_2 (2, 70) = 3.13$, $MS_e = 2183.82$, $p = .05$). A planned comparison showed that effects mainly lay between CAUSAL and TEMPORAL ($F_1 (1, 47) = 11.76$, $MS_e = 2959.83$, $p = .001$; $F_2 (1, 35) = 6.70$, $MS_e = 3897.61$, $p = .014$). Effects for TEMPORAL and ADDITIVE were only significant in the by-subjects analysis ($F_1 (1, 47) = 5.19$, $MS_e = 2301.18$, $p = .027$; $F_2 (1, 35) = 3.14$, $MS_e = 8951.83$, $p = .085$).

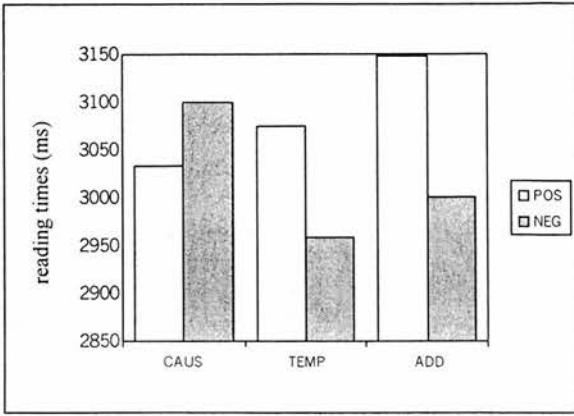


Figure 9 Total RT 3rd clause

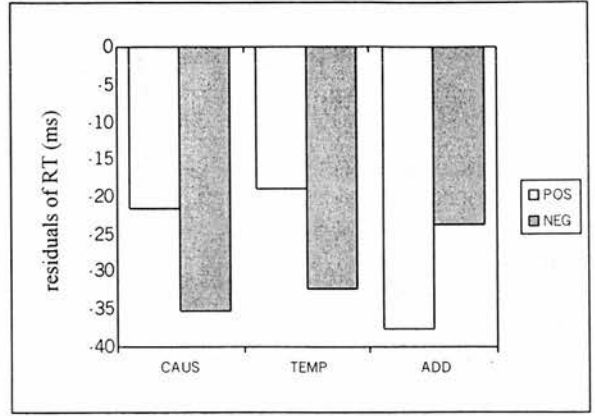


Figure 10 RT conjunctions

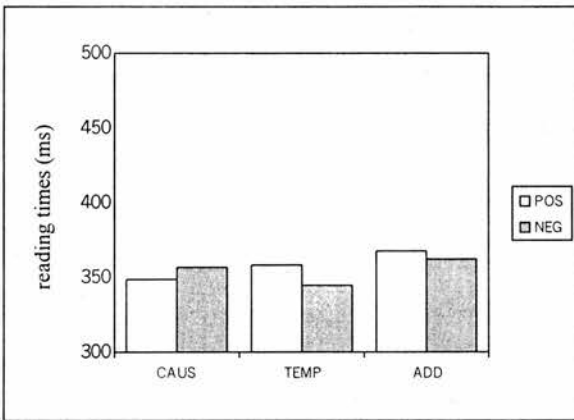


Figure 11 RT 1st word after conjunction

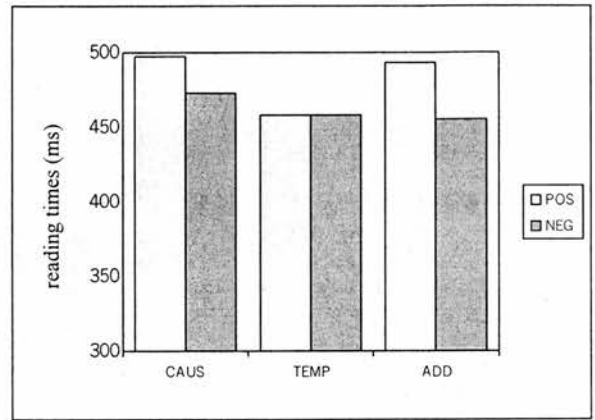


Figure 12 RT final word of 3rd clause

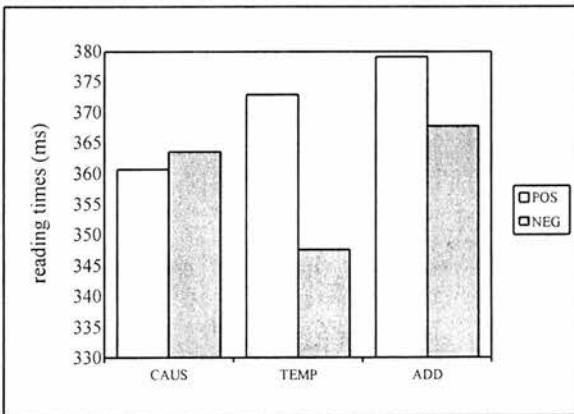


Figure 13 RT 2nd word after conjunction

To test the Coherence Integration Hypothesis, we compared the first word after the conjunction with the final word of the third clause. An ANOVA was carried out in which position, TYPE and POLARITY were entered. Obviously, a position effect can be expected as the first word after the conjunction is different from the last word of the third clause (in word length, frequency, semantics, syntax, etc.). However, an interaction effect can test whether there is a difference between the parameters in the reading time of the first part of the third clause and of the last part. The results show an effect for the interaction between position and TYPE ($F_1(2, 94) = 6.56, MS_e = 1610.146, p = .003; F_2(2, 70) = 4.396, MS_e = 1691.114, p = .016$); the interaction between position and POLARITY ($F_1(1, 47) = 7.311, MS_e = 1443.906, p = .01; F_2(1, 35) = 4.849, MS_e = 1632.857, p = .034$) and the interaction between position, TYPE and POLARITY ($F_1(2, 94) = 4.824, MS_e = 1800.780, p = .01; F_2(2, 70) = 5.922, MS_e = 1100.036, p = .004$). Where CAUSAL relations are processed fastest at the beginning of the third clause, they were processed slowest toward the end. Whereas no difference was found between the POLARITY parameters at the beginning of the third clause, there was a difference toward the end of the third clause. This was predicted by the Coherence Integration Hypothesis.

Discussion

The results of the first reading time experiment were not as strong as we had expected. The total reading time of the third clause did for instance not show any significant effect. In the word-by-word analysis an effect for the reading time on the conjunction was not found either. But the reading times of the words after the conjunctions did show some interesting results. The first word after the conjunction showed that ADDITIVE relations had the highest reading times and CAUSAL relations the lowest reading times, with TEMPORAL relations in between. The same pattern was found for the second word after the conjunction, CAUSAL relations being processed fastest. At the final word of the third clause, however, this pattern was reversed. This is what was predicted by the Coherence Integration Hypothesis: less specific relations are processed incrementally, specific relations toward the end of the third clause. Similar conclusions can be drawn for POLARITY relations. The difference did not reach the significance level at the beginning of the third clause, but becomes significant at the end of it.

In the next experiment, we examined the effects of the same cohesion and coherence relations on the reading times of subjects who are not native speakers of English.

6.9 EXPERIMENT 4

This experiment was a replication of the previous experiment, but using non-native speakers of English. If the effects for cohesion and coherence relations are strong, and cognitive rather than linguistic, similar effects would be found for non-native speakers of English, regardless of their background or fluency.

Method

Subjects

Eighteen subjects were used in this experiment, three subjects for each condition. Subjects were students from the Faculty of Arts of the University of Edinburgh and participated as volunteers (unpaid, no course credit). Subjects were natives from Basque Country, Denmark, Germany, Greece, Hungary, Italy, Japan, Korea, the Netherlands, Spain and Zimbabwe. They had spent a minimum of two years and a maximum of four years in Britain. Subjects were randomly assigned to the six conditions.

Materials and procedure

The same materials and procedure were used as in the previous experiment.

Results

Only those texts were selected for which subjects gave the right answers to the questions. Again, for each of the analyses outliers (2.5 SD from the mean) were removed and replaced by the mean for each cell.

No effects were found for TYPE or POLARITY in the first two clauses. Unexpectedly, no effects were found for the total reading time of the third clause either. Again, analyses were run for the first, second and final word of the third clause.

As in the previous experiment two variables – for the analysis of the reading times of the conjunctions, length and frequency – were entered in a regression analysis ($R_2 = .018, F(2, 645) = 6.030, p = .003$) and the residuals were used for further analysis. An ANOVA on the residuals of the reading times of the conjunctions showed a significant effect for POLARITY only ($F_1(1, 17) = 12.988, MS_e = 20213.654, p = .002; F_2(1, 35) = 30.424, MS_e = 17259.202, p < .001$), with POSITIVE relations being processed faster than NEGATIVE relations. Neither the first and second word after the conjunction, nor the final word of the third clause showed a significant effect for either TYPE or POLARITY.

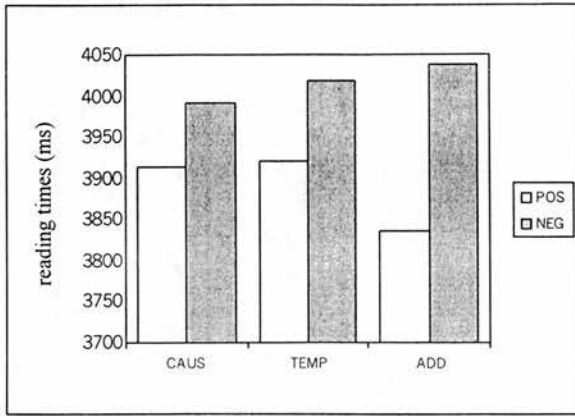


Figure 14 RT 3rd clause

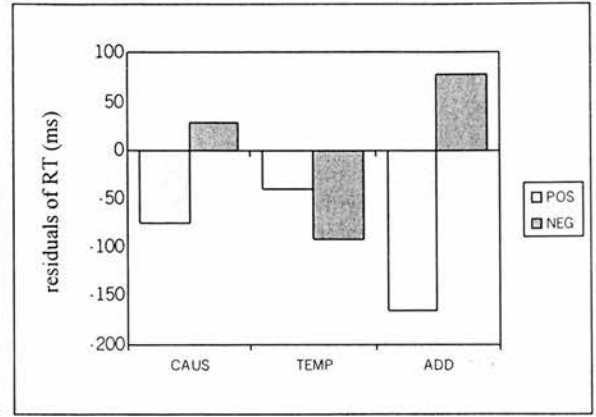


Figure 15 Reading time of conjunction

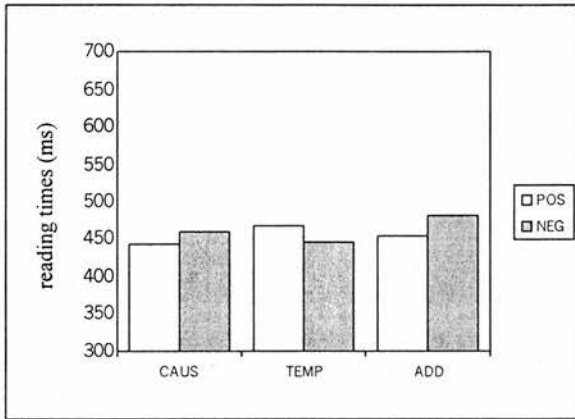


Figure 16 RT 1st word after conjunction

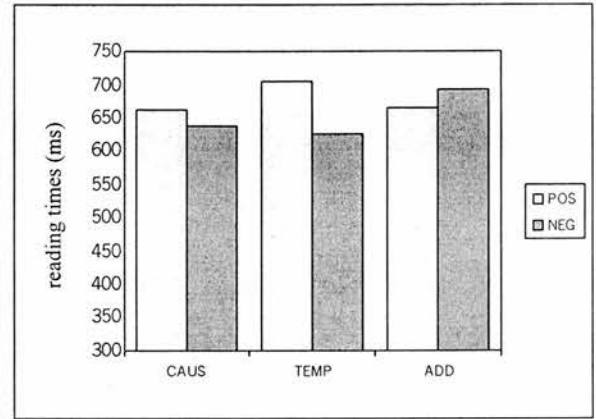


Figure 17 RT final word of 3rd clause

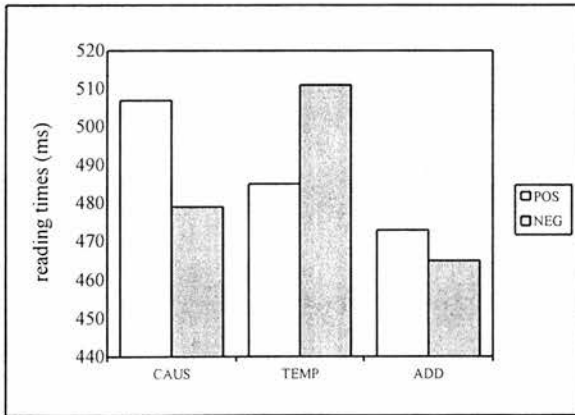


Figure 18 RT 2nd word after conjunction

As in the previous experiment, we next compared the difference between the reading time for the beginning of the third clause (first word after the conjunction) and the reading time for the end of the third clause (last word of the third clause). As before, a comparison between the reading times for the first and last word would probably give different reading times, simply because different words are read. However, in interaction effects between the position and TYPE and POLARITY, the effect due to word differences is filtered out. An interaction effect was found for POLARITY ($F_1(1, 17) = 7.498, MS_e = 206230.851, p = .014$; $F_2(1, 35) = 23.315, MS_e = 412461.702, p < .0001$), but not for TYPE. With POSITIVE relations being processed faster than NEGATIVE relations in the beginning, but not toward the end of the third clause, this supports the Coherence Integration Hypothesis.

Discussion

The reading times for non-native speakers of English showed less support for the hypotheses than those for the native speakers of English. Only the reading time of the conjunction showed support for the POLARITY hypothesis, with POSITIVE relations being processed faster than NEGATIVE relations. This is also what is predicted by the Coherence Integration Hypothesis. Further evidence for this hypothesis comes from the interaction of position and POLARITY in the reading times between the first and the final part of the third clause.

The results found in this experiment do not provide strong evidence for the hypotheses. The explanation is that we used a very small number of subjects, who also came from a variety of countries. It could be argued that, homogeneity in the country of origin would provide more evidence for the effects that were found. Also, subjects lived in Britain for a few years and were constantly exposed to the English language. Whether the results would also have been found for non-native speakers of English who do not live in an English speaking country remains to be seen.

More problematic in this and the previous experiment is that they are hampered by the confound due to the length of one conjunction: the POSITIVE ADDITIVE *What's more*. As this meant two button presses for this conjunction, these results might be unreliable. This problem is solved in the next experiment.

6.10 EXPERIMENT 5

In this experiment we used the same categories as in the previous experiment but replaced *What's more* with the one-word conjunction *Moreover* in the POSITIVE ADDITIVE category. Because the POSITIVE TEMPORAL conjunction *Later* introduces a new sentence, which makes a comparison with NEGATIVE TEMPORAL and CAUSAL relations problematic, we also replaced this conjunction by *before*. Furthermore, we added the conjunctions *and* and *but*. Contrary to what was predicted by the TYPE hypothesis, we found that in the eye movement experiment ADDITIVE relations were processed fastest. We suggested that this result may have been caused by the experimental design. These – what we call – AMBIGUOUS categories – a coherence relation for clauses conjoined by *and* and *but* can easily be CAUSAL, TEMPORAL or ADDITIVE – are least specific. We therefore predict that they are processed incrementally, with highest processing times at the beginning of the third clause.

Furthermore, to increase the power of the analysis we used a larger number of subjects in the experiment.

Method

Subjects

Seventy-two students from the University of Edinburgh participated in this experiment. Half of them participated on either a voluntary basis or for course credit. The other half were paid £2,- for their participation. The three groups were divided equally over the conditions in the experiment. All subjects were native speakers of English and had normal or corrected-to-normal vision.

Materials

Initially, we had designed the experiment to test conjunctions for each of the categories. We now used different conjunctions for the relations, as presented in Table 23.

The last word of the third clause showed an effect for TYPE ($F_1(3, 213)$, $MS_e = 5599.03$, $p = .016$; $F_2(3, 93) = 2.95$, $MS_e = 2951.341$, $p = .037$), with CAUSAL relations being processed more slowly than TEMPORAL, which were processed more slowly than ADDITIVE and AMBIGUOUS relations. An effect was also found between POSITIVE and NEGATIVE CAUSAL relations ($F_1(1, 71) = 4.07$, $MS_e = 8943.20$, $p = .047$; $F_2(1, 71) = 4.13$, $MS_e = 3923.41$, $p = .051$), with POSITIVE relations being processed more slowly than NEGATIVE relations. Again, this is in the line of what is predicted by the Coherence Integration Hypothesis.

This means that those cohesion relations that are less specific, and hence cohesion-based, require an incremental reading process throughout the clause. Those relations that are more specific, and hence coherence-based, require a processing load toward the end of the third clause in a wrapping-up stage.

what, where, why, when, and which of the events and can locally and globally be divided both in vocabulary-driven and grammar-driven relations.

After the introduction of these key concepts, we formulated two research questions:

To what extent is each of the types of cohesion independent of the others in its effects on the comprehender?

