

Signaling coherence relations in text generation: A case study of German temporal discourse markers

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Chapter 1

Introduction

This introductory chapter presents the motivation for the thesis research, and sketches the framework the research is embedded in. The goals of this thesis are introduced, and an overview of the thesis is given.

1.1 Motivation

At first sight, it might not seem worthwhile to give much attention to words such as *vor*, *solange*, *stattdessen* (before, as long as, instead) or *during*, *although*, *however*. After all, they are traditionally classified as *function words*, and their sole purpose is said to structurally relate the *content words* in a text. At least this is what the standard German reference book on linguistics [Bußmann 1990] defines as the task of function words:

Funktionswort.

(1) Bezeichnung für Elemente, die primär grammatische (anstelle von lexikalischer) Bedeutung tragen und vor allem syntaktisch-strukturelle Funktion erfüllen, wie Artikel, Pronomen, Präpositionen, Konjunktionen.¹[Bußmann 1990, p260]

In spite of this widespread view, which suggests that lexical items such as prepositions, conjunctions, and conjunctives are not worth a thorough *semantic* examination, this thesis is devoted to exactly these word classes. The motivation behind this is twofold: Contrary to the predominant view, this thesis argues that these words make a significant contribution to the interpretation of text, and that their function goes well beyond the mere signaling of structural relations (Section 1.1.1). Further, it claims that if one aims at automatically producing text, a motivated choice of these words is essential. And in order to make this motivated choice, comprehensive knowledge on the usage conditions of prepositions, conjunctions, and conjunctives is required (Section 1.1.2).

¹English translation: Function word. (1) Term for items that primarily carry grammatical (instead of lexical) meaning and above all serve a syntactic-structural purpose, such as determiner, pronoun, preposition, conjunction.

1.1.1 Discourse markers in written text

How can it be explained that some texts such as Text A given in Figure 1.1 are hard to read and difficult to understand, while other texts, such as Text B in Figure 1.1,² disclose themselves to the reader without problems? And why is it difficult to grasp the connection between the sentences and paragraphs of Text A, while the relation between text segments and the overall line of argumentation in Text B can easily be inferred?

If one compares Text A to Text B—which is the original version of a newspaper article on prospective labour shortage in Germany as appeared in the *Süddeutsche Zeitung* on June 19th 2001³—one notes a small, but significant difference: Text B contains words such as *jedoch*, *wohingegen*, and *deshalb*, which have been removed from Text A. These words refer back to earlier portions of the text, or signal how the following text fragment is to be interpreted in the light of the present one. For instance, *wohingegen* (whereas) (Text B, line 3) indicates that the information expressed in the preceding sentence contrasts with the information verbalized in the present sentence. *Deshalb* (therefore) (Text B, 4th line from bottom) expresses that the following fact results from the fact presented in the preceding sentence. This information is not made explicit in Text A, and the correct interpretation of the relation between these text spans by the reader is not ensured.

Depending on the text type, written monologic discourse may contain many or few lexical items of this kind. Informative texts such as newspaper articles are not particularly rich in these items, whereas argumentative texts such as editorials and instructional texts usually contain a high percentage of these words. Still, even in informative texts, they are required to ensure the correct interpretation of the text, and they greatly improve the readability of a text, as Texts A and B illustrate. As for an instance of an instructional text, Text C in Figure 1.2 reproduces a page from the Honda Civic car manual. In this text, nearly every clause contains a preposition, a conjunction, or a conjunctive. This is motivated by what I take as the primary function of these words: They signal how parts of a text are related—not just structurally, but in terms of underlying meanings and intentions. For instance, the subordinate conjunction *while* signals that the two actions of pressing and turning have to be performed at the same time, and the preposition *with* tells us that a cold engine is a precondition for filling the tank. The extensive use of these ‘markers’ in instructional texts is due to the fact that in this text type, it is of particular importance that the relation between actions are unambiguously signaled, so that there is no space for

²English translation of the source text (Text B, including discourse markers):

According to the report of the BLK the need for labour/workers in Germany will increase from nearly 35 millionen at present to 37,6 millionen by 2015. **Here**, a trend towards higher qualification is predicted for **both** job training **as well as** academic education, **whereas** the number of jobs in the industry for less qualified will decrease considerably.

In contrast, the number of people willing to take up an employment will, due to the demographic development, fall by 1,8 millionen to 37 millionen over the same period of time; **however**, not all of them have the required qualifications. **Therefore**, as is already the case in information technology and engineering, there will also exist a considerable labour shortage in some other branches before 2015. “After 2015 the shortage will dramatically increase”, the report continues. **At the same time, however** there will be a high number of unemployed in the branches with labour shortage that are not sufficiently qualified.

³BLK: Bund-Länder-Kommission für Bildungsplanung und Forschungsförderung.

Text A:

Dem Bericht der BLK zufolge wird der Bedarf an Arbeitskräften in Deutschland von derzeit knapp 35 Millionen bis zum Jahr 2015 auf etwa 37,6 Millionen steigen. Für die berufliche Ausbildung und für die Hochschulausbildung wird ein Trend zur Höherqualifizierung vorausgesagt. Die Zahl der Arbeitsplätze für geringer Qualifizierte in der Industrie werde deutlich abnehmen. Die Zahl der erwerbsbereiten Personen werde aufgrund der demografischen Entwicklung im selben Zeitraum um 1,8 Millionen auf knapp 37 Millionen Personen sinken; von ihnen bräuchten nicht alle die erforderlichen Qualifikationen mit. Wie schon jetzt in der Informationstechnik und bei den Ingenieuren werde es bereits vor 2015 auch in anderen Branchen einen deutlichen Arbeitskräftemangel geben. “Nach 2015 wird sich dieser Mangel dramatisch verschärfen”, heißt es weiter in dem Bericht. Es werde in den Mangelbranchen weiterhin eine hohe Zahl an Arbeitslosen mit zu geringer Qualifikation geben.

Text B:

Dem Bericht der BLK zufolge wird der Bedarf an Arbeitskräften in Deutschland von derzeit knapp 35 Millionen bis zum Jahr 2015 auf etwa 37,6 Millionen steigen. **Sowohl** für die berufliche Ausbildung **als auch** für die Hochschulausbildung wird **dabei** ein Trend zur Höherqualifizierung vorausgesagt, **wohingegen** die Zahl der Arbeitsplätze für geringer Qualifizierte in der Industrie deutlich abnehmen werde.

Die Zahl der erwerbsbereiten Personen werde **dagegen** aufgrund der demografischen Entwicklung im selben Zeitraum um 1,8 Millionen auf knapp 37 Millionen Personen sinken; von ihnen bräuchten **jedoch** nicht alle die erforderlichen Qualifikationen mit. Wie schon jetzt in der Informationstechnik und bei den Ingenieuren werde es **deshalb** bereits vor 2015 auch in anderen Branchen einen deutlichen Arbeitskräftemangel geben. “Nach 2015 wird sich dieser Mangel dramatisch verschärfen”, heißt es weiter in dem Bericht. **Zugleich** werde es **jedoch** auch in den Mangelbranchen weiterhin eine hohe Zahl an Arbeitslosen mit zu geringer Qualifikation geben.