Does coherence develop (on-line) throughout the comprehension process, does it come about (off-line) in a final wrapping-up stage of the comprehension process, or both?

We proposed to answer these questions in five steps

1. How does text comprehension come about? What levels and processes can be distinguished?
2. What representational system is best to be used in describing the rich structure textual understanding is associated with?
3. To what extent is each of the cohesion strands independent of the others in its effects on the comprehender?
4. What basic categories of grammar-driven cohesion/coherence relations should be distinguished?
5. Does coherence develop (on-line) throughout the comprehension process, does it come about (off-line) in a final wrapping-up stage of the comprehension process or both?

In the second chapter we answered the first question by describing several leading models of text comprehension and combining them with memory models in order to introduce a working model for this research. We showed how Gernsbacher's (1990) Structure Building Framework, Zwaan & Radvansky's (1998) Event Indexing Model, Van den Broek et al.'s (1999) Landscape Model and Kintsch's (1998) Construction Integration Model can be brought together. The resulting blueprint of text comprehension makes a distinction between processes that direct resources toward cohesion-based information and processes that direct resources toward coherence-based

information. On the basis of the cohesion-based and coherence-based distinction, we formulated the main hypothesis, related to the two main questions of this thesis.

Specification Hypothesis

Cohesion-relations that are less specific than others direct the comprehenders' resources toward cohesion-based information, while those relations that are more specific direct the comprehenders' resources toward coherence-based information.

In order to test this hypothesis, an underlying question concerning the textual representation and the mental representation of the events described by the text needed to be answered first. Outlining some general problems in the literature on mental representations, we argued that a formal representation into situations (eventualities and participant roles) would be favourable over those representations generally used in psycholinguistics. The use of situations showed that specific situations entail less specific situations. For instance CAUSAL strands are more specific than TEMPORAL strands, and the latter more specific than ADDITIVE strands, and hence CAUSAL strands entail TEMPORAL and ADDITIVE strands, while TEMPORAL strands entail ADDITIVE strands. Parsing a clause into situations makes it possible to clearly determine the links between situations, something that is necessary for the computational method we use in answering the question on how vocabulary-driven cohesion relations influence coherence.

This question was answered in the fourth chapter. We looked at three questions: the Cohesion Question concerning the effect of vocabulary-driven cohesion relations on comprehension, the Interdependency Question concerning independent and interdependent effects of these relations on comprehension, and the Multiple Strands Question concerning the effect of interdependent relations on comprehension. A range of studies has answered the Cohesion Question. They show how vocabulary-driven REFERENTIAL, LOCATIONAL, TEMPORAL and CAUSAL cohesion facilitates the comprehension process. REFERENTIAL continuity decreases reading times (Haviland & Clark, 1974; Gernsbacher & Robertson, in press) and improves immediate recall (Yekovich & Walker, 1978). Similarly, TEMPORAL continuity decreases reading times (Zwaan, 1996), whereas TEMPORAL discontinuity increases reading times (Anderson,

none has addressed the effect of multiple cohesion relations while controlling for all confounds. This is what we attempted to do in Chapters 5 and 6. Before we tested on-line the effects of REFERENTIAL, LOCATIONAL, CAUSAL, TEMPORAL and ADDITIVE grammar-driven cohesion relations on coherence, a parameterisation of cohesion and coherence relations was introduced. Although all five relations could be grammar-driven, we focussed on those relations that are most often marked by conjunctions: ADDITIVE, TEMPORAL and CAUSAL relations. The parameterisation was constructed on the basis of the shared categories by a series of leading taxonomies of cohesion and coherence relations. Rather than assuming that grammar-driven cohesion relations are processed independently – each conjunction separately – we assumed that they are processed in combinations of the categories TYPE, POLARITY and DIRECTION. The type category was divided into CAUSAL, TEMPORAL and ADDITIVE relations, that resulted from combinations of the setting of the parameters [+/-CAUSAL, +/-TEMPORAL and +ADDITIVE]. The POLARITY category consisted of POSITIVE and NEGATIVE relations (setting of the parameter [+/-POSITIVE]) and the DIRECTION category of FORWARD, BACKWARD and BI-DIRECTIONAL relations (setting of the parameter [+/-FORWARD]). We provided theoretical linguistic evidence for these categories.

Due to the different character of the DIRECTION category compared to the other two categories, we decided to focus on the TYPE and POLARITY categories to answer the question on the effect of grammar-driven cohesion on coherence. In an eye movement experiment and five reading time experiments we investigated processing time of grammar-driven cohesion relations by testing the Specification Hypothesis. We predicted that less specific relations are processed incrementally throughout the comprehension process, whereas more specific relations are processed in a wrapping-up stage toward the end of the clause. Hence we predicted CAUSAL relations to be processed faster than ADDITIVE relations toward the beginning but not toward the end of the clause, and ADDITIVE relations faster than CAUSAL relations toward the end of the clause but not toward the beginning, with TEMPORAL relations in between.

Contrary to our predictions, the eye movement experiment showed that the number of regressions and the fixation times were higher for CAUSAL and TEMPORAL relations than for ADDITIVE relations. However, the results turned out to be less reliable than we had hoped because of unequal cell sizes. We therefore carried out a series of controlled experiments. For these experiments we first selected a series of texts from a large

number that readers would consider natural in six conditions, with a marker from a POSITIVE CAUSAL (e.g. *because*), NEGATIVE CAUSAL (e.g. *although*), POSITIVE TEMPORAL (e.g. *before*), NEGATIVE TEMPORAL (e.g. *until*), POSITIVE ADDITIVE (e.g. *moreover*) and NEGATIVE ADDITIVE relation (e.g. *however*). The selected texts were used in non-cumulative self-paced reading time experiments. The main evidence found in these experiments was the support for the Specification Hypothesis. CAUSAL relations were processed faster than ADDITIVE relations in the beginning of the clause, whereas ADDITIVE relations were processed faster than CAUSAL relations toward the end of the clause. Also, no difference between POSITIVE and NEGATIVE relations was found at the beginning of the clause, while, as expected, NEGATIVE relations were processed faster than POSITIVE relations toward the end of the clause. This suggests that cohesion relations that are less specific and hence cohesion-based cue an incremental reading, whereas more specific relations that are coherence-based are processed toward the end of the comprehension process.

In sum, cohesion relations facilitate the construction of a coherent mental representation by cueing the comprehender for specific directions as to how to process the incoming information. The more precise this information is, the easier the mapping of incoming information onto the developing structure, with specificity defined as the number of coherence relations active in the comprehension process and the specificity of each of these relations.

7.2 DISCUSSION

In the final section of this thesis we will discuss some aspects of this research that have not, or have not enough, been addressed. We will first consider the strengths and weaknesses of this research, followed by some general implications of it. Finally, we will identify some unanswered questions and give some preliminary answers in the light of further research.

7.2.1 Strengths

The aim of this study was to provide insight into comprehension processes and more in particular into the effect of cohesion on coherence. More concretely, theoretically, computationally and experimentally we have provided answers to the question what the effect of vocabulary-driven and grammar-driven cohesion is on coherence. The very nature of psycholinguistic research requires an interdisciplinary approach, combining linguistic theories and methods with psychological ones. We have gone one step further and integrated work in psycholinguistics, formal semantics, cognitive psychology and cognitive science. We answered the question on vocabulary-driven cohesion computationally, the question on grammar-driven cohesion experimentally and showed how these different methods give similar answers. Let us look again at the two methods.

For the computational model, we used pre-defined relations. This means that the user only needs to do a minimum of encoding. Most of the cohesion relations we used were established automatically. This is not the case for most other computational models, notably the ones we discussed in this research, where the user needs to define the links between the ψ -propositions. Furthermore, in most connectionist models on text comprehension the user usually estimates the weights of the relations. In our model weights have been estimated as non-parametric correlations between the experimental summarisation results and the number of links between the situations. That this estimation is a feasible procedure was shown in the successful prediction of summaries. Despite the simple architecture of the computational model, we have been able to predict summaries for texts that proved to correlate significantly with those summaries produced by subjects. This means that the conclusions drawn from the results of the computational models seem to be valid. That this is indeed the case was further shown by the similar computational and experimental results we found with regard to the Specification Hypothesis.

With regard to the experiments no study known to us has ever attempted to compare a large number of cohesion and coherence relations in one reading time experiment. Those studies that compared different conjunctions usually do not compare the reading times at different stages of the comprehension process (Deaton & Gernsbacher, in press). Those studies that looked at the effect of conjunctions on processing time at different stages in the comprehension process do not use cumulative

on-line methods (Townsend & Bever, 1978), while those studies that used cumulative on-line methods do not compare a large number of conjunctions (Millis & Just, 1994). Moreover, no studies on interclausal relationships have been conducted that control for the text in which cohesion relations appear. They keep the text, biased toward a coherence relation, the same, but vary the conjunctions (Deaton & Gernsbacher, in press), put each cohesion relation in a different text that best suits the coherence relation marked by the cohesion relation (e.g. Sanders, Spooren & Noordman, 1992) or use one identical test-sentence while varying the preceding text (Sanders & Noordman, 2000).

Keeping a biased text and changing the conjunctions (Deaton & Gernsbacher, in press) does not allow general conclusions on coherence relations. The only conclusion that can be drawn from these experiments is that one type of cohesion relation is more (or less) appropriate in the text that provided the coherence relation in the first place. On the other hand, changing the text to test cohesion and coherence relations (Sanders et al., 1992) does not allow to control for many hidden variables. The results of the eye movement experiment we conducted have shown the problems with different items. Changing the preceding text (Sanders & Noordman, 2000) partly overcomes these problems, but it is possible that the different information-load the comprehender uses, affects the reading time results.

With the use of identical texts, different cohesion relations and cumulative on-line tests, we have been able to provide an answer to how cohesion and coherence relations are processed. While some have claimed that CAUSAL relations tend to be processed fastest, others have argued that CAUSAL relations are processed slowest, the results of this thesis show that both claims are correct, depending on the position in the clause that is processed. Also, the general claim that NEGATIVE relations take more processing time than POSITIVE relations is falsified: again, the position in the clause is the crucial factor.

The research presented here is innovative and interdisciplinary in that it used a simple but efficient computational paradigm, a simple but efficient parameterisation and a simple but efficient experimental design.

7.2.2 Weaknesses

The benefits of this research however come at a price. For instance, we compared vocabulary-driven cohesion and coherence with grammar-driven cohesion and coherence, using different methods. We concluded that compared vocabulary-driven cohesion and coherence behaves like grammar-driven cohesion and coherence into comprehension and that the computational method is valid because similar results were found for the experimental methods. Clearly, a comparison of vocabulary-driven and grammar-driven relations should have used one method, or a comparison of the methods should have focussed on either vocabulary-driven or grammar-driven cohesion/coherence. This can be seen as a serious flaw in this research. However, because vocabulary-driven and grammar-driven relations are very similar in nature (see Givón 1995), a strong link between the two may be assumed. Furthermore, because the computational model is based on other models whose performance is tested experimentally (CI Model, Landscape Model) a link between both (computational and experimental) methods may be presumed. Hence, the conclusions drawn from seemingly separate methods and seemingly separate data are indeed valid, despite the fact that they do require further research (see next section).

But the experimental data are not free from some problematic issues either. It can be argued that the experimental findings were biased. In the grammar-driven cohesion relations we made a distinction between cohesion- and coherence-based relations, the former directing resources to the surface structure of the text, while the latter directed resources to associative knowledge. ADDITIVE and NEGATIVE relations were defined as cohesion-based, whereas CAUSAL and POSITIVE relations were defined as coherence-based. The question is whether the experimental design may have biased cohesion- and coherence based relations. We argued that the use of a non-cumulative self-paced reading time experiments had the advantage that very precise reading data was measured, because subjects were not able to regress to words they had read earlier. However, it is likely that reading non-cumulatively also means that readers are more focussed on the surface structure of the text than in a normal reading process, for instance because they have to focus on the position of the new word on a blank screen. This handicap is particularly present at the beginning of the clause, when readers cannot anticipate on the remainder of the text. However, if it is true that the experiment is

biased towards a cohesion-based processing and if it is true that this particularly effects the first part of the clause we may expect higher reading times for the ADDITIVE relations and lower reading times for the CAUSAL relations. Also, we may then expect higher NEGATIVE relations and lower POSITIVE relations. Although TYPE relations may be affected in a way not predicted by the hypothesis, POLARITY relations would show the predicted pattern. This would mean that the strong TYPE effects get weaker and the weak POLARITY effects get stronger.

In sum, the weaknesses of this research do not have serious consequences for its conclusions. Like any other study improvements are necessary and future research on cohesion and coherence is therefore desirable.

7.2.4 Applications

We have investigated the effects of cohesion on coherence in order to gain further insight in comprehension processes. Hence, our main aim has been primarily scientific. Although we have focussed on psycholinguistics, a range of disciplines could benefit from the findings of a research like this. Insight in how comprehenders understand texts can help disciplines like cognitive science and artificial intelligence. Studying the natural and artificial structure, behaviour and design of cognitive systems seems to require an understanding of the structure of the communicative product and processes of these systems. Insight in the cohesive structures is useful for various linguistic theories from discourse analysis to language evolution. For language studies, studying these structures in a particular language provides a further insight into that language, while it also enables cognitive generalisations across languages. Similarly for disciplines like literary studies an understanding how comprehenders understand text, and narrative texts in particular, seems useful.

But the findings in research like this also have potential impact for non-scientific matters. Further research on cohesion and coherence relations could for instance contribute to text optimisation. From the understanding the interrelatedness between, and independence of, the vocabulary-driven and grammar-driven strands follow guidelines for writers in how to improve the clarity and readability of text. This educational implication also concerns those with reading difficulties or second language

learners. If it can be pointed out where and how to make cohesive links in the text, coherence can be facilitated.

Finally, a range of implications can be thought of for the computational model of coherence. A program that automatically generates summaries can be applied on the world wide web, in newspapers, book reviews, etc.

Clearly, the presented research does not offer these applications, but paves the way for further research that could lead to them.

7.2.5 Unanswered questions and suggestions for future research

In this research we have discussed many issues that arise in the process of answering the main question of how cohesion affects coherence. Nevertheless, several questions remain unanswered. In the final sections of this thesis we will address some of these questions.

Are there more cohesion and coherence strands than REFERENTIAL, LOCATIONAL, CAUSAL, TEMPORAL and ADDITIVE?

In this research we have assumed that five cohesion strands are active in the comprehension process: REFERENTIAL, LOCATIONAL, CAUSAL, TEMPORAL and ADDITIVE. These five relations can be vocabulary-driven and grammar-driven.

The obvious question is whether these five cohesion and coherence strands are exhaustive. Can we identify more cohesion and coherence strands in text and comprehension? The answer is: yes, we can. As we have pointed out in the first chapter, our taxonomy of relations is heavily based on Givón's discussion of coherence (Givón, 1995). However, Givón defines six coherence strands: referents, temporality, aspectuality, modality/mood, location, action/script. We have classified action/script under CAUSAL cohesion (Chapter 1), more in particular CAUSAL chains (Chapter 4). With respect to aspectuality and modality/mood, Givón does not discuss these strands. In an earlier study Givón these strands are worked out in detail. He defines them as modal continuity, speech-act continuity and perspective continuity (e.g. Givón, 1993: 318). Like with the other strands, they are often clearest in their discontinuity.

Modal discontinuity	She came in and sat on the bed.	<i>realis pas mode +</i>
	She would soon move out for good.	<i>irrealis future mode</i>
Speech-act discontinuity	She came in and sat on the bed.	<i>declarative clause +</i>
	Was she thinking about him.	<i>interrogative clause</i>
Perspective discontinuity	She came in and sat on the bed.	<i>narrator's perspective +</i>
	She was tired, she thought.	<i>character's perspective</i>

Table 1 Additional coherence strands (more abstract global strands) defined by Givón, 1995

Although we certainly believe that these cohesion and coherence strands are important in the comprehension process, we also think that they play an inferior role in the construction of the mental representation. In fact, we believe that these relations are part of what Givón elsewhere (1993: 21) calls meta-communicative functions, which are not directly linked to the task of constructing a mental representation. Givón distinguishes socio-cultural cohesion functions, inter-personal affective functions and aesthetic functions.

It seems that these meta-communicative functions particularly apply to pragmatics and discourse, rather than to semantics and text. Our main concern in this research has been the latter. Hence, the five cohesion and coherence strands we have defined in this research are the ones primarily found in the psycholinguistic literature and seem to be the most important strands in understanding text. We argued that if none of these strands are active or if one of these strands is violated, establishing coherence is difficult, if not impossible, whereas their presence facilitates the comprehension process (necessary and sufficient condition). Although without the extra pragmatic strands coherence is possible, we assume that their presence is further facilitated (sufficient condition).

Does the Interdependency Hypothesis also apply to an interaction between vocabulary- and grammar-driven relations?

We have tested the interrelated-coherence hypothesis and the independent-coherence hypothesis on vocabulary-driven relations and on grammar-driven relations. We did not tested whether vocabulary-driven and grammar-driven relations interact with each other.

In the first chapter we have pointed out how difficult it is to draw a line between vocabulary-driven and grammar-driven relations. We concluded that grammar-driven cohesion/coherence support vocabulary-driven cohesion/coherence and the other way around, but grammar-driven cohesion/coherence is neither sufficient nor necessary for vocabulary-driven cohesion/coherence and vocabulary-driven cohesion/coherence is neither sufficient nor necessary for grammar-driven cohesion/coherence. In sum, what we concluded in Chapter 1 is similar to what we concluded for the five strands in vocabulary-driven and grammar-driven cohesion/coherence: they interact, but independently affect the comprehension process. Further research is needed to test whether, and if so how, the interaction between vocabulary-driven and grammar-driven relations affects the comprehension process across strands (e.g. grammar-driven CAUSAL relations and vocabulary-driven REFERENTIAL relations).

Are the effects of cohesion relations on coherence language specific?

All analyses in this research used the English language. The question thus arises whether the results can be generalised over other languages. Initially, the answer to this question is affirmative. Obviously, the vocabulary-driven cohesion links in the computational model can also be established for at least other West European languages. For the grammar-driven cohesion and coherence relations we have briefly pointed out some other languages in which NEGATIVE TEMPORAL relations are marked more clearly. Furthermore, the psycholinguistic studies we have referred to in this research concerned experiments in Spanish (De Vega, 1995), Dutch (Sanders et al., 1992; 1993), Sanders & Noordman, 2000; French (Ziti & Champagnol, 1992; Caron, Micko & Thuring, 1988), German (Caron et al., 1988). All experiments in these languages showed nothing that would contradict the experiments in English.

With different studies investigating different languages showing similar results and the intuition that these results can be expanded over other languages, we could conclude that the effects of cohesion on coherence is not language specific, but follows similar language processes. Further cross-linguistic research using identical methods and identical items between the languages is however needed.

Are the processes of establishing coherence general language processes or general cognitive processes?

From the conclusion that cohesion and coherence are not dependent on specific languages, we cannot automatically conclude that the construction of a coherent mental representation involves cognitive rather than linguistic processes. However, as became clear in Chapter 2, we do believe that the comprehension processes we described are general cognitive processes and mechanisms. Why do we think this?

On the one hand, we could ask ourselves what is lost by describing processes and mechanisms involved in language tasks as general cognitive rather than linguistic. Gernsbacher (1990: 240ff) turns the question around and asks what is gained by describing language at a general level. She argues, following Reber (1987), that describing language comprehension at a general level saves her from believing in a strong version of nativism, isolates psycholinguistics from psychology, solely rely on linguistic theories, ignore functionalism and prefer theory over data. Our answer would be that describing comprehension at a general level enables generalisation and paves the way for interdisciplinary work: linguistic explanations do not have to be abandoned, while interdisciplinary ways can be explored.

Whether it is true that the processes we have described in this research are indeed general cognitive processes needs to be further explored. We predict that cognitive evidence for the Interdependency and Specification Hypotheses will also be found in the comprehension of speech, moving images and pictorial information, but experiments similar to the ones we have carried out here, using different media, should be conducted to turn our hypotheses into cognitive evidence.

Does cohesion really lie in text and coherence in comprehension?

In various studies on text and comprehension it is stated that cohesion (or coherence in the more general sense abandoned in Chapter 1) cannot lie in the text. On the contrary, it needs to be localised in the mental representation of the reader or the writer (e.g. Garnham & Oakhill, 1997; Spooren, Sanders & Van Wijk, 2000; Zwaan & Radvansky, 1998). Cohesion only comes about because it is interpreted as cohesion.

Clearly, a language expression does not have a meaning in itself but needs to be interpreted. Similarly, cohesion relations can only be identified after (a part of) the coherent mental representation has been constructed. Nevertheless, potential cohesion relations can be identified in the text, while the realisation of these relations depends on

coherence. Making the distinction between cohesion and coherence enables us to make a linguistic analysis of the text essential for both computational and experimental tests.

7.3 CONCLUSION

In this thesis we asked whether, and if so how, cohesion supports coherence. We showed that the higher the number of relation in a clauses, the more likely it is that situation is summarised and recalled. We also showed that processing time is faster when a clause contains a cohesion relation than when it does not. Hence, cohesion supports coherence. How does it support coherence? We showed that some cohesion relations affect comprehension independently, but most interdependently affect comprehension. This suggests that the more specific a cohesion relation is, the easier it is to build a coherent mental representation. We showed that the number of situations summarised and recalled most, have the highest number of cohesion relations. We also showed that if a situation entails another, that situation is more specific and hence comprehended fastest. Finally, we showed that whereas specific relations are processed towards the end of the comprehension process, less specific relations need additional information from the text before coherence takes place. The process from cohesion in text to coherence in comprehension thus comes about at different stages in the comprehension process cued by different cohesion relations in the text.

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APPENDIX I

FULL TEXTS

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TURTLE STORY (VERSION 1)

- (1) One day Mark and Sally were sailing their toy sailboat in the pond
- (2) Suddenly the sailboat began to sink
- (3) Mark was surprised
- (4) He lifted the boat up with a stick
- (5) and found a turtle on top of it
- (6) The turtle became frightened
- (7) and tried to crawl off the boat
- (8) The turtle put Mark in a playful mood
- (9) Mark thought the turtle was hurt
- (10) Mark had always wanted Sally to see a turtle
- (11) so he waded out to the turtle
- (12) and brought it back to her
- (13) Sally felt sorry for Mark
- (14) but the turtle bit her
- (15) Sally didn't like this
- (16) and threw the turtle into the pond
- (17) The turtle crashed into the sailboat
- (18) Sally knew she had made a mistake

TURTLE STORY (VERSION 2)

- (1) One day Mark and Sally were sailing their toy sailboat in the pond
- (2) Suddenly the sailboat began to sink
- (3) Mark was surprised
- (4) He waded out to the boat
- (5) and found a turtle on top of it
- (6) the turtle became frightened
- (7) and tried to crawl off the boat
- (8) The turtle put Mark in a playful mood
- (9) Mark had always wanted Sally to see a turtle
- (10) Mark thought the turtle was hurt
- (11) He gently tried to lift the turtle off the boat,
- (12) but found that its foot had poked through the sail
- (13) Sally felt sorry for Mark
- (14) Sally thought Mark was going to hurt the turtle
- (15) So when Mark got out his pocketknife,
- (16) Sally got upset
- (17) She tried to grab the turtle away from Mark
- (18) Accidentally broke the boat's mast off
- (19) Sally knew she had made a mistake

TURTLE STORY (VERSION 3)

- (1) One day Mark and Sally were sailing their toy sailboat in the pond
- (2) Suddenly the sailboat began to sink
- (3) Mark was surprised
- (4) He pushed the boat onto the shore with a stick
- (5) and found a turtle on top of it
- (6) the turtle became frightened
- (7) and tried to crawl off the boat
- (8) Mark thought the turtle was hurt
- (9) Mark had always wanted Sally to see a turtle
- (10) The turtle put Mark in a playful mood
- (11) He tried to tie the boat to the turtle's back,
- (12) but the turtle bit him on the hand
- (13) Sally thought Mark was going to hurt the turtle
- (14) Sally tried to touch the turtle
- (15) When Mark saw how Sally felt,
- (16) it made him very proud
- (17) Mark tried to show Sally his wound
- (18) and accidentally stepped on the sailboat
- (19) Mark wished he hadn't tried to act so big

BEE STORY (VERSION1)

- (1) One day Molly was visiting her cousin Hank on the farm
- (2) At lunch, Hank asked Molly if she wanted to go out with him and his dad to the raspberry
- (3) bushes in the pasture
- (4) Molly liked raspberries
- (5) so she agreed,
- (6) and the three of them started out for the pasture
- (7) Hank grinned
- (8) as he thought of a trick to play on Molly there
- (9) When they were at the bushes,
- (10) Hank told Molly that there were bees in them
- (11) Molly thought Hank was mean
- (12) Molly had always wanted to catch Hank telling a lie
- (13) Molly became nervous
- (14) She started to pick her berries,
- (15) but fearfully kept looking around
- (16) Hank's dad was very proud of his bushes
- (17) Hank's dad motioned for Molly to come over to him
- (18) Hank's dad knew there weren't any bees in the bushes
- (19) So when Hank's dad heard buzzing coming from them
- (20) he was puzzled
- (21) Hank's dad looked in the bushes
- (22) and there he found Hank buzzing like a bee
- (23) Hank's dad realized what his son was doing,
- (24) and told Molly that she had been tricked.

BEE STORY (VERSION 2)

- (1) One day Molly was visiting her cousin Hank on the farm
- (2) At lunch, Hank asked Molly if she wanted to go out with him and his dad to the raspberry bushes in the pasture
- (3) Molly liked raspberries
- (4) so she agreed,
- (5) and the three of them started out for the pasture
- (6) Hank grinned
- (7) as he thought of a trick to play on Molly there
- (8) When they were at the bushes,
- (9) Hank told Molly that there were bees in them
- (10) Molly became nervous
- (11) Molly thought Hank was mean
- (12) Molly had always wanted to catch Hank telling a lie
- (13) So she began beating the bushes with a stick,
- (14) but no bees flew out of them
- (15) Hank's dad motioned for Molly to come over to him
- (16) Hank's dad knew there weren't any bees in the bushes
- (17) Hank's dad was very proud of his bushes
- (18) When Hank saw how his dad felt,
- (19) he wishes that he hadn't lied about the bees
- (20) Hank ran over to Molly
- (21) and pulled her away from the bushes
- (22) but they were already ruined
- (23) Hank's dad was furious about his bushes

BEE STORY (VERSION 3)

- (1) One day Molly was visiting her cousin Hank on the farm
- (2) At lunch, Hank asked Molly if she wanted to go out with him and his dad to the raspberry bushes in the pasture
- (3) Molly liked raspberries
- (4) so she agreed,
- (5) and the three of them started out for the pasture
- (6) Hank grinned
- (7) as he thought of a trick to play on Molly there
- (8) When they were at the bushes,
- (9) Hank told Molly that there were bees in them
- (10) Molly became nervous
- (11) Molly thought Hank was mean.
- (12) So she started throwing stones at Hank
- (13) and chased him into the raspberry bushes
- (14) Hank's dad was very proud of his business
- (15) Hank's dad knew there weren't any bees in the bushes
- (16) Hank's dad motioned for Molly to come over to him
- (17) When Molly saw Hank's dad wave to her,
- (18) she felt embarrassed
- (19) She went over to Hank,
- (20) and apologized for throwing stones at him
- (21) Hank said he was sorry for trying to trick her,
- (22) and they all began to pick the berries.

AIRPLANE STORY (VERSION 1)

- (1) Once there was a boy named Ralph
- (2) who had a little brother named Billy
- (3) One day Ralph and Billy's parents went out of town
- (4) and left a model airplane kit for each of the boys
- (5) Ralph and Billy were excited
- (6) They laid some newspapers down on the picnic table outside
- (7) and soon had their models glued together
- (8) Ralph asked Billy to bring the models in before lunch
- (9) After lunch that day, it began to rain
- (10) The rain put Billy in a happy mood
- (11) Billy had wanted to play out in the shed on a rainy day for a long time
- (12) The storm reminded Billy that the models had been left out
- (13) Billy ran outside
- (14) and tried to reach the models with a stick
- (15) Ralph thought Billy would take a long time
- (16) Ralph made fun of Billy for going out in the rain
- (17) Ralph became afraid that Billy might ruin something
- (18) When Billy saw how Ralph felt
- (19) he decided to use a chair instead
- (20) But by the time Billy got the chair
- (21) the wind had blown the models into a puddle
- (22) Ralph was horrified
- (23) and wished he had helped his brother

AIRPLANE STORY (VERSION 2)

- (1) Once there was a boy named Ralph
- (2) who had a little brother named Billy
- (3) One day Ralph and Billy's parents went out of town
- (4) and left a model airplane kit for each of the boys
- (5) Ralph and Billy were excited
- (6) They laid some newspapers down on the picnic table outside
- (7) and soon had their models glued together
- (8) The boys decided to let their models dry there on the floor
- (9) After lunch that day, it began to rain
- (10) Billy had wanted to play out in the shed on a rainy day for a long time
- (11) The storm reminded Billy that the models had been left out
- (12) The rain put Billy in a happy mood
- (13) So Billy went outside
- (14) and started to ride his tricycle through the puddles
- (15) Ralph became afraid that Billy might ruin something
- (16) Ralph thought Billy would take a long time
- (17) When Billy heard Ralph tease him
- (18) made fun of Billy for going out in the rain
- (19) his feelings were hurt
- (20) Billy put his tricycle back in the she
- (21) and accidentally stepped on the models
- (22) Ralph was horrified
- (23) and wished he hadn't
- (24) teased his brother

AIRPLANE STORY (VERSION 3)

- (1) Once there was a boy named Ralph
- (2) who had a little brother named Billy
- (3) One day Ralph and Billy's parents went out of town
- (4) and left a model airplane kit for each of the boys
- (5) Ralph and Billy were excited
- (6) They laid some newspapers down on the picnic table outside
- (7) and soon had their models glued together
- (8) Ralph was jealous of Billy's model
- (9) After lunch that day, it began to rain
- (10) The rain put Billy in a happy mood
- (11) The storm reminded Billy that the models had been left out
- (12) So Billy ran outside
- (13) and jumped through the puddles of the shed
- (14) Ralph became afraid that Billy might ruin something
- (15) Ralph made fun of Billy for going out in the rain
- (16) Ralph thought Billy would take a long time
- (17) So when Ralph saw Billy go into the shed
- (18) he was quite pleased
- (19) Billy had just stomped on Billy's model
- (20) when Billy came running down to the basement for more toys
- (21) Ralph knew he had been caught
- (22) and wished he hadn't done such a mean thing

	State	Process	Ev(acc)	Ev(ach)	Agent	Object	Instrument	Source	Goal	Location	Time
1		sail			Mark and Sally	sailboat				pond	one day
2			sink			sailboat					
3	be surprised				Mark						
4			lift		Mark	sailboat	stick				
5				find	Mark	turtle				sailboat	
6	be frightened				turtle						
7		try			turtle	8					
8			crawl off		turtle			sailboat			
9			put		turtle	Mark			playful mood		
10	think				Mark	11					
11	be hurt				turtle						
12	want				Mark	13					
13		see			Sally	turtle					
14			wade out		Mark			water	turtle		
15			bring back		Mark	turtle			Sally		
16		think			Sally	17					
17		hurt			Mark	turtle					
18	feel sorry				Sally				Mark		
19		try			Sally	20					
20		touch			Sally	turtle					
21		bite			turtle	Sally					
22	like not				Sally	21					
23			throw		Sally	turtle			pond		
24			crash		turtle				sailboat		
25		know			Sally	26					
26	make mistake				Sally						

Table 1 Turtle story (version 1)

	State	Process	Ev(acc)	Ev(ach)	Agent	Object	Instrument	Source	Goal	Location	Time
1		sail			Mark and Sally	sailboat				pond	one day
2			sink			sailboat					
3	be surprised				Mark						
4			wade out		Mark			water	sailboat		
5				find	Mark	turtle				sailboat	
6	be frightened				turtle						
7		try			turtle	8					
8			crawl off		turtle			sailboat			
9	want				Mark	10					
10		see			Sally	turtle					
11	think				Mark	12					
12	be hurt				turtle						
13		try			Mark						
14			lift		Mark	turtle		sailboat			
15	find				Mark	16					
16		poke			Mark's foot				sail		
17	feel sorry				Sally				Mark		
18		try			Sally	19					
19		touch			Sally	turtle					
20	think				Sally	20					
21		hurt			Mark	turtle					
22		get			Mark	knife					
23	get upset				Sally						
24		try			Sally	25					
25			grab away		Sally	turtle		Mark			
26				break off		mast					
27		know			Sally	26					
28	make mistake				Sally						

Table 2 Turtle story (version 2)

	State	Process	Ev(acc)	Ev(ach)	Agent	Object	Instru	Source	Goal	Loc	Time
1		sail			Mark and Sally	sailboat				pond	one day
2			sink			sailboat					
3	be surprised				Mark						
4			push		Mark	sailboat	stick		shore		
5				find	Mark	turtle				sailboat	
6	be frightened				turtle						
7		try			turtle	8					
8			crawl off		turtle			sailboat			
9	think				Mark	10					
10	be hurt				turtle						
11	want				Mark	12					
12		see			Sally	turtle					
13			put		turtle	Mark			playful mood		
14		try			Mark	15					
15			tie		Mark	sailboat			turtle's back		
16		bite			turtle	Mark's hand					
17	feel sorry				Sally				Mark		
18		see			Mark	19					
19	feel				Sally	how					
20	make proud				Mark	20					
21		try			Mark	22					
22		show			Mark	wound					
23			step on		Mark	sailboat					
24		wish			Mark	25					
25		try			Mark	26					
26			act big		Mark						

Table 3 Turtle story (version 3)