Figure 1.1: Extract from a newspaper article on prospective labour shortage in Germany. Reproduced from *Süddeutsche Zeitung*, June 19th, 2001

Text C:

Wait **until** the engine is cool, **then** turn the radiator cap clockwise **until** it stops. DO NOT PRESS DOWN **WHILE** TURNING THE CAP. **After** any remaining pressure has been relieved, remove the cap **by** pressing down **and** again turning it counterclockwise. Add enough coolant **to** fill the radiator, **and** reinstall the cap. Be sure to tighten it securely. Fill the reserve tank up to the max mark **with** the engine cold.

Figure 1.2: Extract from the Honda Civic car manual

(mis)interpretation.

The ‘markers’ of underlying relations between text fragments operate either within a clause (preposition), within a sentence (conjunctions), or between sentences (conjunctives). In short, they are a formally heterogeneous but functionally homogeneous group of words. In text linguistics, these lexical items are assigned the function of making underlying *coherence relations* between adjacent text spans explicit [Heinemann and Viehweger 1991, Hobbs 1985]. The underlying assumption here is that a text can be formally described (and represented) by means of the relations holding between adjacent portions of text. For instance, the relationship indicated by *wohingegen* might be described as a CONTRAST relation, and the one indicated by *deshalb* as a RESULT relation. The type of coherence relation (also referred to as discourse relation) is signaled by linguistic means, a prominent one being the lexical items highlighted in sample texts B and C. Since these items ‘mark’ the type of discourse relation, I refer to them as *discourse markers* in this thesis.

Discourse markers are said to provide surface clues for the interpretation of text. In case no such clues are given, as in Text A above, relations between text spans remain implicit and often ambiguous, and may result in incoherent discourse:

A discourse is coherent if the hearer knows the communicative role of each portion of it; that is, if the hearer knows how the speaker intends each clause to relate to each other clause. [Mann and Thompson 1988]

In this understanding, discourse only succeeds if the interrelationships between text segments are properly expressed:

One essential part of comprehending and creating discourse is the recognition of intended relations holding both between component discourse segments and between the discourse entities introduced by the discourse [Bateman and Rondhuis 1997, p3]

In support of this view are psycholinguistic studies that present overwhelming evidence for the importance of surface clues such as discourse markers for text understanding and

readability [Sanders 1997, Wrobel 1994]. Psychological experiments have shown that the presence of a discourse marker facilitates the interpreter’s ability to infer the relation intended by the message sender [Wrobel 1994].

Text linguistics and psycholinguistics alike maintain that *occurrence* (i.e. whether a discourse marker is used at all), *placement* (i.e. where a marker is placed), and *choice* of discourse markers affect the *quality* of a text and facilitate understanding. As a consequence, the contribution of discourse markers to the interpretation of text cannot be explained by examining their syntactic function only. Instead, the following questions need to be addressed: What coherence relations can be signaled by a discourse marker? And, since language offers a range of different discourse markers for expressing a coherence relation, what is the additional meaning signaled by a discourse marker, and how can discourse markers realizing the same relation be distinguished? Take, for instance, the concession relation from the newspaper article (Text B, Figure 1.1), which can be expressed by different conjunctives (example 1.1):

- (1.1) *Nach 2015 wird sich dieser Mangel dramatisch verschärfen [...]*
 After 2015 will itself this shortage dramatically aggravate [...]
Zugleich werde es {jedoch | trotzdem | dennoch | gleichwohl} auch
 At the same time will there {however | nevertheless | still | nonetheless} also
in den Mangelbranchen weiterhin eine hohe Zahl an
 in the branches with labour shortage still a high number of
Arbeitslosen mit zu geringer Qualifikation geben.
 unemployed with too low qualification exist.
 ‘After 2015 this shortage will dramatically increase [...] At the same time, {**however** | **nevertheless** | **still** | **nonetheless**}, there will be a high number of unemployed in the branches with a labour shortage that are not sufficiently qualified.’

Likewise, the precedence relation from the technical instructional text (Text C, Figure 1.2) can be expressed in a variety of ways (example 1.2):

- (1.2)
- a. {**After** | **As soon as** | **No sooner than**} *any remaining pressure has been relieved, remove the cap [...]*
 - b. **Before** *removing the cap, relieve any remaining pressure.*
 - c. *Relieve any remaining pressure.* {**Then** | **Afterwards**} *remove the cap.*

The precise semantic and pragmatic differences between similar markers can be quite difficult to determine. For instance, the temporal markers *after* and *as soon as* in example (1.2a) differ merely in the permissible time span between the two actions; *as soon as* and *no sooner than* differ in whether they mark the following information as occurring too early; and *after* and *before* differ regarding the information they present as central. Other examples illustrating the significance of fine-grained meaning differences—not from the sample

texts—include the concessive markers *although* and *even though* which differ merely in emphasis; the causative markers *because* and *since* differ in whether they mark the following information as *given* or not; the German causative markers *weil* and *denn* differ in the illocution type of the conjuncts (proposition versus statement).

This calls first of all for a description of discourse markers that moves beyond their syntactic properties, and second, for a representation of discourse markers that can capture these fine-grained differences in meaning and usage. In this thesis, I adhere to the framework of *Systemic Functional Linguistics* (SFL) [Halliday 1994] in the description of discourse markers. In a nutshell, SFL maintains that all variation in surface form has a meaning, and postulates the notion of ‘form follows function’, in other words, every surface form follows from its function in discourse. SFL then aims at describing the precise relationship between the situational context of an utterance and its verbalization. Adopting a functional framework makes it possible to systematically represent the environments in which a linguistic form may occur because they are described in terms of the semantic and pragmatic conditions of usage of the surface form. As such, this framework supports the classification of discourse markers according to function and form, and captures their relation to discourse. A study of a wide range of English discourse markers along this line has been performed by [Martin 1992]; however, no such account exists for German discourse markers.

Finally, studying discourse markers seems a worthwhile endeavour for yet another reason: While there is widespread agreement that the coherence of a text can be characterized by certain discourse relations that can hold between adjacent text spans, there is less agreement on the nature and the precise set of coherence or discourse relations (see among others [Halliday and Hasan 1976, Hobbs 1985, Sanders *et al.* 1992, Bateman and Rondhuis 1997] [Knott 1996]). One way of approaching this abstract problem is to focus on the surface, i.e. by studying the linguistic means employed to signal coherence relations in a text, in particular discourse markers. The use of discourse markers can thus provide insights into the set of coherence relations holding in text (see [Knott 1996] for a detailed study for English and [Knott and Sanders 1998] for a contrastive study of English and Dutch).

1.1.2 Discourse marker choice in text generation

The research reported here is set in the context of (multilingual) text generation. The overall objective of natural language generation is to automatically convert some kind of non-linguistic information into written natural language. *Text generation* (TG) then aims at the automatic production of not just single sentences but entire texts (see [Reiter and Dale 2000] for a general introduction). It is used in various applications: Dialogue systems, machine translation, and text summarization all require a text generation component. Text generation is also a research topic in its own right: Text generation techniques are employed to produce weather reports from meteorological data (FOG, [Goldberg *et al.* 1994]), technical instructions from knowledge bases (IDAS [Reiter *et al.* 1995], TechDoc [Rösner and Stede 1994]), and hypertext documents from taxonomic knowledge (PEBA [Milosavljevic and Dale 1996]). They assist in text authoring (DRAFTER [Paris *et al.* 1995], PlanDoc [McKeown *et al.* 1994]),

and generate patient health information (PIGLET [Cawsey *et al.* 1995]), to name only a few applications.⁴

Most available text generation systems exhibit a pipeline architecture, that is, they realize a three-stage process consisting of text planning, sentence planning, and sentence realization. In brief, starting from a non-linguistic input, i.e. the information to be verbalized, and communicative goals, the first component, known as the text planner, converts this into a linguistic data structure, the discourse structure. The discourse structure consists of chunks of knowledge related by coherence relations. In the sentence planning phase, the discourse structure is transformed into a sequence of sentence-semantic specifications, which are then verbalized by a sentence generator.

Given the importance of discourse markers for the interpretation and readability of text, discourse marker choice is essential once we move from sentence generation to text generation, i.e. from producing not just single sentences but paragraph-size text. At least, if we are not satisfied with texts like text A above, we have to address the issue of discourse marker choice. Ignoring this task severely restricts the expressiveness of a generator, and limits the comprehensiveness of the text produced. Therefore, for any but the most simple applications of text generation, marker selection is an important task if one wants to ensure that the discourse goals are met. And if the application is the production of instructional texts, the text type examined in this thesis, the unambiguous signaling of coherence relation becomes even more important, for the reasons stated above.

As a consequence, a text generation system has to be equipped with sufficient knowledge for selecting an appropriate discourse marker. Discourse marker choice, however, is not a straightforward task, as has been supported above. For most coherence relations, languages offer a range of different discourse markers, allowing for a corresponding range of paraphrases for expressing the relation. Fine-grained meaning variants are expressed by different but similar markers, such as the concessive markers *although*, *even though* and *though*. In a text generation scenario, the question arises of when to choose which marker. But why does the choice actually matter? Why not always choose the same marker to signal, for instance, a CONCESSION relation? For one thing, different markers signal pragmatic and semantic aspects on top of the coherence relation itself. For instance, the concessive markers *although* and *even though* differ in emphasis, the causative markers *because* and *since* differ in whether they mark the following information as *given* or not, and the German temporal markers *sobald* and *kaum dass* differ with respect to the reader's attitude towards the situations. Not paying attention to these fine-grained meaning differences severely restricts the expressiveness of a text generator and may also decrease the readability or even endanger the correct interpretation of a text. In particular, a text type such as technical instructions requires that the relationships between text spans are unambiguously signaled to avoid unintended (and possibly dangerous) reader activities. Further, the goal of text quality makes us want to choose between markers: for stylistic reasons (e.g. to ensure variation), due to text type constraints, or due to the communicative goals.

⁴This enumeration is indicative only, and by no means complete. For a more comprehensive list see for instance a textbook on natural language generation [Reiter and Dale 2000] or a survey article on automated discourse generation, e.g. [Bateman 1998].

Accordingly, from the generation perspective, a serious task arises if the produced text is not only to simply signal the coherence relation, but moreover to reflect pragmatic goals, stylistic considerations, and the different connotations markers have. To handle this choice task, two issues have to be clarified: First, one has to determine the semantic and pragmatic differences between discourse markers and describe them in such a way that they can be integrated into a computational model. Ideally, this would be a declarative resource which is not tailored towards a particular language, and not geared towards a particular generation system; in this research, it will be a discourse marker lexicon. Second, one has to examine the interdependencies between discourse markers and other linguistic means available for signaling coherence relations, and to design a strategy for discourse marker selection. Both issues will be dealt with in this thesis.

1.2 Scope of the study

In this thesis, I examine linguistic means to signal coherence relations. I restrict myself to *discourse markers*, i.e. those function words that signal the relations between text segments. [Martin 1992, p200] lists several alternative linguistic forms that can carry this function. In the present study, I focus on conjunctives, coordinating and subordinating conjunctions, and prepositions in their function as discourse markers.⁵ The text type under consideration is technical instructional text. This choice delimits the range of discourse markers examined.

Parts of this thesis deal with discourse markers in general, while others focus on a specific class of discourse markers. The ‘Test for discourse markers in German text’ in Chapter 4, the discussion of the discourse level in Chapter 8, the discourse marker lexicon proposed in Chapter 9, and the selection procedure defined in Chapter 10 all apply to the entire class of discourse markers. When it comes to tying down the fine-grained difference between discourse markers, and to describing them in a linguistic formalism, I do not cover the entire range of discourse markers, but focus on a marker group that is predominant in instructional texts: *temporal discourse markers*.

The linguistic study of temporal markers is restricted to German. English temporal markers are considered in so far as they are required to demonstrate the multilingual potential of the proposed declarative resource, the discourse marker lexicon, and the discourse marker selection procedure. To meet this end, I will rely on the functional descriptions of English temporal markers of [Martin 1992] and [Hitzeman 1995].

As regards the present application, the automatic production of technical instructional texts, I focus on the sentence planning phase of the generation process, and on the discourse marker lexicon as one knowledge source at this stage. The selection procedure is language-neutral, as is the discourse marker lexicon. Finally, I am concerned with marker selection only, and do not deal with marker occurrence and marker placement.

⁵The motivation behind this will be given in Chapter 4 when the framework and the methodology are introduced.

1.3 Goals of this research

This research is situated in the context of automatic multilingual text generation. The issue in focus is designing a linguistic account of marker function and form, whose results can be used to support the motivated choice of discourse markers in the automatic production of written monologic text. Just as the motivation stems from two areas—linguistic description, using the framework of SFL, and automatic text generation—the ultimate goals of this thesis reflect these two realms: First, the thesis research aims at providing a linguistically sound description of discourse marker usage. Second, the insights from the linguistic study are used to improve the output of text generation systems by providing means to select the most appropriate marker. This involves more specific goals of the following kinds:

1. Linguistic description. The discussion above suggests that a thorough examination of discourse marker function and form is indispensable, and that knowledge of this kind needs to be accumulated. Hence, the objectives of this thesis in the linguistic field are:

- To provide a definition of the class of discourse markers and to define a set of criteria for identifying them in text.
- To identify dimensions of discourse marker description: What is required in addition to the ‘syntactic function’ ascribed to discourse markers by standard reference books?
- To give a thorough analysis of one marker group (temporal markers) along these dimensions.
- To arrive at a representation of discourse marker function and form in a uniform framework, in my case Systemic Functional Linguistics, which so far has not been used in the representation of German markers.
- To compare this representation to available accounts in English and Dutch, and to extract common parameters in the description of discourse markers, thus providing the grounds for a multilingual classification of discourse markers, as is suggested in [Matthiessen *et al.* 1991, Bateman *et al.* 1991].

I argued above that discourse markers above all signal the coherence relation holding between portions of a text. The coherence relation thus gives part of the meaning of markers. There are many approaches to describing these relations, but they do not necessarily provide sufficient information to support an exhaustive characterization of marker usage. As a consequence, an additional goal is:

- To motivate the set of coherence relations holding in technical instructional texts, provide definitions of coherence relations, and explicate the relation between coherence relations and their linguistic realization.