	State	Process	Ev(acc)	Ev(ach)	Agent	Object	Instru	Source	Goal	Loc	Time
1			visit		Molly	Hank				farm	one day
2			ask		Hank	3			Molly		
3	want				Molly	4					
4		go			Molly	raspberry			bushes		lunch
5	like				Molly						
6	agree				Molly						
7		start			Molly, Hank, dad				bushes		
8		grin			Hank						
9		think			Hank	10					
10			play trick		Hank	Molly					
11	be				Molly, Hank, dad						
12		tell			Hank	13			Molly		
13	be				bees					bushes	
14	think				Molly	15					
15	be mean				Hank						
16	want				Molly	17					
17				catch	Molly	18					
18			lying		Hank						
19	be nervous				Molly						
20			pick		Molly	raspberry					
21		look around			Molly						
22	be proud				dad	bushes					
23		motion			dad				Molly		
24	know				dad	no bees				bushes	
25		hear			dad	buzzing		bushes			
26		look			dad					bushes	
27				find	dad	28					
28				realise	dad	29					
29		buzz			Hank			bushes			
30		do			Hank	something					

31	tell				dad				Molly		
32			trick						Molly		

Table 4 Bee story (version 1)

	State	Process	Ev(acc)	Ev(ach)	Agent	Object	Instrument	Source	Goal	Location	Time
1			visit		Molly	Hank				farm	one day
2			ask		Hank	3			Molly		
3	want				Molly	4					
4		go			Molly				bushes		lunch
5	like				Molly	raspberry					
6	agree				Molly						
7		start			Molly, Hank, dad				bushes		
8		grin			Hank						
9		think			Hank	10					
10			play trick		Hank	Molly				bushes	
11	be				Molly, Hank, dad					bushes	
12		tell			Hank	13			Molly		
13	be				bees					bushes	
14	be nervous				Molly						
15	be mean				Hank						
16	want				Molly	17					
17				catch	Molly	18					
18			lying		Hank						
19	beat				Molly	bushes	stick				
20	fly				no bees			bushes			
21		motion			dad				Molly		
22	know				dad	no bees				bushes	
23	be proud				dad	bushes					
24		see			Hank	dad					
25		wish			Hank	26					
26		lie			Hank			bees			

27			run over	Hank					Molly	
28			pull out	Hank						
29	be ruined								bushes	
30	be furious			dad					bushes	

Table 5 Bee story (version 2)

	State	Process	Ev(acc)	Ev(ach)	Agent	Object	Instrument	Source	Goal	Location	Time
1			visit		Molly	Hank				farm	one day
2			ask		Hank	3			Molly		
3	want				Molly	4					
4		go			Molly				bushes		lunch
5	like				Molly	raspberry					
6	agree				Molly						
7		start			Molly, Hank, dad				bushes		
8		grin			Hank						
9		think			Hank	10					
10			play trick		Hank	Molly				bushes	
11	be				Molly, Hank, dad					bushes	
12		tell			Hank	13			Molly		
13	be				bees					bushes	
14	be nervous				Molly						
15	want				Molly	16					
16				catch	Molly	17					
17			lying		Hank						
18	think				Molly	19					
19	be mean				Hank						
20		throw			Molly	stones					
21		chase			Molly	Hank			Hank	bushes	
22	be proud				dad	bushes					
23	know				dad	no bees				bushes	

24		motion				dad				Molly		
25		see				Molly		26				
26		wave				dad				Molly		
27	feel embarrassed					Molly						
28		go over				Molly				Hank		
29		apologised				Molly		30				
30		throw				Molly	stones					
31		say sorry				Hank		32				
32		trick				Hank		Molly				
33		pick				Molly, Hank, dad	raspberry					

Table 6 Bee story (version 3)

State	Process	Ev(acc)	Ev(ach)	Agent	Object	Instr	Source	Goal	Location	Time
1	named				Ralph					once
2	named				Billy					
3	be			Ralph and Billy's parents					out of town	
4			leave	Ralph and Billy's parents	model airplane kit			Ralph and Billy		one day
5	be excited			Ralph and Billy						
6		lay down		Ralph and Billy	newspapers				picnick table	
7		glue together		Ralph and Billy	model airplane kit					
8	ask			Ralph	9			Billy		
9			bring in	Billy	airplane models					
10	rain			rain	Billy			happy mood		lunch
11	put			rain						
12	rain									
13	want			Billy	14					
14	play			Billy					shed	
15	remind			Billy	16					
16	be			airplane models					rain	

17	run				Billy					outside		
18	try				Billy			19				
19			reach		Billy		airplane models	stick				
20	think				Ralph			21				
21	take time				Billy							
22	make fun				Ralph			Billy			rain	
23	be afraid				Ralph			24				
24			ruin		Billy		airplane models					
25	see				Billy		Ralph					
26		use chair			Billy		chair					
27		get			Billy		chair					
28			blow		wind		airplane models				puddle	
29	be horrified				Ralph							
30	wish				Ralph							
31	help				Ralph		Billy					

Table 7 Airplane story (version 1)

	State	Process	Ev(acc)	Ev(ach)	Agent	Object	Inst	Source	Goal	Location	Time
1	named					Ralph					once
2	named					Billy					
3	be				Ralph and Billy's parents					out of town	
4				leave	Ralph and Billy's parents	model airplane kit			Ralph and Billy		one day
5	be excited				Ralph and Billy						
6		lay down			Ralph and Billy	newspapers				floor of shed	
7		glue together			Ralph and Billy	model airplane kit					
8	decide				Ralph and Billy						
9				dry	Ralph and Billy	airplane models				floor of shed	

7			glue together		Ralph and Billy		model airplane kit					
8	be jealous				Ralph		airplane model					
9		rain										
10		put			rain		Billy		happy mood			
11		remind			Billy		12					
12	be				airplane models						rain	
13		rain										
14	want				Billy		14					
15		play			Billy						shed	
16		go			Billy				shed		puddles	
17	be afraid				Ralph		24					
18				ruin	Billy		airplane models					
19		make fun			Ralph		Billy				rain	
20		think			Ralph		21					
21		take time			Billy							
22		see			Ralph							
23	be				Billy						shed	
24	be pleased				Ralph							
25			stamp		Ralph		airplane model					
26			run down						toys			
27		catch					Ralph				basement	
28		wish			Ralph							
29		do			Ralph		mean thing					

Table 9 Airplane story (version 3)

	State	Process	Ev(acc)	Ev(ach)	Agent	Object	Instrument	Source	Goal	Location	Ti
1		take			father + son	donkey			town		
2		sell				donkey				market place	
3		not go			father + son	distance					
4			meet		father + son	pretty maidens					

5			return										
6	talk				pretty maidens								
7	laugh				pretty maidens								
8			cry out		maiden								
9	see				maidens				father + son				
10	walk				father + son								donkey
11	tell				father				son				
12			get		son				donkey				
13	stroll along				father								
14	traveled				father + son								down the road
15			come up		father + son				old men				
16	say				old man								
17	show				respect							old age	
18	ride				son				donkey				
19	walk				father								
20			get down		son								
21	ride				father								
22			get down		son				donkey				
23			take place		father				donkey				
24			not have gone		father son								
25			happened		father + son				women and child				
26	ashamed				father								
27	cry				women								
28	ride				father				donkey				
29			hardly keep up		son								
30			hoisted		father				son				
31				reach	father + son				town				
32	say				townsman								
33	be				donkey								
34	say				father								
35	not think				townsman								

36		overwork					father + son	donkey				
37	be strong						father + son					
38		carry					father + son	donkey				
39		carry					donkey	father + son				
40		say					father					
41		please					townsman					
42		try					father + son					
43			get down				father + son	donkey				
44			tie				father + son	donkey's legs				
45		take					father + son	pole				
46			carry				father + son	donkey				bridge
47		lead					bridge		market place			
48	be						odd sight					
49		gather					people	father + son + donkey				market place
50		laugh					people	father + son + donkey				
51		like					donkey					
52		be tied					donkey					
53		kicked					donkey					
54			break				donkey	rope				
55			tumble off				donkey					water
56			scramble away				donkey					thicket
57			hang down				father and son	heads				
58			make				father and son	way		home		
59			learn				father and son	everybody				
60			please				father and son	not everybody				
61			lose				father and son	donkey				

Table 10 Father, son and donkey story

APPENDIX II

The illustrations in this appendix are linked to the taxonomies given in Chapter 5.

Note: Tables 22-24 can be compared by conjunction and number.

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Additive	External/internal	Additive simple	additive		For the whole day he climbed up the steep mountainside, almost without stopping. And in all this time he met no one. (238)
			negative		I couldn't send all the horses, you know, because two of them are wanted in the game. And I haven't sent the two Messengers either. (246)
			alternative		'Shall we try another figure of the Lobster Quadrille?', the Gryphon went on. 'Or would you like the Mock Turtle to sing you a song?' (246)
	Internal	Complex	emphatic	Additive	My client says he does not know this witness. Further, he denies ever having seen her or spoken to her. (246)
				Alternative	Perhaps she missed the train. Or else she's changed her mind and isn't coming. (247)
			de-emphatic	After-thought	'You'll see me there', said the Cat, and vanished ... While she was looking at the place where it had been, it suddenly appeared again. 'By-the-by, what became of the baby?' said the Cat, 'I'd nearly forgotten to ask. (249)
		Apposition	Expository		I wonder whether that statement can be backed up by adequate evidence. – In other words, you don't believe me. (248)
			Exemplificatory		'What sort of things do <i>you</i> remember best?' Alice ventured to ask. 'Oh, things that happened the week after next,' the Queen replied in a careless tone. 'For instance, now,' she went on... 'there is the King's Messenger. He's in prison now, being punished... (248)
	Comparison	Similar		Treating people as responsible citizens brings out the best in them; they behave as such. In the same way if you treat them as criminals they will soon begin to act like criminals. (76: 247)	
		Dissimilar		Our garden didn't do very well this year. By contrast, the orchard is looking very healthy. (76: 247)	

All examples from Halliday & Hasan (1976)

Table 1 Halliday & Hasan (1976), ADDITIVE relations

Adversative	External/internal	Adversative 'proper'	Simple		All the figures were correct; they'd been checked. Yet the total came out wrong. (250)
			Containing 'and'		'Dear, dear! How queer everything is today! And yesterday things went on just as usual.' (252)
			Emphatic		... it swept her straight off the seat, and down among the heap of rushes. However, she wasn't a bit hurt, and was soon up again. (251)
	Internal	Contrastive	internal	Avowal	... In fact,' he went on, holding his head down, and his voice getting lower and lower, 'I don't believe that pudding ever <i>was</i> cooked! In fact, I don't believe that pudding ever will be cooked! (253)
			external	Simple emphatic	At this time Tweedledee was trying his best to fold up the umbrella, with himself in it ... But he couldn't quite succeed and it ended in his rolling over, bundled up in the umbrella, with only his head out. (250)
		Correction	of meaning		He showed no pleasure at hearing the news. Instead he looked even gloomier. (254)
			of wording		'What a beautiful belt you've got on!' Alice suddenly remarked ... 'At least,' she corrected herself on second thoughts, 'a beautiful cravat, I should have said – no, a belt, I mean – ...
		Dismissal	Closed		'I say, this isn't fair!' cried the Unicorn, as Alice sat with the knife in her hand, very much puzzled how to begin. 'The Monster has given the Lion twice as much as me!' 'She's kept none for herself, anyhow,' said the Lion. (255)
	Open-ended		'... the March Hare said –' 'I didn't!' the March Hare interrupted in a great hurry ... 'Well, at any rate, the Dormouse said –' the Hatter went on. (255)		

All examples from Halliday & Hasan (1976)

Table 2 Halliday & Hasan (1976), ADVERSATIVE relations

Causal	External/internal	Causal	general	simple	... she felt that there was no time to be lost, as she was shrinking rapidly; so she got to work at once to eat some of the other bit. (256)
				emphatic	... she wouldn't have heard it all, if it hadn't come <i>quite</i> close to her ear. The consequence of this was that it tickled her ear very much ... (256)
			specific	reason	for this reason, on account of this
				result	as a result of this, in consequence of this
				purpose	for this purpose, with this in mind/view
	Internal	Causal	reversed	simple	The next morning she was glad and proud that she had not yielded to scare. For he was most strangely and obviously better. (258)
			specific	reason	it follows from this, on this basis
				result	arising out of this
				purpose	to this end
		Conditional	Simple emphatic	'And what does it live on?' 'Weak tea with cream in it.' A new difficulty came to Alice's head. 'Supposing it couldn't find any?' she suggested. 'Then it would die of course.' (258)	
			generalized	Alice looked all round the table, but there was nothing on it but tea. 'I don't see any wine,' she remarked. 'There isn't any,' said the March Hare. 'Then it is not very civil of you to offer it,' said Alice angrily. (258)	
			reversed polarity	I was not informed. Otherwise I should have taken some action. (259)	
		Respective	direct	One factor is the level of taxation of personal incomes. With regard to this question, the impressions current among the members of the public are often very far removed from the truth. (260)	
			reversed polarity	The musicians themselves were somewhat disappointed at the relative lack of interest displayed in the new works which they represented. Leaving that aside, the whole tour seems to have been remarkably successful. (26)	

All examples from Halliday & Hasan (1976)

Table 3 Halliday & Hasan (1976), CAUSAL relations

Temporal	External/internal	simple	sequential	'But that must happen very often,' Alice remarked thoughtfully. 'It always happens,' said the Gnat. After this, Alice was silent for a minute of two, pondering. (261)
			simultaneous	'You'll get used to it in time,' said the Caterpillar; and it put the hookah into its mouth and began smoking again. This time Alice waited patiently until it chose to speak again. (262)
			preceding	The weather cleared just as the party approached the summit. Until then they had seen nothing of the panorama around them (263)
		conclusive	simple	All this time the Guard was looking at her, first through a telescope, then through a microscope, and then through an opera-glass. At last he said 'You're travelling the wrong way,' and shut up the window and went away.
		correlative forms	sequential	[Obrecht] subjects his <i>cantus firmus</i> to the most abstruse manipulations. First he extracts all the longs from the tune, and strings them together in succession; then he does the same with the breves, and finally with the semibreves. He then reverses this procedure, starting with the shorter values first. (263)
			conclusive	First he extracts all the longs from the tune, and strings them together in succession; then he does the same with the breves, and finally with the semibreves. He then reverses this procedure, starting with the shorter values first. (263)
		Internal	Complex	immediate
	interrupted			soon, presently, later, after a time, formerly
	repetitive			next time, on another occasion, the last time
	specific			next day, five minutes later, five minutes earlier
	durative			meanwhile, all this time
	terminal			by this time, up till that time, until then
	punctiliar			next moment, at this point/moment, the previous moment
	internal temporal		sequential	first ... then, first ... next
			conclusive	at first ... finally, at first .. in the end
	correlative forms		sequential	then, next, secondly ...
			conclusive	finally, as a final point, in conclusion
	Here and now		past	And then we are back in a strange land, the later Middle Ages, where our modern preoccupations can only hinder understanding. So far we have tried to imagine the way an interested but instructed listener might react ... (264)
			present	The Middle Ages have become the Renaissance, and a new world has come into being: our world. In that way is it 'our world'? At this point we run into some difficulty. (264)
			future	[And then we are back in a strange land, the later Middle Ages, where our modern preoccupations can only hinder understanding. From now on we will try to imagine the way an interested and instructed listener might react.]
	summary		summarizing	Nutrition can determine how you look, act and feel; whether you are grouchy or cheerful, homely or beautiful [...] In short, it can determine your zest for life, the good you put into it, and the fulfillment you get from it. (265)
			resumptive	It is perfectly possible for an examination to be reliable but invalid [...] To return to the effects of examination upon teaching; when a teacher does his own testing then there need to be no effect on his teaching ... (266)

Table 4 Halliday & Hasan (1976), TEMPORAL relations

temporal	simultaneous	coextensive	durative			<p>a. We stand and wait. Throughout the judge handles the dogs.</p> <p>b. While we stand and wait the judge handles the dogs</p>
			punctiliar			<p>a. The dog barked. Simultaneously the judge sneezed.</p> <p>b. When the dog barked, the judge sneezed.</p>
		overlapping	durative anterior dependent	stative		<p>a. We waited for several minutes. Meanwhile the judge arrived.</p> <p>b. While we waited the judge arrived.</p>
				non-stative		<p>a. We walked around the ring. Meanwhile John left.</p> <p>b. As we walked around the ring John left.</p>
			punctiliar posterior dependent			<p>a. –</p> <p>b. When the judge arrives, we'll have been waiting for several minutes.</p>
	successive	following	anterior dependent	non-deictic		<p>a. We walk the ring with our dogs. Then we just wait.</p> <p>b. After we walk the ring with our dogs we just wait.</p> <p>c. Our circle of the ring with our dogs precedes our wait.</p>
				deictic	extension to present	<p>a. We entered the competition last year. Up to now we haven't won.</p> <p>b. Since we entered the competition last year we haven't won.</p>
			extension from present		<p>a. We've started competing again. From now on we expect to do better.</p> <p>b. Now that we've started competing again we expect to do better.</p>	
			posterior dependent			<p>a. The judge handles the dogs. Previously, we'd tabled them.</p> <p>b. Before the judge handles the dogs, we'd tabled them.</p> <p>c. Our tabling of the dogs was followed by the judge handling them.</p>
			following immediately	anterior dependent	relief	
		relief un-marked				<p>a. The judge looked into the dog's mouth. Immediately it barked.</p> <p>b. As soon as the judge looked into the dog's mouth, it barked.</p>
		posterior dependent				<p>a. –</p> <p>b. We waited until the judge told us to get the best of our dogs.</p>

All examples from Martin (1992)

Table 5 Martin (1992), HYPOTACTIC EXTERNAL TEMPORAL relations

consequential	manner <i>(contingential)</i>	cause (obligation)	contingency (modalised)	condition	exclusive			a. We mated two champions. Thus we won a lot of prizes.						
								b. By mating two champions, we won a lot of prizes.						
	c. Mating two champions enabled us our winning of a lot of prizes.													
	consequence <i>(unmodalised)</i>							a. We arrived late. So we didn't have much time to prepare.						
								b. Because we arrived late, we didn't have much time to prepare.						
								c. Our late arrival led to us having little preparation time.						
								purpose	fear	inclusive	counter-factual	modality possible	a. Our dog had to stand nice and still. Otherwise we wouldn't have won.	
													b. Unless our dog had stood nice and still, we wouldn't have won.	
													c. Our dog standing nice and still was a necessary condition of our win.	
													factual	a. He might have arrived on time. Then he would have won.
														b. If he'd arrived on time he would have won.
														c. Not arriving on time as predicted precluded his win.
desire		modality probable	a. We might go. Then we will win.											
			b. If we go, we'll win.											
			c. Going will open the possibility of winning.											
modality certain	a. We'll probably turn up. Then we'll win.													
	b. As long as we show up we'll win.													
	c. Just showing up will make a win likely.													
modality probably/certain	a. We'll certainly turn up. Then we'll win.													
	b. Provided that we'll turn up, we'll win.													
	c. Just turning up will ensure (the certainty of) a win													
fear	modality possible	a. We didn't want to lose. So we didn't enter.												
		b. We didn't enter for fear of losing.												
		c. Our fear of losing prevented us from entering.												
desire	modality probably/certain	a. We wanted to win and had a chance. So we entered.												
		b. We entered in case we won.												
		c. The chance of winning encouraged us to enter.												
modality probably/certain	a. We wanted to win and had a good chance. So we entered.													
	b. We entered so that we would win.													
	c. The prospect of winning led us to enter.													