2. Application in text generation. Although discourse markers have received considerable attention over the last few years in the text generation community, there is no overall treatment of discourse markers. As a matter of fact, present systems lack sufficient information on discourse marker function and form, and there exists no proper framework to motivate the choice between similar markers. Further, I argued above that the dependencies between marker choice and other generation decisions are rather intricate. The idea of avoiding them is, presumably, the reason for the simplistic treatment of marker choice in typical generators to-date. They regard discourse markers as mere consequences of the structural decisions, and hence they do not perform any choice. Thus, they cannot make use of the full potential of markers that languages offer for a given relation.

In this thesis I demonstrate that this strategy, which is typical for dealing with closed-class lexical items in general, is too great a simplification in the case of discourse markers. Therefore, an objective of this research is to design a procedure for motivated marker choice. Hence, the following subgoals have to be accomplished:

- To identify knowledge on discourse markers required to enable a motivated choice of discourse markers in automated text generation system.
- To develop a resource that describes the similarities and differences between different markers, and to provide sample discourse marker representations. This resource should support multilinguality.
- To improve the expressiveness of a text generator, i.e. to integrate motivated discourse marker choice into the overall text generation process. This involves in particular:
 - developing a sentence-planning approach that takes discourse marker choice as a task in its own right and that captures the interaction between discourse markers and other decisions at that stage of the generation process.
 - defining the input to the discourse marker selection procedure, the discourse structure.
 - producing a computational model of discourse marker choice, i.e. a language-neutral procedure for selecting appropriate discourse markers for a coherence relation.
- To demonstrate the functionality of the approach proposed in this thesis by working through a number of examples, some of them bilingual (German and English).

The overall goals characterize an interdisciplinary undertaking, joining the fields of linguistics and natural language processing. Results in both areas benefit from each other. On the one hand, the functional classification of discourse markers provides the knowledge required to develop a declarative resource for text generation, since it not only describes marker meaning in sufficient detail, but also accounts for the interaction of discourse markers and other linguistic means. On the other hand, text generation provides a vehicle for testing the adequateness of marker classification. Integrating the theoretical description into a computational model easily reveals contradictions and missing information.

1.4 Organization of the thesis

The thesis is divided into three parts:

Part I: State of the art and methodology

Chapter 2 reviews the state of the art in representing knowledge on discourse markers in descriptive and computational approaches, and in selecting discourse markers in the context of automatic text generation. Based on this survey, shortcomings are identified, and the goals of this thesis regarding discourse marker choice and description are formulated.

Chapter 3 gives a survey of the approaches to discourse representation in (multilingual) text generation. The predominant approach here and in discourse selection in particular is *Rhetorical Structure Theory* (RST). RST is introduced, its major assumptions are discussed, and alternative approaches are presented. Based on this overview, shortcomings are identified, and the goals of this thesis regarding discourse representation are presented.

Chapter 4 introduces the linguistic framework for describing discourse markers and the methodology applied in this thesis to collect discourse markers and to arrive at an adequate description of individual markers. A ‘Test for discourse markers in German texts’ is presented.

Part II: Linguistic analysis of German temporal discourse markers

Chapter 5 determines the set of discourse markers in technical instructional texts, and motivates the choice of the marker group examined in this thesis, temporal discourse markers. A brief survey of the state of the art of temporal marker description in German is given. Based on existing research and corpus analyses, the parameters that have to be considered in a comprehensive account of temporal marker usage, i.e. the dimensions of temporal marker analysis, are presented.

Chapter 6 turns to the linguistic analysis of temporal markers. It presents a comprehensive study of meaning and usage conditions of German temporal discourse markers. Each temporal marker is described along the dimensions proposed in Chapter 5. The analysis results in a specification of the paradigmatic and syntagmatic conditions of use of German temporal markers.

Chapter 7 presents a functional description of German temporal discourse markers. It introduces Martin’s conjunctive relation networks [Martin 1992] and their relation to lexicogrammar, and then addresses the methodological question of how to derive a functional description given the results of the temporal marker analysis. A functional classification of German temporal conjunctive relations and temporal markers is proposed, and compared to available accounts in English and Dutch.

Part III: Lexical modelling and application

Chapter 8 introduces my ideas on the discourse level. A discourse representation is presented that adequately describes the coherence relations holding between discourse seg-

ments in multilingual technical instructions, and that meets the demands of discourse marker representation and choice. A detailed analysis of coherence relations holding in the text type under discussion, technical instructional texts, motivates a paradigmatic description of rhetorical relations, thus yielding composite relations that have many advantages over the ‘atomic’ relation definitions used in RST.

Chapter 9 argues that a discourse marker lexicon is the most suitable representation for discourse marker knowledge to support the motivated selection of discourse markers in (multilingual) text generation systems. It introduces the discourse marker lexicon as a generic resource for storing discourse marker meaning and usage. The global organization of the lexicon and the shape of individual lexicon entries are presented, following the recommendations of the Expert advisory group on language engineering standards (EAGLES) for lexical semantic encoding.

Chapter 10 addresses the question of how discourse markers are selected. It discusses how the discourse marker lexicon is used at the sentence planning stage of the generation process. The generation lexicon for discourse markers is introduced, sample lexicon entries for German and English temporal markers are given, and a procedure for selecting discourse markers is proposed. Several examples illustrate how the lexicon can be used to produce alternative verbalizations of temporal coherence relations holding between two situations.

Chapter 11 summarizes the thesis research, and points out the major contributions of the work. The thesis concludes with an outlook on directions of future research, names issues left unresolved, and lists topics for future research.

Notational conventions

Typeface conventions: Different typefaces are employed in this thesis to distinguish between entities belonging to different realms of representation: Throughout the thesis, *slant* is used for linguistic examples and *italics* for emphasis in the running text. SMALL CAPS are reserved for concepts and relations at the pre-linguistic level, **typewriter** for computational data-structures and UPPER CASE for proper names of NLP systems. Numbered examples are given in *italics*, here, **boldface** is used for emphasis. [Square brackets] delimit discourse segments in a text. Finally, in the discussion of system networks, UPPER CASE is used for names of systems, and [square brackets] for features in the system network.

Use of asterisks and question marks: In linguistics, asterisks and question marks are used to mark utterances that are considered as ungrammatical, or whose well-formedness is doubted. Following the linguistic convention, I use an asterisk * in front of utterances that I consider ungrammatical, and mark utterances whose well-formedness is questionable with ?.

Glosses and translations: German examples are accompanied by English glosses and translations. Glosses are word-by-word translations to elucidate the lexical and syntactic properties of the German sample text. Translations, on the other hand, are well-formed English sentences whose purpose is to convey the same communicative function as the German source text, even if it requires the use of different lexical and syntactic means.

Part I

State of the art and methodology

Chapter 2

Earlier research on discourse markers: Description and choice

This chapter reviews the state of the art in representing knowledge on discourse markers in descriptive and computational approaches to discourse marker description and choice, and in selecting discourse markers in the context of automatic text generation.

The chapter starts with a discussion of terminological issues and the definitions of discourse markers provided in the literature, and describes different tests for identifying discourse markers in unrestricted text (Section 2.1). Section 2.2 then surveys the treatment of discourse marker choice in current natural language generation systems. The chapter concludes with a discussion of the different approaches to discourse markers in descriptive linguistics and computational linguistics (Section 2.3).