All examples from Martin (1992)

Table 6 Martin (1992), HYPOTACTIC EXTERNAL CONSEQUENTIAL relations

comparative	contrast	exception	a. We enjoyed the show. Only we lost the final event. b. We enjoyed the show except that we lost the final event. c. Our loss in the final event marred our enjoyment of the show.
		replacement	a. We should have gone to the show. Instead we stayed home. b. Instead of going to the show we stayed home. c. Going home was replaced by staying home.
		opposition	a. We won with the Corgis. But we lost with the Dachshunds. b. While we won with the Corgis, we lost with the Dachshunds. c. Our win with the Corgis contrasted with our loss with the Dachshunds.
	similarity		a. We won with the Corgis. Similarly we came first with the Dachshunds. b. We won with the Corgis, just as we did with the Dachshunds. c. Our win with the Corgis was paralleled by our first with the Dachshund.

All examples from Martin (1992)

Table 7 Martin (1992), HYPOTACTIC EXTERNAL COMPARATIVE relations

additive	correlative		[Both the Dachshund and the Corgi performed well in the show.]
	–		
	addition	positive	a. Our Dachshund performed well. And she looked splendid on the day. b. Besides performing well our Dachshund looked splendid on the day.
		negative	a. She didn't move at all well in the ring. Nor did she stand still when tabled. b. Alongside not moving very well in the ring, she didn't stand still when tabled.
alternation		a. You could go down to Melbourne. Or you could go in the Easter Show. b. If you don't go down to Melbourne, you could go in the Easter Show.	

All examples from Martin (1992)

Table 8 Martin (1992), HYPOTACTIC EXTERNAL ADDITIVE relations

comparative	comparative					
difference	similarity					
opposition	reformulation					
retraction	comparison	contigu	rework	generality	global	<p><i>The riot began</i> shows that riot is a process term, even though it is in the nominal form. Similarly, <i>the violence ended</i> suddenly marks <i>violence</i> as a process term even though it has no corresponding verb form.</p> <p>In short, several colligations in the text show that many nominals are encoding actions, not things.</p>
					local	<p><i>The riot began</i> shows that riot is a process term, even though it is in the nominal form.</p> <p>In general, nominals which function as Mediums for processes which characterise them as having beginnings and ends are in fact realising actions.</p>
				abstraction	<p><i>The riot began</i> shows that riot is a process term, even though it is in the nominal form.</p> <p>That is, the fact that <i>riot</i> is a noun does not mean that it cannot represent an action as it its colligation with <i>began</i> shows.</p>	
				exhaust	<p>When a clause shows that an idea encoded as a noun has a temporal beginning or end, this stands as evidence that the “idea” is an action.</p> <p>For example, <i>The riot began</i> shows that riot is a process term, even though it is in the nominal form.</p>	
				exemplify	<p><i>The riot began</i> shows that riot is a process term, even though it is in the nominal form.</p> <p>In particular certain of these occur as Mediums with verbs indicating they have a beginning and end, which concepts apply only to actions.</p>	
				particularise	<p>The text has a number of actions encoded as nouns which colligation clearly shows to be actions.</p> <p>In particular certain of these occur as Mediums with verbs indicating they have a beginning and end, which concepts apply only to actions.</p>	
				generalise	<p><i>The riot began</i> shows that riot is a process term, even though it is in the nominal form.</p> <p>In general, nominals which function as Mediums for processes which characterise them as having beginnings and ends are in fact realising actions.</p>	
				correct	<p>The way in which Liz addresses Mary is also significant: she feels perfectly free to use her first name, whereas Mary does not once use Liz’s name.</p> <p>In fact, Mary does not address Liz by any name.</p>	
			adjust	amplify	<p>The way in which Liz addresses Mary is also significant: she feels perfectly free to use her first name, whereas Mary does not once use Liz’s name.</p> <p>At least Mary does not use Liz’s name when actually addressing her. She does use it once when quoting something an former client had told her about Mary.</p>	
				diminish	<p>The way in which Liz addresses Mary is also significant: she feels perfectly free to use her first name, whereas Mary does not once use Liz’s name.</p> <p>Indeed Mary does not address Liz by at all, by name or otherwise.</p>	
				augment	<p><i>The riot began</i> shows that riot is a process term, even though it is in the nominal form.</p> <p>Similarly, the violence ended suddenly marks violence as a process term even though it has no corresponding term.</p>	
				interrupted	<p><i>The riot began</i> shows that riot is a process term, even though it is in the nominal form. It is a general fact about human language that while actions are congruently realised as verbs and nouns ... Such incongruence can be exploited by the media for ideological purposes.</p> <p>Similarly, the violence ended suddenly marks violence as a process term even though it has no corresponding term.</p>	
					<p>It would certainly be wrong to dismiss the results of such asocial linguistics as being false.</p> <p>Rather, we can see it as incomplete, in the same way that linguists of the 1970s find earlier grammars incomplete because they had little to say about syntax or pragmatics. (Hudson 1980: 19)</p>	

			contrast			<p>On the one hand we could view such grammars as false, or at least as politically impossible.</p> <p>On the other it might be preferable to see them as incomplete; this is the more comforting liberal view.</p>
		converse				<p>The most general and important point that has come out of this chapter is probably the close connection between data and theory. Until the data on quantitative variations on linguistic variables became available through the work of Labov, it was unnecessary to take seriously the need for quantitative statements in a linguistic theory. And conversely the lack of a place for such statements in linguistic theory prevented most linguists from bothering to look for relevant data. (Hudson 1980: 190)</p>

All examples from Martin (1992)

Table 9 Martin (1992), INTERNAL COMPARATIVE relations

additive	exchange punctuating					
	turn building	staging	framing	open	<p>Now, we can solve this particular problem by letting <i>John</i>, the old Z element, be a constituent of both clauses... Okay.</p> <p>Now what about the logical structure here.</p>	
				close	<p>Now, we can solve this particular problem by letting <i>John</i>, the old Z element, be a constituent of both clauses... Okay.</p> <p>Now what about the logical structure here.</p>	
			side- tracking	depart	<ul style="list-style-type: none"> - Are you coming tonight? I can give you a lift. - Sure. - Incidentally I saw Ben this morning and he was looking well. Guess he is recovered from his flu. I'd been a little worried about him, getting sick so often an all. - Yeah, me too. - Anyway, I'll see you around eight then. - Okay. 	
		return		<ul style="list-style-type: none"> - Are you coming tonight? I can give you a lift. - Sure. - Incidentally I saw Ben this morning and he was looking well. Guess he is recovered from his flu. I'd been a little worried about him, getting sick so often an all. - Yeah, me too. - Anyway, I'll see you around eight then. - Okay. 		
		developing		addition	simple	We go to dinner; as well we could try and see a movie.
			cumulative		<p>Processes like <i>laugh</i> and <i>cry</i> are not mental ones. Their typical tense selection for ongoing action is [present in present] (<i>*Why do you cry?</i>).</p> <p>Moreover, they cannot project (<i>*He laughed that he'd got it wrong.</i>).</p>	
					<p>Processes like <i>laugh</i> and <i>cry</i> really ought to be treated as behavioral ones. Their typical tense selection for ongoing action is [present in present] and they take a conscious Medium. They cannot project; <i>I laughed that he lost</i> is very unlikely.</p> <p>Furthermore, they are agnate to mental processes of reaction, being the physical manifestation of strongly liking and disliking (<i>thrill, please, upset, destroy, etc.</i>)</p>	
				alternation		We could eat at seven. Or won't you be hungry then?

All examples from Martin (1992)

Table 10 Martin (1992), INTERNAL ADDITIVE relations

consequential	concessive	objection	dismiss		
			concede	modality possible	
				modality probable	
		modality certain			
		counter-explanation			
	non-concessive	conclude			
justify					

All examples from Martin (1992)

Table 11 Martin (1992), INTERNAL CONSEQUENTIAL relations

temporal	successive	ordering	
		terminating	
	simultaneous	adjacent	
		interrupted	

All examples from Martin (1992)

Table 12 Martin (1992), INTERNAL TEMPORAL relations

Circumstance		(n) Probably the most extreme case of Visitors Fever I have ever witnessed was a few summers ago (s) when I visited relatives in the Midwest. (48)
Solutionhood		(s) One difficulty ... is with sleeping bags in which down and feather fillers are used as insulation. The insulation has a tendency to slip towards the button. (n) You can redistribute the filler. ... (49)
Elaboration		(n) Sånnga-Såby Kursgård, Sweden, will be the site of the 1969 International Conference on Computational Linguistics, September 1-4. (s) It is expected that some 250 linguists will attend from Asia, West Europe. East Europe including Russia, and the United States. (53)
Background		(n) Home addresses and telephone numbers of public employees will be protected from public disclosure under a new bill approved by Gov. George Deukmejian. (s) Assembly Bill 3100 amends the Government Code, which required that the public records of all state and local agencies, containing home addresses and telephone numbers of staff, be open to public inspection. (89: 51)
Enablement and Motivation	Enablement	(n) Training on jobs. A series of informative inexpensive pamphlets and books on worker health discusses such topics as filling compensation claim, ionizing radiation, asbestos, and several occupational diseases. (s) For a catalog and order form write WIOES, 2520 Milvia St., Berkeley, CA 95704. (55)
	Motivation	(n) The Los Angeles Chamber Ballet (the ballet company I am dancing with) is giving 4 concerts next week ... Tickets are \$7.50 except for the opening night ... (s) The show is made up of new choreography and should be very entertaining. (56)
Evidence and Justify	Evidence	(n) The program as published for calendar year 1980 really works. (s) In only a few minutes, I entered all the figures from my 1980 tax returns and got a result which agreed with my hand calculations to the penny. (12)
	Justify	(n) The next music day is scheduled for July 21 (Saturday), noon-midnight. (s) I'll post more details later, but this is a good time to reserve the place on your calendar. (89: 10)
Relations of Cause	Volitional Cause	(s) Writing has almost become impossible (n) so we had the typewriter serviced (and I may learn to type decently after all these years). (58)
	Non-Volitional Cause	(... we've been able to mine our own iron ore, coal, manganese, dolomite, all the material we need to make our own steel.) (s) And because we can mine more than we need, (n) we've plenty of manganese and iron ore for export. (60)
	Purpose	(s) To see which Syncom diskette will replace the ones you are using now, (n) send for our free "Flexi-Finder selection guide and the name of the supplier nearest to you. (64)
Antithesis and Concession	Antithesis	(Every rule has exceptions,) (n) but the tragic and too-common tableaux of hundreds or even thousands of people snake-lining up for any task with a paycheck illustrates a lack of jobs, (s) not laziness. (13)
	Concession	(s) Although Jim lists tennis, Chinese, and travel to exotic locales among his favorite hobbies, (n) one can't help but wonder at the unmentioned interests that help spark Jim's creativity. Leading him to concoct an unending stream of imaginative programs. (89: 50)

Condition and Otherwise	Condition	(n) Employees are urged to complete new beneficiary designation forms for retirement of life insurance benefits (s) whenever there is a change in marital or family status. (66)
	Otherwise	(It's new brochure time, and that means a chance for new project write-ups.) (n) Anyone desiring to update their entry in this brochure should have their copy in by Dec. 1. (s) Otherwise the existing entry will be used. (67)
Interpretation and Evaluation	Interpretation	(n) Steep decline in capital spending commitments and building permits, along with a drop in the money stock pushed the leading composite down for the fifth time in the past 11 months to a level of 0.5% below its high in May 1984. (s) Such a decline is highly unusual at this stage in an expansion. (67)
	Evaluation	(n) Features like our uniquely sealed jacket and protective hub ring make our disks last longer. And a soft inner liner cleans the ultra-smooth disc surface while in use. (s) It all adds up to better performance and reliability. (69)
Restatement and Summary	Restatement	(n) A WELL GROOMED CAR REFLECTS ITS OWNER. (s) The car you drive says a lot about you. (89: 56)
	Summary	(n) For top quality performance from your computer, use the flexible discs known for memory excellence. [this statement is motivated in the next sentences] (s) It's a great way way to improve your memory and get a big bonus in computer performance.
Other (non-nucleated) Relations	Sequence	(n) Peel oranges (n) and slice crosswise. (n) Arrange in a bowl (n) and sprinkle with rum and coconut. (n) Chill until ready to serve. (89: 56)
	Contrast	(n) Animals heal, (n) but trees compartmentalize. They endure a lifetime of injury and infection by setting boundaries that resist the spread of microorganisms. (89: 57)

All examples from Mann & Thompson (1987). (n) = nucleus; (s) = satellite.

Table 13 Mann & Thompson (1987).

Occasion		(1) Walk out of the door of this building. (2) Turn left. (3) Go to the corner. (85: 10) (1) He noticed the broken connection in the control mechanism, (2) and took it to his workshop to fix. (85: 11)
Evaluation		Did you bring your car today? My car is at the garage. (85: 12) The funniest thing happened to me. (A story) (85: 12)
'Prior knowledge'	Background	(1) And one Sunday morning about ohhhh five o'clock in the morning I sat down in the Grand – no, no, not in the Grand Central, in the Penn Station, (2) and while I was sitting there a young cat came up to me, ... (85: 12)
	Explanation	(1) He was in a foul humor. (2) He hadn't slept well that night. (2) His electric blanket hadn't worked. (85: 13)
Expansion	Parallel	(1) Set stack A empty (2) and set link variable P to T. (85: 15) (1) When sometime lofty towers I see down-rased. (2) And brass eternal slave to mortal rage. (Shakespeare) (85: 16)
	Elaboration	(1) Go down First Street. (2) Just follow First Street three blocks to A Street. (85: 18) (1) Al Haig's never been in politics – (2) he can't even spell the word "vote". (85: 19)
	Exemplification	(1) This algorithm reverses a list. (2) If its input is "A B C", its output is "C B A". (85: 19) (1) We cannot affirm that the technical evolution of East Asia followed the same course as it did in the West. (2) Certainly no stage corresponding to the Mousterian tradition has been found in China. (85: 20)
	Contrast	(1) You are not likely to hit the bull's eye (2) but you are more likely to hit the bull's eye than any other equal area. (85: 21) (1) Research proper brings into play clockwork-like mechanisms; (2) discovery has a magical essence. (85: 21)
	Violated expectation	John is a lawyer, (2) but honest. (1) We are in favor of a democratic republic as the best form of the state for the proletariat under capitalism; (2) but we have no right to forget that wage slavery is the lot of the people even in most of the democratic bourgeois republic. (85:22)

All examples from Hobbs (1985)

Table 14 Hobbs (1985)

Spatial situation	Spatial proximity		-	where
	Spatial proximity	Spatial connection of repeated events	-	wherever

All examples from Knott & Dale (1994)

Table 15 Knott & Dale (1994), SPATIAL relations

Temporal situation	Previous event		-After we had stepped out of the house, there was a huge clap of thunder. -After we had left the house, Jim began to talk more freely.	after (subordinator)
		Enabling previous event	As soon as we had stepped out of the house, there was a huge clap of thunder.	as soon as
			Once we had left the house, Jim began to talk more freely.	once
			Jim felt the pain for the first time when he was travelling to work	when
		2nd item to be represented	-	previously
			-	earlier
			-	before (sentential adverb)
	Simultaneous event		Once we had left the house, Jim began to talk more freely.	as soon as
			Jim felt the pain for the first time while he was travelling to work	while
			-When the children rushed by, Bob noticed that some of them were crying. -We were all shocked when we heard that Kennedy had been assassinated.	when
		Simultaneous repeated events	-	whenever
		2nd item to be represented	-	at the same time
			-	simultaneously
			-	in the meantime
	It was a lazy Sunday afternoon. Bill tinkered with his old Honda. Meanwhile, Bob mooched about on the deck reading the papers.		meanwhile	
	Future event			before (subordinator)
		Moment at which event ceases	-Mary held her breath, until she turned red. -Until you settle the matter amicably, or you will never be friends again. -John walked all afternoon, until he reached a huge forest.	until
	Current circumstances for future event		-	now that
			-	now
	Past circumstances for current/past event		I have been frightened of bees since I was a child.	since

All examples from Knott & Dale (1994)

Table 16 Knott & Dale (1994), TEMPORAL relations.