2.1 Definitions in research literature

The term *discourse marker* has been used in the descriptive linguistics and computational linguistics literature to cover a wide spectrum of lexical items, ranging from interjections such as *Hmm*, *naja*, *well* in spoken dialogue, which provide specific meta-information about the utterance or the interpersonal relationship between discourse participants (see for instance [Schiffrin 1987], and more recently [Fischer and Brandt-Pook 1998] and [Fischer 2000]), to prepositions and conjunctions like *trotz*, *nachdem* (despite, after) and *with*, *while* in spoken and written discourse, which are generally conceived as signaling the coherence relation that relates two text segments (e.g. [Halliday and Hasan 1976, Sanders *et al.* 1992, Hovy 1993, Bateman and Rondhuis 1997]). In this thesis, I am concerned with discourse markers in written monologic discourse; thus the discussion in the remainder of this chapter is restricted to discourse markers that occur in written monologue.

2.1.1 Terminology and definitions

There is some confusion as to the terminology used to refer to lexical entities that somehow link parts of a text, in particular, regarding the terminology employed in linguistics and the terms used in the context of natural language processing (NLP) applications. In NLP, discourse markers also go under names such as *cue phrases* or *cue words* [Grosz and Sidner 1986, Knott 1996, Marcu 1997], *discourse cues* [DiEugenio *et al.* 1997], *rhetorical markers* [Scott and de Souza 1990], *discourse connectives* [Webber *et al.* 1999a], and *sentence and clausal connectives* [Knott and Mellish 1996]. In contrast, linguistic reference books, grammars, or handbooks on text linguistics employ the terms *connective* / *Konnektiv* [de Beaugrande and Dressler 1981, Bußmann 1990, Crystal 1997], *Konnektor* [Fabricius-Hansen 2000, Pasch *et al.*, in prep.], *Junktor* [Weinrich 1993], or *Satzverknüpfer* [Helbig and Buscha 1991].

The terminology employed reflects the different conceptions of the nature of discourse markers in these two research areas: In NLP applications, discourse markers are regarded predominantly as a discourse phenomenon, which is in line with functionally oriented approaches to language, but contrasts with the more formal definitions provided by structurally oriented linguistic accounts. I discuss these two conflicting views in turn, starting with the structural perspective.

Standard linguistic resources of German such as [Helbig and Buscha 1991] and [Bußmann 1990] always employ syntactic criteria to define connectives. For instance, Bußmann, in her reference book on German linguistic terminology, suggests the following understanding of the term *Konnektiv* (connective):

Konnektiv. (1) Sprachlicher Ausdruck mit satzverknüpfender Funktion (Konnexion). Zur Klasse der K. gehören u.a. Konjunktionen und Konjunkionaladverbien. Sie verknüpfen entweder Propositionen bzw. Sachverhalte (semantische K.) oder Illokutionen (pragmatische K.).¹ [Bußmann 1990, p409]

A preliminary version of the ‘Handbuch deutscher Konnektoren’ (Handbook of German connectives) [Pasch *et al.*, in prep.], a very helpful resource for German discourse markers, provides the following definition of *Konnektoren* (connectives):

Es sind dies sprachliche Ausdrücke, die auf der oberen Ebene grammatischer Kombinatorik—Syntax—angesiedelt sind, und zwar insofern, als sie Sätze verknüpfen.² [Pasch *et al.*, in prep., p1]

Note that both definitions stress that *Konnektoren* and *Konnektive* combine sentences; other linguistic units such as clauses or phrases, or even larger text segments such as entire

¹The English edition of Bußmann’s dictionary [Bußmann 1996] provides the English translation: **Connective.** (1) Linguistic expression with the function of joining sentences (connection). **Conjunctions** and **conjunctive adverbs** belong to the class of connectives. They join either **propositions** or state of affairs (semantic connectives) or illocutions (pragmatic connectives). [Bußmann 1996, p96]

²English translation: These are linguistic expressions that are situated at the top level of grammatical combination theory—syntax, in so far as they connect sentences.

paragraphs, are not mentioned. Crystal's definition of connectives [Crystal 1997] is less constrained by referring to 'units at any level', though neither of the definitions refers to the discourse marker's broader function in discourse at all:

[used] to characterize words or morphemes whose function is primarily to link linguistic units at any level [Crystal 1997, p74]

In contrast, text linguistics moves away from the syntactic surface and maintains that connectives signal semantic relations between the content expressed in sentences, that is, the propositions underlying a text [Fabricius-Hansen 2000, Heinemann and Viehweger 1991]. For instance, [Fabricius-Hansen 2000] in her survey of clause-combining means states:

Sprachliche Ausdrücke wie *dagegen*, *nämlich*, *denn* und *weil*, die eine explizite Konnexionsstiftende Wirkung haben, werden Konnektive (Konnektoren) genannt [...] Konnexion besteht zwischen Satzinhalten—Propositionen.³ [Fabricius-Hansen 2000, p331]

Likewise, approaches in the systemic functional tradition argue that the common lexicographic practise of having syntactic behaviour as the criterion for inclusion to the set of discourse markers does not apply. Instead, they foreground discourse phenomena, and start from the assumption that the coherence of a discourse can be characterized by certain discourse relations that can hold between adjacent spans of text:

conjunctive elements [...] express certain meanings which presuppose the presence of other components in the discourse. [Halliday and Hasan 1976, p226]

In Halliday and Hasan's understanding, they are

specifications of the way in which what is to follow is systematically connected to what has gone before. [Halliday and Hasan 1976, p227]

Building upon this idea, discourse markers are now defined as the lexical items that indicate the kind of semantic/rhetorical relationship holding between adjacent text spans on the linguistic surface, for instance, *because*, *since* and *for that reason* are all different markers for causal relations, and *although*, *despite* and *however* signal a concessive relationship (see among others [Knott 1996, Martin 1992, Moser and Moore 1995, Rey 1997]). In this understanding, discourse markers are semantically two-place predicates, whose arguments can be either single propositions, or complex discourse segments.

Following the definitions given by text linguists, the group of discourse markers becomes a syntactically heterogeneous set. Connectives as defined in [Bußmann 1990] or

³English translation: Linguistic expressions such as *in contrast*, *however*, *for* and *because*, which have the effect of establishing connections, are called connectives [...] The connection exists between the content of sentences—propositions.

[Pasch *et al.*, in prep.] are a prominent subgroup, comprising conjunctions and conjunctives, but discourse markers are not restricted to this. They further encompass word classes such as prepositions, prepositional phrases, and a wide range of sentential adverbs; see for instance [Weinrich 1993, p610] in his discussion of different syntactic types of connectives, *Junktoren* in his terminology. [Knott 1996, p66ff], in his work on English, maintains that items from the following five word classes can function as discourse markers in text (as defined by [Quirk *et al.* 1972]; see also [Weinrich 1993, Rey 1997, Grote *et al.* 1997, Stede and Umbach 1998] for similar sets):

- **Coordinators** linking clauses, such as *but, or, and*.
- **Subordinators** introducing subordinate clauses in complex sentences, such as *although, before*.
- **Conjunct adverbs** modifying entire clauses, for example, *however, as a consequence*.
- **Prepositional phrases** which often refer back to the previous clause, such as *in that respect, at this point*.
- **Phrases which take sentential complements**, for example, *it follows that*.

This list is, however, not complete as it leaves out prepositions, which can also code connections between text segments as in *Despite the heat, we didn't go swimming*. Here, the preposition alone indicates the type of link between two text segments. This is in contrast to the prepositional phrase included in the set given above, where it is the preposition in combination with the nominal phrase it governs that expresses the coherence relation.

Accounts that define the discourse marker group by functional criteria, i.e. by its usage conditions, differ with respect to the functions they assume, and hence impose different classifications on the set of discourse markers. Most researchers believe that the primary function of discourse markers is to structure the discourse and to indicate the coherence relations (see for instance [Halliday and Hasan 1976, Martin 1992, Knott 1996, Scott and de Souza 1990, Vander Linden 1994]). This assumption is particularly popular in text generation applications where one task is to adequately signal the coherence relations holding between two text segments.

Others like [Caron 1997] believe that

rather than conveying information about states of things, connectives can be conceived as procedural instructions for constructing a semantic representation [Caron 1997, p70]

Similarly, [Noordman and Vonk 1997] assume three procedural functions of discourse markers: segmentation, integration, and inference (see also [Marcu 1997, p115]). I return to the different types of functional classification in Section 2.3 of this chapter.

<p>(M1): nichtflektierbar X ist nicht flektierbar.</p> <p>(M2): keine Kasusvergabe X vergibt keine Kasusmerkmale an seine syntaktische Umgebung.</p> <p>(M3): semantisch relational X drückt eine spezifische zweistellige semantische Relation aus.</p> <p>(M4): Argumente propositional Die Argumente der relationalen Bedeutung von X sind propositionale Strukturen.</p> <p>(M5): Konnekte Satzstrukturen Die Ausdrücke für die Argumente der relationalen Bedeutung von X können Satzstrukturen sein.</p>

Figure 2.1: Test for connectives from [Pasch *et al.*, in prep.]

2.1.2 Identifying discourse markers in text

A few studies go beyond merely giving a definition for the set of discourse markers and provide strategies for actually identifying the members of this set in any given text. Again mirroring the two conflicting views on what discourse markers are, one encounters two types of tests for discourse markers: Tests either build on (morpho)syntactic properties or on functional criteria.

The test proposed in [Pasch *et al.*, in prep.] establishes clear—mostly syntactic—criteria for deciding whether a German lexical item X is a connective. Figure 2.1 reproduces their test for connectives.⁴ All those German lexical entities X that meet criteria M1 to M5, which test for structural features (morphosyntactic properties like inflection and case assignment, and syntactic evidence) belong to the class of connectives. Given this test, the class of connectives is actually defined as the class of ‘Satzkonnektoren’ (sentence connectives), a restriction deliberately imposed by [Pasch *et al.*, in prep.]. Hence, this test fails to accommodate sentences with *um ... zu* constructions (to-infinitive), and further leaves out all prepositions (*trotz, wegen, nach, vor ...* (despite, because of, after, before, ...)), which can also indicate coherence relations.

Several studies on discourse markers, in particular those in the context of NLG, assume a definition based on coherence relations. As argued above, the task is now to identify a group of discourse markers that are syntactically heterogeneous but functionally homogeneous. Knott’s *Test for relational phrases* is such a functionally oriented test

⁴English translation of the test:

(M1): **not inflectional**: X cannot be inflected.

(M2): **no case assignment**: X does not assign case features to its syntactic environment.

(M3): **semantically relational**: X expresses a specific two-place semantic relation.

(M4): **arguments propositional**: The arguments of the relational meaning of X are propositional structures.

(M5): **conjuncts are sentential structures**: The expressions for the arguments of the relational meaning of X can be sentential structures.

1. Isolate the phrase and its **host clause**. The host clause is the clause with which the phrase is immediately associated syntactically; for instance, if the passage of text to be examined is
 - a. ... John and Bill were squabbling: John was angry *because* Bill owed him money.
That was how it all started ...then the isolated phrase and clause would be
 - b. *because* Bill owed him money.
2. Substitute any anaphoric or cataphoric terms in the resulting text with their antecedents, and include any elided items. [...]
3. If the candidate phrase is indeed a relational phrase, the resulting text should appear **incomplete**. An incomplete text is one where one or more extra clauses are needed in order for a coherent message to be framed. [...]
4. Any phrases which refers directly to the text in which they are situated (such as *in the next section, as already mentioned*) are to be excluded from the class of relational phrases. [...]
5. Phrases which pass the test only because they include comparatives (for instance *more worryingly, most surprisingly*) are also to be excluded from the class of relational phrases. [...]
6. Sometimes, more than one cue phrase can be found in the isolated clause (e.g. *and so, yet because*). In such cases, both phrases should pass the test when considered individually in the same context. In other words, the host clause should appear incomplete with either phrase.

Figure 2.2: Test for relational phrases, reproduced from [Knott 1996, p64].

[Knott 1996, Knott and Mellish 1996]. Instead of seeking syntactic evidence, he suggests a corpus-based identification. The central idea behind this test is that discourse markers (or cue phrases in Knott’s terminology) have a function which extends beyond a single clause, and since “they link clauses and sentences together to create larger units of text”, discourse markers cannot make sense when associated with one text segment in isolation (cf. [Knott 1996, p63]). He argues that a sentence like

(2.1) **Because** *Joe owed John money*

requires prior context to be understood, hence *because* is a discourse marker candidate. In other words, if an isolated clause is uninterpretable without its surrounding context, as in the example above, but becomes interpretable if the cue phrase (here, *because*) is removed, then it is taken to be a cue phrase. Figure 2.2 gives a somewhat condensed version of the test; see [Knott 1996, p64] for the test in full. As it stands, Knott’s test also has several drawbacks: First, it catches only those items relating clauses; in *Despite the heavy rain, we went for a walk* it would not detect a cue phrase,⁵ and second, it is geared to English.

Finally, work in the context of text analysis/rhetorical parsing provides strategies on identifying discourse markers which are again mainly based on surface clues. [Marcu 1998, Marcu 1997] build on the observation that different orthographic environments often correlate with different discourse functions for identifying the phrases that play a role in discourse. For example, if the cue phrase *besides* occurs at the beginning of a sentence and is not followed by a comma, then it usually acts as an intra-causal connector; if the same cue phrase occurs at the beginning of a sentence and is followed by a comma, then it indicates an inter-sentential relationship [Marcu 1997, p144]. Yet, these heuristics as such do not define general criteria for identifying discourse markers in a corpus, but only classify items that are known to be discourse markers as belonging to a particular group. Moreover, like Knott’s test, the heuristics are also geared towards English, and cannot be applied to other languages without major changes, because there is no one-to-one correspondance between discourse markers in different languages nor between the properties of the linguistic context that affect marker choice.

2.2 Discourse markers in multilingual generation

Until recently, research on natural language processing has devoted comparatively little attention to discourse markers, despite the fact that discourse markers play a crucial role in processing text (see also [Rey 1997, Stede and Umbach 1998] for a similar view). But with the increasing capability of natural language processing (NLP) beyond sentence level, and hence the need to process discourse structure, studies of the role of discourse markers in the translation, interpretation and production of text have increased rapidly. Knowledge of the function and use of discourse markers is exploited in various NLP applications, including among others:

⁵Knott himself comments on this, and argues that he deliberately left out tests for phrases (and hence prepositions) because he wanted to keep the test as simple as possible, see [Knott 1996, p65].