Causal/purpose relations	Projected	John summoned his nerve and made a break for the door; so pandemonium broke out in the bar.	so
		Mary held her breath, so that she turned red.	so that
	Anticipated event	Sally left the engine running in case she was in a hurry when she came back.	in case
	Hypothetical cause of lack of event	Unless you settle the matter amicably, or you will never be friends again.	unless
		Unless you settle the matter amicably, or you will never be friends again.	otherwise
			if not
		-There are several possibilities. It could be in the office; or it could be at home; finally it could be in Phil's place. -It could be in the kitchen; or it could be in the living room.	or
		-	or else
		-	else
		-The service began at nine o'clock; then it runs every half hour. -Dan set about making the boat ready. He took off the sail cover and threaded the sheets; then he checked the motor. -There are several possibilities. It could be in the office; then it could be at home; finally it could be in Phil's place. -I don't think that Bob can win. Firstly, he is out of training. Then, he's running at altitude; and finally, he's up against some pretty tough opponents. -John summoned his nerve and made a break for the door; then, pandemonium broke out in the bar. -Suppose that Liz had genuinely forgotten our appointment: then, she wouldn't have sounded so apologetic on the phone this evening. -If you behave well tonight, then you'll have extra pocket money on Friday. -John walked all afternoon, then he reached a huge forest.	then
		Suppose that Liz had genuinely forgotten our appointment: if so, she wouldn't have sounded so apologetic on the phone this evening.	if so
		-	in that case
		-	if not
		-	on the assumption (that)
		-Supposing that I really am one of the lucky winners, then that holiday in Tonga may be on the cards after all! -Supposing that they are travelling at about sixty miles an hour, they will arrive in about twenty minutes.	supposing that
		Unlikely hypothetical cause of event	-If ever I strike rich, I promise that I'll give you a fifty percent share in the business. -If ever she decided to leave me, I would be heartbroken.
	1st item to be presented	Suppose that they are travelling at about sixty miles an hour, they will arrive in about twenty minutes.	suppose (that)

Causal/purpose relations	Hypothetical cause of lack of desirable event	-	let us assume (that)	
		Hypothetical cause of desirable event	-	providing (that)
		-	provided (that)	
		You can stay up with us on condition that you promise to be quiet.	on condition that	
	Realised cause		-The proposal is useful, because it gives us a fallback position in the forthcoming negotiations collapse. -Because we've got nothing but circumstantial evidence in this case, it's going to be difficult to get a conviction. -Compulsive gamblers fall into their addiction because it provides an escape, however temporary, from the real world. -John stayed in bed that day, because he was sick. -John must have been sick on Monday, because he stayed all day in bed.	because
			-The proposal is useful, since it gives us a fallback position in the forthcoming negotiations collapse. -Since we've got nothing but circumstantial evidence in this case, it's going to be difficult to get a conviction. -John stayed in bed that day, since he was sick. -John must have been sick on Monday, since he stayed all day in bed.	since
			-The proposal is useful, as it gives us a fallback position in the forthcoming negotiations collapse. -John stayed in bed that day, as he was sick. -John must have been sick on Monday, as he stayed all day in bed.	as
		2nd item to be presented	-	after all
			-	for
		Semantic cause	John stayed in bed that day, on the grounds that he was sick.	on the grounds that
		Pragmatic cause	-It's a fairly good piece of work, given that you have been under a lot of pressure lately. -Given that we've got nothing but circumstantial evidence in this case, it's going to be difficult to get a conviction. -John must have been sick on Monday, given that he stayed all day in bed.	given that
				thus
			-The footprints are deep, and clearly defined. Therefore, the thief was a heavy man. -The number is divisible by four; thus it is divisible by two.	therefore
			-Sue left the country before the year was up; so she lost her right to permanent residence. -The footprints are deep, and clearly defined. So the thief was a heavy man.	so
			The number is divisible by four; hence it is divisible by two.	hence
		Semantic result	John summoned his nerve and made a break for the door; consequently, pandemonium broke out in the bar.	consequently
				as a consequence

Causal/purpose relations	Realised cause	-John summoned his nerve and made a break for the door; as a result, pandemonium broke out in the bar. -The number is divisible by four; as a result it is divisible by two.	as a result
	Pragmatic result	-The footprints are deep, and clearly defined. It follows that the thief was a heavy man. -The number is divisible by four; it follows that it is divisible by two.	it follows that

All examples from Knott (1996)

Table 17 Knott & Dale (1994), CAUSAL/PURPOSE relations

	Temporally/ presentationally repeated spans		once again
			again
			once more
Similarity relations	Similarity		likewise
			similarly
	Similarity between some thematic roles	-Jim jumped off the cliff, so Bill also jumped off. -I don't like Jim. He has no sense of humour; He also has no brains. -It could be in the kitchen; also it could be in the living room. -It's a good idea to keep them in their present jobs. Mullen has a flair for research; also, - Clarke is well suited to fieldwork.	also
		-Dan set about making the boat ready. He took off the sail cover and threaded the sheets; he checked the motor too. -It looks as though Dan was preparing to sail. He had taken off the sail cover and threaded the sheets; I saw him checking the motor too. -Jim jumped off the cliff. Bill also jumped off too.	too
		-Dan set about making the boat ready. He took off the sail cover and threaded the sheets; he checked the motor as well. -There are several possibilities. It could be in the office; it could be at home as well; finally it could be in Phil's place. -Jim jumped off the cliff. Bill also jumped off as well. -It could be in the kitchen; It could be in the living room as well.	as well
	Similarity	Parallels between spans	correspondingly

All examples from Knott (1996)

Table 18 Knott & Dale (1994), SIMILARITY relations

Negative polarity relations	Contrast/expected preventer of event		though	
			although	
		Contrast	<p>We should swap Liz and Kim. Liz is excellent in defence, while Kim is much better in goal.</p> <p>While I am normally a timid man, on this occasion I was roused to anger.</p> <p>Bill and Bob could not be more different. While Bill excels in all kinds of sports, Bob lives for his schoolbooks.</p>	while
			<p>-We should swap Liz and Kim. Liz is excellent in defence, whereas Kim is much better in goal.</p> <p>-That night, Bill and Bob were dressed very differently. Bill was wearing a red suit; whereas Bob was wearing a blue one.</p> <p>-Bill and Bob could not be more different. Whereas Bill excels in all kinds of sports, Bob lives for his schoolbooks.</p> <p>-I'm more or less a committed socialist, whereas she's far to the right of Genghis Khan.</p> <p>-It's a good idea to keep them in their present jobs.</p> <p>Mullen has a flair for research; whereas Clarke is well suited to fieldwork.</p>	whereas
		1st item to be presented		on one hand
		2nd item to be presented		on the one hand
			<p>We should swap Liz and Kim. Liz is excellent in defence, on the other hand Kim is much better in goal.</p> <p>-That night, Bill and Bob were dressed very differently. Bill was wearing a red suit; on the other hand, Bob was wearing a blue one.</p> <p>-I'm not sure whether she should get the job. She is pretty smart; on the other hand, she didn't show much enthusiasm in the interview.</p> <p>-It could be in the kitchen; on the other hand, it could be in the living room.</p> <p>We could go out for a walk. On the other hand, it's raining: we may be better off indoors.</p>	on the other hand
			<p>We could go out for a walk. Then again, it's raining: we may be better of indoors.</p>	then again
				at the same time
				by contrast
				in contrast
		Expected preventer of event		notwithstanding that
				despite the fact that
			<p>-She does more work than the rest of us put together, even though she is part-time.</p> <p>-Even though I am normally a timid man, on this occasion I was roused to anger.</p>	even though

Negative polarity relations	Contrast/unexpected event (2nd item to be presented)		-She is part-time; but she does more work than the rest of us put together. -Jim was starving; but there was no food in the house.	but
			-She is part-time; however, she does more work than the rest of us put together. -Jim was starving; however, there was no food in the house.	however
				yet
	Unexpected event (2nd item to be presented)			on the other hand
				then again
				at the same time
			by contrast	
			in contrast	

Table 19 Knott & Dale (1994), *NEGATIVE POLARITY relations*

Clarifications	Restatement		-The footprints are deep, and clearly defined. That is to say, the thief was a heavy man. -Foley doesn't like cowards; and if you don't agree to meet him, he'll think you are a coward. If you face up to him he'll respect you, and he'll be more likely to make concessions. That is to say, we do think you should go to the meeting, but we don't think you should agree to his demands. -The latest reports indicate that she doesn't want to visit our country. That is to say, she does want to visit, but not in the present political climate.	that is to say
			-As we have already seen, the story he told to Foley was completely different to the story he has given us. In other words, he must be lying. -Foley doesn't like cowards; and if you don't agree to meet him, he'll think you are a coward. If you face up to him he'll respect you, and he'll be more likely to make concessions. In other words, we do think you should go to the meeting, but we don't think you should agree to his demands.	in other words
			I don't despise him at all: on the contrary, I have a lot of respect for him.	on the contrary
	Positive Restatement of negative			for example
	Exemplification			for instance
				to take an example
			-I don't despise him at all: in fact, I have a lot of respect for him. -I liked Perkins a great deal: in fact, the whole squadron liked him -Grandpa's always going on about his experiences during the war. In fact, he was only in the catering corps; but he still seems to have had a pretty hairy time.	in fact
	Additional information			in actual fact
			I liked Perkins a great deal: actually, the whole squadron liked him.	actually
			-It's high quality, good value for money, and easy to use: in short, the RX-470 is an excellent package, and we highly recommend it. -As we have already seen, the story he told to Foley was completely different to the story he has given us. In short, he must be lying. -Forensic has drawn a blank, door-to-door questioning is getting nowhere, and we can't even begin to think of a motive. In short, the case is a complete shambles.	in short
Summary	Summary of large span		to summarise	
Cl			in sum	
			summarising	

			Foley doesn't like cowards; and if you don't agree to meet him, he'll think you are a coward. If you face up to him he'll respect you, and he'll be more likely to make concessions. To sum up, we do think you should go to the meeting, but we don't think you should agree to his demands.	to sum up
			-It's high quality, good value for money, and easy to use: summing up, he RX-470 is an excellent package, and we highly recommend it. -Foley doesn't like cowards; and if you don't agree to meet him, he'll think you are a coward. If you face up to him he'll respect you, and he'll be more likely to make concessions. Summing up: we do think you should go to the meeting, but we don't think you should agree to his demands.	summing up
	Summary	Summary of large span	-As we have already seen, the story he told to Foley was completely different to the story he has given us. In conclusion, he must be lying. -Foley doesn't like cowards; and if you don't agree to meet him, he'll think you are a coward. If you face up to him he'll respect you, and he'll be more likely to make concessions. In conclusion, we do think you should go to the meeting, but we don't think you should agree to his demands.	in conclusion
			-It's high quality, good value for money, and easy to use: to conclude he RX-470 is an excellent package, and we highly recommend it. -As we have already seen, the story he told to Foley was completely different to the story he has given us. To conclude, he must be lying.	to conclude
				essentially then
			-It's high quality, good value for money, and easy to use: all in all he RX-470 is an excellent package, and we highly recommend it. -Foley doesn't like cowards; and if you don't agree to meet him, he'll think you are a coward. If you face up to him he'll respect you, and he'll be more likely to make concessions. All in all, we do think you should go to the meeting, but we don't think you should agree to his demands.	all in all
			We were telling about Frank; and about how tidy his flat is these days. It's quite amazing, considering how it used to look. Incidentally, did you know that Frank has given up his job? He's now writing full time.	incidentally

All examples from Knott (1996)

Table 20 Knott & Dale (1994), CLARIFICATIONS relations

causal	semantic	basic	positive	1a. cause-consequence	Because they have to fly long distances in a short period of time, the cranes are in poor condition on arrival.
				1b. condition-consequence	If they make it to Spain in two weeks, the cranes are in poor condition on arrival.
			negative	2. contrastive cause-consequence	Although the cranes are good flyers, they are in poor condition on arrival.
		non-basic	positive	3a. consequence-cause	The cranes are in poor condition on arrival, because they have just crossed the Pyrenees.
				3b. consequence-condition	The cranes are in poor condition on arrival, if they make it across the Pyrenees.
			negative	4. contrastive consequence-cause	The cranes are in poor condition on arrival, although they take long and frequent rests during their journey.
	pragmatic	basic	positive	5a. argument-claim	The cranes can be caught easily in Northern Spain, so they are in poor condition on arrival.
				5b. condition-claim	Provided that it may be assumed that the research data can be trusted, the cranes are in poor condition on arrival.
			negative	6. contrastive argument-claim	Although not all the research data point in the same direction, the cranes are in poor condition on arrival.
		non-basic	positive	7a. claim-argument	They are in poor condition on arrival, for they have sometimes lost half of the weight they had when they left Scandinavia.
				7b. claim-condition	They are in poor condition on arrival, at least if it may be assumed that weight is a good indicator for their condition. (Upon arrival they have sometimes lost half of the weight they had when they left.)
			negative	8. contrastive claim-argument	The cranes appear to be in poor condition, although they weigh about as much as when they left.
additive	semantic	positive	9. list	In groups of 100 to 300 birds on average, the cranes enter Spain. They are in poor condition on arrival.	
		negative	10a. opposition	The cranes are in poor condition on arrival. By contrast, they are in good condition when they leave.	
			10b. exception	The cranes are in poor condition on arrival. This does not hold for the two-year old birds. (They appear to be the strongest.)	
	pragmatic	positive	11. enumeration	The cranes are in poor condition on arrival. Moreover, more than twenty percent of them do not survive the journey.	
		negative	12. concession	The cranes are in poor condition on arrival, but most of them recover quickly.	