- **Natural language understanding** (NLU), in particular:
 - rhetorical parsing [Marcu 1997a, Marcu 1998, Corston-Oliver 1998]
 - deriving argument structure [Teufel 1998]
- **Text summarization** [Ono *et al.* 1994, Marcu 1997]
- **Machine translation** (MT) [Rey 1997]
- **Knowledge acquisition from text** [Barker 1994]
- **Natural language generation** (NLG) (see discussion below)

This section reviews the treatment of discourse marker choice in natural language generation, with special emphasis on multilingual text generation (MLG).

In text generation, discourse markers are regarded as an important means to signal the coherence relations holding between parts of a text, and to achieve cohesive text. This emphasis on discourse markers as indicators of coherence relations is motivated by observations made by, for instance, [DiEugenio *et al.* 1997], who investigate instructional texts and observe that 181 of 406 discourse relations are signaled by cue phrases, and [Redeker 1990], who notes that one discourse marker occurs approximately every two clauses. Given that generation systems have moved from sentence generation, or the production of fairly stereotypical text, to the generation of complex text, discourse marker choice is now an area of active research (see for instance, the COLING-ACL'98 workshop on 'Discourse markers and discourse relations' [Stede *et al.* 1998]).

Initial approaches to discourse marker production realized a one-to-one mapping from coherence relation to linguistic form, such as always expressing a CONCESSION using *although/obwohl* or a RESULT using *so that/damit* (for instance, [McKeown 1985, Hovy 1988, Moore and Paris 1993]). This strategy, however, is not sufficient when aiming at text tailored to a particular audience, situation, etc., and when aiming at the production of adequate discourse markers to support text comprehension and inferences, as has been pointed out by [Stede and Umbach 1998]. Producing an appropriate discourse marker is a complex task: [Moser and Moore 1995] and [DiEugenio *et al.* 1997] assume three distinct though interrelated decisions that have to be made when generating discourse markers (example (2.2) is taken from text 20 (TC.20) from my small corpus of technical instructional texts,⁶ example (2.3) from a leaflet on the German Bundestag):

- **Marker occurrence:** Whether to place a marker or not?

(2.2)

- a. *Disconnect the spark plug wire, **then** remove **and** discard the old plug.*
- b. *Disconnect the spark plug wire. Remove the old plug. Discard it.*

- **Marker placement:** Where to place the marker?

⁶Detailed information on the corpus is provided in Chapter 4.

(2.3)

- a. *In principle, **however**, the third reading of a bill in Parliament ends with the final vote.*
- b. ***However**, in principle, the third reading of a bill in Parliament ends with the final vote.*

- **Marker selection:** Which marker to use?

(2.4)

- a. *He still works, **although** he is very old.*
- b. *He still works, **even though** he is very old.*

These tasks are by no means sequential but interact. For instance, marker placement is restricted by marker selection. The subordinating conjunctions *obwohl/although*, signaling a CONCESSION, can only be placed at the beginning of the subordinate clause, while the conjunctives *trotzdem/however* can occur in various positions in their host clause.

Most work in the context of text generation has addressed the question of marker selection. In this section, I first discuss research on marker placement and occurrence, and then turn to the issue of marker selection. In particular, I examine the types of discourse markers covered in existing approaches, the factors influencing marker choice, the representation of marker knowledge, and the placement of marker choice in the overall generation framework.

2.2.1 Marker occurrence and placement

Research on marker occurrence addresses the question of what the criteria are for including a discourse marker in text. If a marker is to be included, marker placement, that is the positioning of the marker in the connected discourse segments, becomes an issue.

There has been little research on both tasks. With respect to marker occurrence, present text generation systems tend to be overtly explicit by using discourse markers for all coherence relations in text to ensure that the reader can always recover the relation between text segments as intended by the writer; an example is the TECHDOC system [Rösner and Stede 1994]. Their approach rests on the heuristic postulated by [Scott and de Souza 1990, p50] to “always generate accurate and unambiguous textual markers of the rhetorical relations that hold between propositions of the message”. In contrast, systems such as the SPIN generator follow the other extreme and only employ discourse markers to signal relations within sentences [Kosseim and Lapalme 1994, Kosseim and Lapalme 1995]. Yet, given the observation made by [Moser and Moore 1995, Redeker 1990] and [Marcu 1997] that about half of the coherence relations are explicitly signaled in text, neither of the approaches is appropriate.

In their work, [Moser and Moore 1995, Moser and Moore 1995b] and [DiEugenio *et al.* 1997] approach the problem in a more principled manner. Moser and Moore describe a methodology for identifying the factors that influence marker occurrence and placement in explanatory text. In a first step, they formulate hypotheses about cue usage based on intuition

and findings in the literature, which are then evaluated in an extensive corpus study to motivate heuristics to be incorporated into a text generation system. Major findings are the following. Cue occurrence depends above all on the order of relata (in their terminology, on the order of core and contributor); cue placement is also constrained by order, and furthermore by the type of relation. However, no discourse markers are described using these features. [DiEugenio *et al.* 1997] carry on the work by Moser and Moore, and investigate when and how to use a cue phrase in tutorial explanations: They again identify a set of features (relating to segment structure, relation type and the embedding of a segment in discourse), then annotate a corpus with these features, and finally use machine learning techniques to induce decision trees from the annotated corpus, which give the feature choices in an hierarchical order. Based on these trees, [DiEugenio *et al.* 1997] conclude that cue occurrence is mostly influenced by global properties of the discourse, such as the level of embedding. On the other hand, cue placement is mainly affected by the syntactic properties of the relata and their complexity. The most important conclusion is that individual features have no predictive power for either cue occurrence or placement, and that the best combination of features cannot be found by manual inspection.

A related study is [Soria and Ferrari 1998] who examine the reasons for the writer's or speaker's decision for using rather than not using explicit clues such as discourse markers. In contrast to the two studies discussed above, they conclude that the effects of lexical marking depend on the relation type, and hence marker occurrence is at least partially constrained by the type of relation. Experiments show that lexicalization is not necessary for additive and consequential relations, but facilitate the reader's or hearer's ability to infer contrastive relations.

In short, marker occurrence and placement have not been an issue in text generation, and no principled approach to these tasks exists. Initial studies show that both tasks are complex, and decisions depend on many interacting factors, but no general solution has been provided. This thesis leaves this issue aside and concentrates on marker selection, which is discussed next.

2.2.2 Marker selection

Research on connectives within text generation has focused on the selection of discourse markers to produce coherent and cohesive multi-sentential text. For most coherence relations, language offers a variety of appropriate markers, as several studies of individual relations have shown (see below). Accordingly, from the generation perspective, a serious choice task arises if the produced text is not only simply to signal the coherence relation, but moreover to reflect pragmatic goals, stylistic considerations, and the different connotations markers have. This section reviews the different approaches to the marker selection task.

2.2.2.1 Coverage of present accounts

Studies on marker selection can be divided into two broad categories. The first category includes studies that take a particular coherence relation as a starting point, and that examine how this relation is signaled on the linguistic surface, for instance, [Vander Linden 1994] on the PRECONDITION relation. The second group includes studies that are concerned with identifying the characteristic properties of a small set of similar markers, and with determining the reasons behind choosing a particular marker from this set in a given context; an example here is the work by [Elhadad and McKeown 1990] on *since* and *because*.