All examples from Sanders et al. (1993)

Table 21 Sanders, Spooren & Noordman (1993)

	words	Halliday & Hasan (1976)			Martin (1992)		
		Adversative	Internal	Contrastive	Avowal		
1	actually	Adversative	Internal	Contrastive	Avowal		
2	"admittedly x, but y"						
3	after					Temporal	Successive
4	After all					Consequential	Consequence
5	alternatively	Additive	Internal	"Complex, emphatic"	Alternative	Additive	Alternation
6	although					Consequential	Concession
7	although						
8	although						
9	although						
10	an hour later	Temporal	Internal	Complex (external only)	Specific		
11	and	Additive	External/internal	Additive simple	Additive	Additive	Addition
12	and	Adversative	Internal	Contrastive (external)	Simple		
13	anyhow	Adversative	Internal	Dismissal	Open-ended		
14	arising out of this	Causal	Internal	"Causal, specific"	Result		
15	as					Comparative	Similarity
16	as					Consequential	Consequence
17	as a result	Causal	External/internal	Causal specific	Result		
18	as if					Comparative	Similarity
20	at least	Adversative	Internal	Correction	Of wording		
21	at the same time	Adversative	Internal	Contrastive	Emphatic		
22	at the same time	Temporal	External/internal	"Temporal, simple (external only)"	Simultaneous		
23	At the same time					Temporal	Simultaneous
24	because	Causal	Internal	Reversed causal	Simple	Consequential	Consequence
25	because						
26	before long						
27	before						
28	besides	Additive	Internal	"Complex, emphatic"	Additive	Additive	Addition
29	but	Adversative	External/internal	Adversative 'proper'	Containing 'and'	Comparative	Contrast
30	but	Adversative	Internal	Contrastive (external)	Simple	Consequential	Concession
31	by contrast	Additive	Internal	Comparison	Dissimilar		

words	Halliday & Hasan (1976)			Martin (1992)		
32 by contrast						
33 "by x, y"						
34 by the way	Additive	Internal	"Complex, de-emphatic"	Afterthought		
35 consequently	Causal	External/internal	Causal general	Emphatic		
36 despite this						
39 even then						
41 finally	Temporal	External/internal	Conclusive	Simple	Successive	Distinctive Internal
42 finally	Temporal	Internal	Internal temporal	Conclusive		
43 first ... next	Temporal	Internal	Correlative forms	Sequential		
44 first ... then	Temporal	External/internal	Correlative forms	Sequential		
45 for	Causal	Internal	Reversed causal	Simple	Consequence	"External/internal: "Cohesive"
46 for instance	Additive	Internal	Apposition	Exemplificatory		
47 fortunately						
48 furthermore						
49 hence	Causal	External/internal	Causal general	Simple		
50 however	Adversative	External/internal	Adversative 'proper'	Emphatic	Concession	"External/internal: "Cohesive"
51 however	Adversative	Internal	Contrastive	Emphatic	Condition	Hypotactic
52 if						
53 if						
54 in addition	Additive	Internal	"Complex, emphatic"	Additive	Addition	Distinctive Internal
55 in any case	Adversative	Internal	Dismissal	Closed		
56 in any case	Adversative	Internal	Dismissal	Open-ended		
57 in any event						
58 in case						
59 in conclusion	Temporal	Internal	Internal temporal	Conclusive	Purpose	Hypotactic
60 In contrast				Consequential	Consequence	Distinctive Internal
61 in contrast				Comparative	Contrast	"External/internal: "Cohesive"
62 in fact	Adversative	Internal	Contrastive	Avowal		

words		Halliday & Hasan (1976)				Martin (1992)	
63	in order that						
64	in other words	Additive	Internal	Apposition		Expository	
65	in short	Temporal	Internal	Summary		Summarizing	
66	in that case	Causal	Internal	Conditional (also external)		Emphatic	
67	incidentally	Additive	Internal	"Complex, de-emphatic"		Afterthought	
68	instantly						
69	instead	Adversative	Internal	Correction		Of meaning	Contrast
70	it follows	Causal	Internal	"Causal, specific"		Reason	
71	it follows that						
72	likewise	Additive	Internal	Comparison		Similar	Similarity
73	meanwhile	Temporal	Internal	Complex (external only)		Durative	Simultaneous
74	moreover						
75	nevertheless	Adversative	External/internal	Adversative 'proper'		Emphatic	Concession
76	next						
77	not that						
78	now that						
79	on the other hand	Additive	Internal	Comparison		Dissimilar	Successive
80	on the other hand	Adversative	Internal	Contrastive		Emphatic	Contrast
81	only if						
82	only when						
83	or	Additive	External/internal	Additive simple		Alternative	Alternation
84	or else	Additive	External/internal	Additive simple		Alternative	Paratactic
85	otherwise	Causal	Internal	Conditional (also external)		Reversed polarity	Condition
86	otherwise	Causal	Internal	Respective		Reversed Polarity	
87	previously	Temporal	External/internal	"Temporal, simple (external only)"		Preceding	Successive
88	provided that						
90	similarly	Additive	Internal	Comparison		Similar	

	words	Halliday & Hasan (1976)			Martin (1992)		
91	since				Consequential	Consequence	Hypotactic
92	since				Temporal	Successive	Hypotactic
93	so	Causal	External/internal	Causal general	Consequential	Consequence	Paratactic
94	so						
95	suddenly						
96	that is	Additive	Internal	Apposition	Comparative	Similarity	Distinctive Internal
97	then	Causal	External/internal	Causal general	Temporal	Simultaneous	Paratactic
98	then	Causal	Internal	Conditional (also external)	Temporal	Successive	Paratactic
99	then	Temporal	External/internal	“Temporal, simple (external only)”	Consequential	Condition	Distinctive Internal
100	then	Temporal	Internal	Internal temporal	Consequential	Condition	“External/internal: ‘Cohesive’”
101	then again						
102	therefore	Causal	External/internal	Causal general	Consequential	Consequence	“External/internal: ‘Cohesive’”
103	Thereupon	Temporal	Internal	Complex (external only)	Temporal	Successive	“External/internal: ‘Cohesive’”
104	Though	Adversative	External/internal	Adversative ‘proper’			
105	Thus	Additive	Internal	Apposition	Consequential	Manner	“External/internal: ‘Cohesive’”
106	To						
107	Unfortunately						
108	Unless				Consequential	Condition	Hypotactic
109	Until						
110	When				Temporal	Simultaneous	Hypotactic
111	When						
112	Whereas				Comparative	Contrast	Hypotactic
113	Wherever						
114	While				Temporal	Simultaneous	Hypotactic
115	While						
116	Yet	Adversative	External/internal	Adversative ‘proper’	Consequential	Concession	“External/internal: ‘Cohesive’”

Table 22 Comparison Halliday & Hasan (1976) and Martin (1992)

words	Knott & Dale (1994)		Sanders et al. (1993)			
	Clarifications	Additional information				
1 actually						
2 "admittedly x, but y"						
3 after	Temporal situation	Previous event				
4 After all	Causal/purpose relations	Realised cause				
5 alternatively		2nd item to be pres.				
6 although	Negative polarity relations	Contrast/expected preventer of event	CAUS SEM	BAS	NEG 2	Contrastive Cause-Consequence
7 although			CAUS SEM	NON-BAS	NEG 4	Contrastive Consequence-Cause
8 although			CAUS PRAG	BAS	NEG 6	Contrastive Argument-Claim
9 although			CAUS PRAG	NON-BAS	NEG 8	Contrastive Claim-Argument
10 an hour later						
11 and						
12 and						
13 anyhow						
14 arising out of this						
15 as	Causal/purpose relations	Realised cause				
16 as						
17 as a result	Causal/purpose relations	Realised result				
18 as if						
20 at least						
21 at the same time	Temporal situation	Simultaneous event				
		2nd item to be represented				

words	Knott & Dale (1994)				Sanders et al. (1993)			
	Negative polarity relations	Contrast/expected preventer of event	Contrast	2nd item to be pres.				
22 at the same time								
23 At the same time								
24 because	Causal/purpose relations	Realised cause			CAUS SEM	BAS	POS	1a Cause-Consequence
25 because					CAUS SEM	NON-BAS	POS	3a Cause-Consequence
26 before long								
27 before								
28 besides								
29 but	Negative polarity relations	Contrast/unexpected event (2nd item to be pres.)	2nd item to be pres.		ADD PRAG	-	NEG	12 Concession
30 but								
31 by contrast	Negative polarity relations	Contrast/expected preventer of event	Contrast	2nd item to be pres.	ADD SEM	-	NEG	10b Exception
32 by contrast	Negative polarity relations	Contrast/unexpected event (2nd item to be pres.)	Unexpected event (2nd item to be pres.)					
33 "by x, y"								
34 by the way	Interruption	Digression						
35 consequently	Causal/purpose relations	Realised result	Semantic result					
36 despite this								
39 even then								
41 finally								
42 finally								
43 first ... next								
44 first ... then								
45 for	Causal/purpose relations	Realised cause	2nd item to be pres.		CAUS PRAG	NON-BAS	POS	7a Claim-Argument

words	Knott & Dale (1994)		Sanders et al. (1993)				
	Clarifications	Exemplification					
46 for instance							
47 fortunately							
48 furthermore							
49 hence	Causal/purpose relations	Realised result					
50 however	Negative polarity relations	Contrast/unexpected event (2nd item to be pres.)	2nd item to be pres.				
51 however							
52 if				CAUS SEM	BAS	POS	1b Condition-Consequence
53 if				CAUS SEM	NON-BAS	POS	3b Consequence-Condition
54 in addition							
55 in any case	Interruption	Return to previous point					
56 in any case							
57 in any event	Interruption	Return to previous point					
58 in case	Causal/purpose relations	Anticipated event acting as volitional cause					
59 in conclusion	Clarifications	Summary	Summary of large span				
60 In contrast	Negative polarity relations	Contrast/expected preventer of event	Contrast				Conclusion 2nd item to be pres.
61 in contrast	Negative polarity relations	Contrast/unexpected event (2nd item to be pres.)	Unexpected event (2nd item to be pres.)				
62 in fact	Clarifications	Additional information					
63 in order that							
64 in other words	Clarifications	Restatement					
65 in short	Clarifications	Summary					
66 in that case	Causal/purpose relations	Hypothetical result of event					

words	Knott & Dale (1994)		Sanders et al. (1993)				
	Interruption	Digression					
67 incidentally							
68 instantly							
69 instead							
70 it follows	Causal/purpose relations	Realised result	Pragmatic result				
71 it follows that							
72 likewise	Similarity relations	Similarity					
73 meanwhile	Temporal situation	Simultaneous event	2nd item to be represented				
74 moreover				ADD PRAG	POS	11 Enumeration	
75 nevertheless							
76 next							
77 not that							
78 now that	Temporal situation	Current circumstances for future event					
79 on the other hand	Negative polarity relations	Contrast/expected preventer of event	Contrast			2nd item to be pres.	
80 on the other hand	Negative polarity relations	Contrast/unexpected event (2nd item to be pres.)	Unexpected event (2nd item to be pres.)				
81 only if							
82 only when							
83 or	Causal/purpose relations	Hypothetical result of lack of event					
84 or else	Causal/purpose relations	Hypothetical result of lack of event					
85 otherwise	Causal/purpose relations	Hypothetical result of lack of event					
86 otherwise							
87 previously	Temporal situation	Previous event	2nd item to be represented				

	words provided that	Knott & Dale (1994)				Sanders et al. (1993)						
		Similarity relations	Causal/purpose relations	Temporal situation	Similarity Realised cause Past circumstances for current/past event Projected result Realised result	CAUS	PRAG	BAS	POS	5b	Condition-Claim	
88	provided that											
90	similarly	Similarity relations			Similarity							
91	since	Causal/purpose relations			Realised cause							
92	since	Temporal situation			Past circumstances for current/past event							
93	so	Causal/purpose relations			Projected result	CAUS	PRAG	BAS	POS	5a	Argument-Claim	
94	so	Causal/purpose relations			Realised result							
95	suddenly											
96	that is											
97	then	Causal/purpose relations			Hypothetical result of event							
98	then											
99	then											
100	then											
101	then again											
102	therefore	Causal/purpose relations			Realised result							
103	thereupon											
104	though	Negative polarity relations			Contrast/expected preventer of event							
105	thus	Causal/purpose relations			Realised result							
106	to											
107	unfortunately											
108	unless	Causal/purpose relations			Hypothetical cause of lack of event							
109	until	Temporal situation			Future event							Moment at which event ceases
110	when	Temporal situation			Previous event							Enabling previous event

	words	Knott & Dale (1994)			Sanders et al. (1993)								
		Temporal situation	Simultaneous event	Contrast/expected preventer of event									
111	when	Negative polarity relations	Spatial situation	Temporal situation	Contrast								
112	whereas												
113	wherever												
114	while												
115	while												
116	yet												

Table 23 Comparison Knott & Dale and Sanders et al. (1993)

	words	K1	K2	K3	K4	K5	K6	K7	K8
1	actually								
2	“admittedly x, but y”	PRAG		-		NEG	NON	ACT	
3	after								
4	After all								
5	alternatively								
6	although								
7	although								
8	although								
9	although								
10	an hour later								
11	and	-				-	NON		-?
12	and								
13	anyhow								
14	arising out of this								
15	as								
16	as								
17	as a result	SEM	CAUS	BILAT	COUNT	POS	NON	ACT	CAUS
18	as if								
20	at least								
21	at the same time								
22	at the same time								
23	At the same time								
24	because	PRAG		BILAT	COUNT	POS	PRES	ACT	CAUS
25	because								
26	before long	SEM					NON	ACT	CAUS
27	before	SEM					PRES	ACT	CAUS
28	besides	PRAG		UNIL	COUNT	NEG	NON		CAUS
29	but	-	-		COUNT	NEG	NON	ACT	-
30	but								
31	by contrast								
32	by contrast								
33	“by x, y”	PRAG	RES	BILAT		POS	PRES	ACT	CAUS
34	by the way								
35	consequently								
36	despite this	PRAG	CAUS	BILAT	COUNT	NEG	NON	ACT	CAUS
39	even then	-				POS		-	
41	finally					POS	NON	ACT	
42	finally								
43	first ... next								
44	first ... then								
45	for								
46	for instance								
47	fortunately	SEM	RES	UNIL		POS	NON	ACT	CAUS
48	furthermore	PRAG		“UNIL,”		POS	NON	ACT	IND?
49	hence								
50	however								
51	however								
52	if	-	-	-	COUNT	-	PRES	HYP	CAUS
53	if								

	words	K1	K2	K3	K4	K5	K6	K7	K8
54	in addition								
55	in any case								
56	in any case								
57	in any event								
58	in case								
59	in conclusion								
60	In contrast								
61	in contrast								
62	in fact								
63	in order that	PRAG	RES	BILAT		POS	PRES		CAUS
64	in other words								
65	in short								
66	in that case					POS	NON	HYP	CAUS
67	incidentally								
68	instantly	SEM					NON	ACT	CAUS
69	instead			UNIL	COUNT	NEG	NON	ACT	CAUS
70	it follows								
71	it follows that	PRAG		BILAT		POS	NON	ACT	CAUS
72	likewise								
73	meanwhile	SEM		UNIL			NON	ACT	CAUS
74	moreover								
75	nevertheless								
76	next	-				POS	NON	ACT	
77	not that	PRAG					NON		
78	now that								
79	on the other hand	-		UNIL		NEG	NON	ACT	IND
80	on the other hand								
81	only if	-				NEG	PRES	HYP	CAUS
82	only when	SEM				NEG	PRES	ACT	CAUS
83	or	-	-	-	ANCH	NEG	NON	HYP	CAUS
84	or else								
85	otherwise		RES	BILAP	ANCH	NEG	NON	ACT	CAUS
86	otherwise								
87	previously								
88	provided that			BILAT	COUNT	-	PRES	HYP	CAUS
90	similarly								
91	since								
92	since								
93	so	-	-	BILAT		POS			CAUS
94	so								
95	suddenly	SEM					NON	ACT	CAUS
96	that is								
97	then								
98	then								
99	then								
100	then								
101	then again	PRAG		UNIL		NEG	NON	ACT	IND
102	therefore								
103	thereupon								

	words	K1	K2	K3	K4	K5	K6	K7	K8
104	though								
105	thus								
106	to	PRAG	RES			POS	PRES		CAL'S
107	unfortunately	SEM	RES	UNIL		NEG	NON	ACT	CAUS
108	unless	PRAG	CAUS	BILAT	ANCH	NEG	PRES	HYP	CAUS
109	until	SUM	CAUS	BILAT	A.NCH	NEG	PRES	ACT	CAUS
110	when	SEM	-	-	COUNT		PRES	ACT	
111	when								
112	whereas	SEM		UNIL		NEG	PRES	ACT	IND
113	wherever								
114	while	-		-		-	PRES	ACT	-?
115	while								
116	yet								

Table 24 Comparison Knott (1996)

APPENDIX III

Overview of the texts used in the non-cumulative self-paced reading time experiments reported in Chapter 6.

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TEXTS USED FOR SECOND COHESION EXPERIMENT

The athletes were preparing themselves for the 80-metre hurdles

The start of the race was very riveting

[conjunction] the expected winner fell

NASA was following every development of the space shuttle flight

Initially they were not very satisfied

[conjunction] the shuttle came into orbit early

Tony was a heavy drinker

He had a bad headache

[conjunction] he drank the usual amount of alcohol

The position of the President is not very stable

Last month the senate decided to start impeachment hearings

[conjunction] the President denied perjury

The detective investigated the murder case

He had no obvious suspects

[conjunction] some obscure footprints in the sand were found

BBC1 and BBC2 were the only channels I had

Generally I didn't like the programmes

[conjunction] there were a lot of re-runs

The amusement park opened for the summer season

Many attractions were not that exciting

[conjunction] they opened the new roller-coaster

Sue had broken her hip

She was less worried than you might expect

[conjunction] the complications got to be very serious

The fatwa on Salman Rushdie lasted for several years
It caused a lot of commotion
[conjunction] it was suddenly lifted

The journalist had a long interview with the MP
He continued asking about the allegations
[conjunction] the MP broke down

The bookstore was just at the other end of the street
I hardly went there to buy books
[conjunction] I saw they had a lot of books on science

Nigel drove to work
There was only a slight delay on the road
[conjunction] there was a major accident in the right lane

Harry had a busy day
He went for a business lunch
[conjunction] he had an afternoon meeting

The Egyptian empire lasted many centuries
For a long time Egypt was a wealthy country
[conjunction] the Romans conquered it

The AGM discussed the future of the company
The treasurer said the future looked bright
[conjunction] he heard the president had announced his retirement

The opening of the club was advertised in every newspaper
A lot of people planned to come to the venue
[conjunction] they heard the spice girls were performing

The course was given in the first and the second terms

The students enjoyed themselves very much

[conjunction] the lecturer was regularly late

The documentary discussed the existence of aliens

I wasn't sure whether they really existed

[conjunction] there were some obscure pictures

The PhD candidate was very nervous before the examination

The beginning of the oral went very well

[conjunction] the examiners asked a few very profound questions

My favourite band played last night

The concert was very good

[conjunction] they played the songs from their latest album

Rob fancied Janet

Janet hesitated to date Rob

[conjunction] he asked her out a few times

The painter had a complete portfolio of paintings

He was not sure whether to sell one of the paintings

[conjunction] a large price was offered for the whole collection

My neighbour played the saxophone

I didn't like it

[conjunction] he practised every day

The sailboat was at the head of the race

The captain of the ship decided to hoist an extra sail

[conjunction] the wind increased

The student union was carefully considering the situation
Students complained about the amount of work they had
[conjunction] they had their exams at the end of May

The trial lasted several days
The judge had difficulty in coming to a decision
[conjunction] he realised the accused was telling lies

George and Susan met for a date
Susan did not feel very comfortable
[conjunction] George laughed very heartily

For a long time the airport needed more space
The government considered moderate expansion
[conjunction] environmental groups protested against any expansion

Years ago researchers discussed the existence of the Loch Ness monster
Nobody then believed it existed
[conjunction] there was one rather blurry picture showing the monster

The famous actor played the main role in the movie
A lot of people went to see it
[conjunction] the newspaper reported that the actor was having an affair

Researchers were worried about the purple African butterfly
They concluded the species was becoming extinct
[conjunction] they counted a thousand in western Africa

The terrorist attacks shocked the nation
The newspapers were full of furious editorials
[conjunction] the government started to counterattack

ADDITIONAL FOUR TEXTS USED IN FIRST COHESION EXPERIMENT

Long ago, the milkman came to our door every morning

He delivered milk door-to-door in smaller villages

[conjunction] supermarkets became more common in the suburbs

The PhD student wanted to graduate soon

He worked practically day and night

[conjunction] the final chapter of his thesis was almost finished

Things were not going very well at Gate 12

The check-in staff were in a panic

[conjunction] the aeroplane was delayed for five hours

The collapse of the Asian economy caused confusion all over the world

the economic situation in Europe was particularly worrying

[conjunction] the unemployment rate changed drastically

ADDITIONAL TEXTS USED IN DATA COLLECTION

Alzheimer's patients are often tested on their memory capacity

They can do some very simple tasks

[conjunction] their memory is very limited

The competition between companies is fierce

Microsoft fired many well-trained employees

[conjunction] the company needed specialised personnel

Allan and Jean got on the train

They had not bought tickets

[conjunction] the conductor came by

The forest fires lasted for weeks
Firemen from all over the country were asked for help
[conjunction] the base team was short-handed

Mark did not sleep well at night
Initially, the new job was perfect for him
[conjunction] he worked night shifts

For years Trevor played the lottery
He was thinking about not buying tickets any longer
[conjunction] he won 50 pounds in total

The GP looked at the knee carefully
He was uncertain about the lump
[conjunction] it was rather big

The newlyweds returned from their honeymoon
They had spent the second week on the beach
[conjunction] the weather was particularly hot

Safety on North Sea drilling platforms has to improve
For a long time a modernisation plan was put on hold
[conjunction] the cause of the Piper Alpha disaster was carefully analysed

Fred and Jane had booked a full-board hotel in Greece
They enjoyed their holidays
[conjunction] they moved to another hotel

The football team was fighting for a victory
They did not bring Ronaldo into the game
[conjunction] he was scoring several goals in the last minute

Rebecca had always wanted a child
The pregnancy went well
[conjunction] she went into labour early

The police stopped the driver of the car
They wanted to arrest him
[conjunction] they saw his driving license

William Hague opened the party conference
The audience was bored
[conjunction] he talked like he used to

After a long busy week I really enjoy the weekend
I go hiking in the Highlands
[conjunction] I want to relax

He did his military service in the Air Force
He did not like the forces
[conjunction] he served for a long time

It was the start of the academic year
The students were getting themselves ready
[conjunction] the library was open

As a teenager, Robbie loved shopping
Her parents always complained about the money
[conjunction] she paid a fair price for clothing

The taxi-driver brought us to the airport
We were not very happy with him
[conjunction] he ignored the traffic light

You can never be sure about the weather in Scotland
Walter and Alice very much enjoyed their holiday there
[conjunction] the weather changed

The writer was invited to read from his work
The audience was very disappointed
[conjunction] he read his short poems

Paul just finished his latest book
I wasn't sure whether I liked it
[conjunction] I saw the first draft

Jim and Catherine often ate at a local restaurant
They left a small tip
[conjunction] the service got to be reasonably good

A group of climbers went to the Highlands this weekend
They did not return from their trip in time
[conjunction] they worked in Glasgow

Usually there are all kinds of students on this course
Last year Rachel was one of the good ones
[conjunction] she began working methodically

The couple felt desperate
Burglars visited their house repeatedly
[conjunction] they moved to an area close to the harbour

The operation took only two hours to complete
The surgeon wanted to finish the operation quickly
[conjunction] he was quite sure about the cause of the lump

Joe and Cindy were looking forward to their trip to the USA

There were many problems with boarding the plane

[conjunction] the new cabin crew arrived

We are not sure whether to invite Charles and Monica to the party

Monica is often quite irritating

[conjunction] Charles loses his temper

The tension in the Middle East is increasing

The United Nations has made every effort to negotiate

[conjunction] the United States have their own problems

The funeral was held in the woods

The ceremony was very embarrassing

[conjunction] the brother of the deceased made a speech

Michael expected friends over for dinner

He concentrated on preparing an elaborate salad

[conjunction] the turkey was burnt

Things were not going very well at Gate 12

The check-in staff were in panic

[conjunction] the aeroplane was delayed for five hours

My partner always lost her keys

I used to forget my keys all the time

[conjunction] I left them on my desk

The accident in which she was involved changed our lives

I was very worried about her

[conjunction] she had an odd reaction to her injuries

James Bond films are always very good

The earlier films were the best

[conjunction] Roger Moore played the role of Bond

The bride arrived an hour before the wedding ceremony started

Everything was going very well

[conjunction] the groom came in 20 minutes before the ceremony started

An impeachment procedure was started against Bill Clinton

Earlier on he committed adultery

[conjunction] he was President of the United States

Laura woke up at nine o'clock this morning

She rushed to the university

[conjunction] the lecture room had been changed

Judy was fond of pets

She did not like cats

[conjunction] she had a dog

The trial of the serial killer lasted five months

The media were furious about the trial

[conjunction] he was sentenced to three years imprisonment

Jack always hurried to his office

He usually felt very hungry in the morning

[conjunction] he had an early breakfast

The robber robbed several banks in London

In his early years he was not very fortunate

[conjunction] he got and spent a fair amount of money

They went to a theme party
The bouncer refused them entrance
[conjunction] they were wearing shorts

We walked along the cliff
I couldn't see much
[conjunction] I looked down

The exhibition attracted thousands of people
They wanted to go to the museum
[conjunction] they realised it was the final day of the exhibition

Miami Beach is notorious for its white sharks
A lot of people used to go to the beach
[conjunction] somebody noticed a shark

APPENDIX IV

The tables in the chapter are linked to the analyses reported in Chapter 6.

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EXPERIMENT 1: EYE MOVEMENT

POLARITY	TYPE			total
	CAUSAL	TEMPORAL	ADDITIVE	
POSITIVE	6.99 (10)	6.33 (19)	1.78 (3)	5.24 (32)
NEGATIVE	10.71 (3)	17.14 (6)	3.70 (3)	8.33 (12)
total	7.60 (13)	7.46 (25)	2.41 (6)	

Note: real numbers in brackets

Table 1 Percentage of words being regressed twice or more

EXPERIMENT 2: READING TIME 1 (IMPLICIT – EXPLICIT)

EXPLICITNESS	POSITION			Mean
	1 ST WORD	2 ND WORD	LAST WORD	
EXPLICIT	372 (8.2)	384 (13.4)	505 (14.4)	420 (9.1)
IMPLICIT	516 (12.6)	363 (8.5)	501 (11.9)	460 (9.2)
Mean	444 (7.5)	374 (7.9)	503 (9.4)	

Note: Error rates in parentheses; times in milliseconds.

Table 2 Explicit versus implicit in third clause

EXPERIMENT 3: READING TIME 2

POLARITY	TYPE			Mean
	CAUSAL	TEMPORAL	ADDITIVE	
POSITIVE	3032 (96.1)	3075 (86.1)	3148 (76.0)	3054 (83.6)
NEGATIVE	3100 (94.9)	2959 (102.6)	2999 (89.5)	3019 (89.1)
Mean	3066 (91.7)	3017 (86.4)	3075 (82.7)	

Note: Error rates in parentheses; times in milliseconds.

Table 3 Mean total reading times third clause

POLARITY	TYPE			Mean
	CAUSAL	TEMPORAL	ADDITIVE	
POSITIVE	-21.52 (7.07)	-18.85 (8.60)	-37.74 (12.77)	-20.18 (6.62)
NEGATIVE	-35.29 (10.11)	-32.38 (7.53)	-23.65 (8.49)	-30.44 (6.05)
Mean	-28.40 (6.67)	-25.65 (6.65)	-30.70 (11.64)	

Note: Error rates in parentheses; times in milliseconds.

Table 4 Mean residuals of reading times of conjunctions

POLARITY	TYPE			Mean
	CAUSAL	TEMPORAL	ADDITIVE	
POSITIVE	349 (6.8)	358.67 (5.3)	367 (8.4)	358 (4.9)
NEGATIVE	356 (6.1)	344.84 (6.7)	362 (6.9)	354 (4.2)
Mean	352 (5.3)	352 (5.1)	365 (5.82)	

Note: Error rates in parentheses; times in milliseconds.

Table 5 Mean reading times of first word after the conjunction

POLARITY	TYPE			Mean
	CAUSAL	TEMPORAL	ADDITIVE	
POSITIVE	361 (9.9)	373 (10.3)	379 (10.4)	371 (10.2)
NEGATIVE	364 (8.3)	348 (9.2)	368 (8.9)	360 (8.8)
Mean	362 (8.5)	360 (8.7)	373 (8.7)	

Note: Error rates in parentheses; times in milliseconds.

Table 6 Mean reading times of second word after the conjunction

POLARITY	TYPE			Mean
	CAUSAL	TEMPORAL	ADDITIVE	
POSITIVE	498 (12.4)	458 (6.7)	493 (11.6)	483 (7.6)
NEGATIVE	474 (11.8)	458 (8.9)	455 (9.1)	462 (7.0)
Mean	485 (10.3)	458 (5.9)	474 (8.4)	

Note: Error rates in parentheses; times in milliseconds.

Table 7 Mean reading times of last word of third clause

POSITION	POLARITY	TYPE			Mean
		CAUSAL	TEMPORAL	ADDITIVE	
First	POSITIVE	349 (6.8)	359 (5.3)	367 (8.4)	358 (4.9)
First	NEGATIVE	356 (6.1)	345 (6.7)	362 (6.9)	354 (4.3)
Last	POSITIVE	498 (12.4)	458 (6.7)	493 (11.6)	483 (7.6)
Last	NEGATIVE	473 (11.8)	458 (8.9)	455 (9.1)	462 (7.0)
First	Mean	352 (5.3)	352 (5.1)	365 (5.8)	
Last	Mean	485 (10.3)	458 (5.9)	474 (8.4)	

Table 8 Position x TYPE x POLARITY

EXPERIMENT 4: READING TIME 3 (NON-NATIVES)

POLARITY	TYPE			Mean
	CAUSAL	TEMPORAL	ADDITIVE	
POSITIVE	3913 (140.9)	3922 (147.8)	38237 (166.1)	3891 (127.7)
NEGATIVE	3992 (171.6)	4020 (168.1)	4040 (134.8)	4017 (135.3)
Mean	3952 (137.9)	3971 (135.0)	3938 (139.9)	

Note: Error rates in parentheses; times in milliseconds.

Table 9 Reading time third clause

POLARITY	TYPE			Mean
	CAUSAL	TEMPORAL	ADDITIVE	
POSITIVE	-74.97 (36.93)	-38.90 (55.52)	-165.83 (25.32)	-93.23 (31.10)
NEGATIVE	29.44 (41.79)	-92.19 (47.37)	78.89 (25.32)	5.38 (37.99)
Mean	-22.76 (33.64)	-65.55 (43.40)	-43.47 (32.61)	

Note: Error rates in parentheses; times in milliseconds.

Table 10 Residuals of reading time conjunction

POLARITY	TYPE			Mean
	CAUSAL	TEMPORAL	ADDITIVE	
POSITIVE	444 (18.2)	467 (25.5)	453 (27.3)	455 (21.9)
NEGATIVE	460 (29.8)	447 (23.1)	480 (22.4)	462 (23.4)
Mean	452 (22.4)	457 (22.4)	466 (23.9)	

Note: Error rates in parentheses; times in milliseconds.

Table 11 Reading time first word after conjunction

POLARITY	TYPE			Mean
	CAUSAL	TEMPORAL	ADDITIVE	
POSITIVE	508 (32.8)	485 (32.3)	473 (28.3)	489 (27.9)
NEGATIVE	479 (33.7)	512 (34.3)	465 (25.8)	485 (29.5)
Mean	493 (30.5)	498 (31.8)	469 (25.9)	

Note: Error rates in parentheses; times in milliseconds.

Table 12 Reading time second word after conjunction

POLARITY	TYPE			Mean
	CAUSAL	TEMPORAL	ADDITIVE	
POSITIVE	661 (46.8)	705 (51.1)	665 (55.5)	677 (45.6)
NEGATIVE	638 (53.1)	626 (43.7)	692 (57.2)	652 (46.2)
Mean	650 (47.8)	666 (37.4)	678 (51.9)	

Note: Error rates in parentheses; times in milliseconds.

Table 13 Reading time last word of third clause

EXPERIMENT 5: READING TIME 4

POLARITY	TYPE				Mean
	CAUSAL	TEMPORAL	ADDITIVE	AMBIGUOUS	
POSITIVE	3105 (125.3)	3193 (132.4)	3218 (144.1)	3044 (141.0)	3140 (131.0)
NEGATIVE	3061 (123.4)	3109 (131.4)	3118 (136.5)	2975 (142.2)	3066 (128.2)
Mean	3083 (120.9)	3151 (126.3)	3168 (137.5)	3009 (139.6)	

Note: Error rates in parentheses; times in milliseconds.

Table 14 Reading times of third clause

POLARITY	TYPE				Mean
	CAUSAL	TEMPORAL	ADDITIVE	AMBIGUOUS	
POSITIVE	-59.55 (10.37)	-37.65(10.89)	-38.45 (13.98)	-19.33(10.98)	
NEGATIVE	-57.63 (9.43)	-36.53(10.39)	-29.87 (12.22)	-24.39 (9.60)	-38.74 (8.44)
Mean	-58.59 (8.15)	-37.09 (8.65)	-34.16 (11.14)	-21.86 (8.52)	-37.11 (7.54)

Note: Error rates in parentheses; times in milliseconds.

Table 15 Residuals of reading times of conjunctions

POLARITY	TYPE				Mean
	CAUSAL	TEMPORAL	ADDITIVE	AMBIGUOUS	
POSITIVE	343 (5.9)	363 (9.5)	381 (8.5)	343 (5.9)	358 (5.7)
NEGATIVE	363 (9.5)	355 (6.3)	365 (7.7)	351 (7.2)	359 (4.8)
Mean	353 (4.7)	359 (6.9)	373 (7.1)	347 (6.0)	

Note: Error rates in parentheses; times in milliseconds.

Table 16 Reading times of first word after conjunction

POLARITY	TYPE				Mean
	CAUSAL	TEMPORAL	ADDITIVE	AMBIGUOUS	
POSITIVE	369 (9.6)	374 (10.2)	385 (10.1)	363 (9.1)	373 (7.0)
NEGATIVE	360 (6.0)	369 (7.8)	373 (8.7)	360 (9.9)	366 (6.0)
Mean	365 (7.0)	372 (7.6)	379 (7.7)	362 (8.2)	

Note: Error rates in parentheses; times in milliseconds.

Table 17 Reading times of second word after conjunction

POLARITY	TYPE				Mean
	CAUSAL	TEMPORAL	ADDITIVE	AMBIGUOUS	
POSITIVE	512 (15.1)	488 (10.9)	474 (11.3)	475 (13.7)	487 (9.3)
NEGATIVE	481 (13.1)	491 (12.2)	467 (12.9)	481 (13.0)	480 (9.3)
Mean	497 (11.8)	490 (8.9)	470 (10.4)	478 (11.3)	

Note: Error rates in parentheses; times in milliseconds.

Table 18 Reading times of last word of the third clause

POSITION	POLARITY	TYPE				Mean
		CAUSAL	TEMPORAL	ADDITIVE	AMBIG.	
First	POSITIVE	343 (5.9)	363 (9.5)	381 (8.6)	343 (6.0)	358 (5.7)
First	NEGATIVE	363 (6.0)	355 (6.3)	366 (7.7)	351 (7.2)	359 (4.8)
Last	POSITIVE	483 (29.6)	478 (23.3)	455 (20.4)	477(23.9)	473 (21.1)
Last	NEGATIVE	471 (21.4)	518 (26.1)	474 (20.8)	474(30.0)	484 (21.8)
First	Mean	353 (4.7)	359 (7.0)	373 (7.1)	347 (6.0)	
Last	Mean	477 (22.5)	498 (22.4)	465 (19.3)	475(24.7)	

Note: Error rates in parentheses; times in milliseconds.

Table 19 Position x TYPE x POLARITY