The majority of work on discourse markers belongs to the first category. Since the most common approach to representing coherence relations in text generation is *Rhetorical Structure Theory* (RST) [Mann and Thompson 1988], most studies are concerned with the linguistic realization of a specific RST-relation. Various studies have been undertaken in the context of the production of technical instructional texts, a popular application domain of text generation techniques. In this domain, RST's subject-matter relations⁷ are the predominant coherence relations. Therefore, a number of studies examine the linguistic realization of subject-matter relations in this particular domain, and propose heuristics for including and choosing discourse markers given a particular RST-relation based on various parameters. For example, [Rösner and Stede 1992], who deal with subject-matter relations such as SEQUENCE, CAUSE, RESULT, PRECONDITION, MEANS, RST-UNTIL, etc, follow the strategy proposed in [Scott and de Souza 1990] and include a discourse marker for every relation in the RST tree. They base their choice of a particular English marker on nucleus/satellite order, sentence structure, complexity of the related segments, and the stylistic constraint of avoiding repetition of the same discourse marker. [Delin *et al.* 1996] look at a similar set of relations, also in the context of technical instructions, but consider English, French and Portuguese realizations. They argue that the syntactic expression is the major constraining factor in marker choice. [DiEugenio 1993] investigates the PURPOSE relation and the reasons for using either *to* or *by* in instructional texts, but mainly from the perspective of language understanding. Finally, [Vander Linden 1994] and [Vander Linden and Martin 1995] examine the realization of PURPOSE, PRECONDITION, RESULT and SEQUENCE relations in English instructional texts. In contrast to the former studies, this work is not restricted to discourse markers as expressions for coherence relations; instead, they describe how to choose systematically among a range of expressions—lexical and syntactic—based on elements of the communicative and linguistic context.

[Delin *et al.* 1994] for English, French, Portuguese and [Grote 1995] for German follow a similar goal: They, too, regard markers as one aspect among others in realizing an underlying relation; discourse markers again constitute a prominent means, but realizations without discourse markers are also accounted for in four languages. However, they do not start from RST-relations, but explore the possible verbalizations of the procedural relations *Generation* and *Enablement* as introduced by [Goldman 1970].

⁷Subject-matter relations are those relations that describe semantic relationships holding between text spans; details are presented in Chapter 3.

Independently of any particular domain, [Stede 1995] analyses German and English SUBSTITUTION markers such as *stattdessen*, *instead*, *aber*, *but* and addresses translation problems. [Power *et al.* 1999] discuss the selection between different realizations of the CONCESSION relation, namely *however*, *but* and *although*, depending on syntactic context and position in the discourse tree. [Knott 1998] considers how COMPARISON relations can be integrated within an RST-like model of discourse, in particular the relations CONTRAST and SIMILARITY. He illustrates how defeasible rules can help to choose among *whereas*, *while*, *also* and *too* as prototypical realizations of these two relations. Finally, [Scott and de Souza 1990] give heuristics for the realization of ELABORATION and EVIDENCE; in their view, realization mainly interacts with aggregation and the segments' position in the discourse tree.

The second category of approaches includes groups of semantically related discourse markers. Here, temporal discourse markers are the ones that have received most attention. [Dorr and Gaasterland 1995] present a detailed study of the English temporal subordinating conjunctions *before* and *while*. They examine the application of linguistic theories of tense and aspect to temporal marker choice proceeding from a pair of propositions, and show how marker choice strongly interacts with realizational choices concerning aspect and tense. [Lascarides and Oberlander 1993] take a different approach to the English temporal connectives *before*, *after* and *when*. They focus on their discourse behaviour, and discuss the interaction between presupposed material, discourse context, and the reader's background knowledge, and examine the role of discourse markers in the accommodation of new material. To reach this end, they employ a logical theory of discourse attachment (DICE) that rests on SDRT, a semantically-based theory of discourse structure (an extension of DRT, [Kamp 1981]). [Gagnon and Lapalme 1996] take a similar approach in the production of French temporal expressions, starting from a DRT representation of the discourse. However, the focus of their work is on temporal adverbs; conjunctions and prepositions are only briefly addressed.

The automatic production of German temporal expressions has also been addressed. [Klenner 1991] developed the TELOS system to describe a sequence of events using the German temporal markers *nachdem*, *bevor*, *während*, *als* and *bis* (after, before, during, as, until). However, the selection procedure is driven by the underlying temporal relation alone (as defined by [Allen 1984]), and adopts the one-relation-one-marker strategy. [Schilder 1993] describes a larger set of temporal markers building on Herweg's work [Herweg 1990], and presents the TEMPLOG generator that produces temporal subordinate conjunctions (without generating the conjoined text segments) from a conceptual representation of two events. Similar to [Klenner 1991], this approach mainly builds on properties of the temporal relation, but differs from Klenner's work in that more fine-grained distinctions in temporal marker meaning are supported. In both approaches, interactions between marker choice and the linguistic context are not dealt with. In contrast, [Schilder 1998] accounts for this interaction. He shows how aspect and syntactic category influence marker choice, but discusses only a single temporal marker, *nachdem* (after).

There is also work on the use of discourse markers in argumentative discourse: [Elhadad 1992, Elhadad and McKeown 1990] investigate the influence of argumentative intent on marker

choice and from this angle look at *but* and *although*, and at the difference between *since* and *because*. They define each connective by a set of constraints between features of the propositions it connects (described in the *interpretative format*, IF), in particular: speech act of proposition, functional status, polyphonic features and thematization procedures. A surface generator based on the *Functional Unification Formalism* (FUF) uses the IFs to choose between the four connectives. [Moser and Moore 1995b] re-examine the results on *since* and *because*, and suggest that the order of relata has also to be taken into account in addition to the pragmatic features listed by Elhadad.

2.2.2.2 Factors influencing marker choice

In order to make an informed choice of discourse markers, a text generation system must be equipped with detailed knowledge on the nature of markers. In the various approaches to marker selection discussed above quite different sets of parameters are proposed as determining the choice of the most appropriate discourse marker in a given context. This diversity is largely due to the range of markers considered and the application domains. Further, research on marker placement and marker occurrence also suggests parameters, which, however, mostly relate to structural properties of the discourse and not to the nature of the coherence relation.

Factors guiding discourse marker occurrence and selection can be subdivided into three classes: first, features describing the coherence relation signaled by the discourse marker, and the semantic and pragmatic properties of the discourse segments to be related; second, properties of the linguistic context of the discourse marker, i.e. constraints on the lexical and syntactic realization of the relata; and third, features describing the properties of the discourse structure. The following list summarizes the most frequent features or parameters encountered in the literature.

Marker meaning. Features describing different aspects of discourse marker meaning, for instance, its semantics, the intention realized, etc:

- **Rhetorical relation**, i.e. type of RST-relation, for instance, [Scott and de Souza 1990, Rösner and Stede 1992, Vander Linden 1994, Knott 1998].
- **Semantic relation**, often referred to as informational relation. More than 30 informational relations (causal, temporal, etc) are employed in [DiEugenio *et al.* 1997]; Generation and Enablement in [Delin *et al.* 1994, Delin *et al.* 1996, Grote 1995]; temporal relations in [Dorr and Gaasterland 1995, Klenner 1991], etc.; defeasible rules are employed in [Knott 1998] to account for comparison and similarity.
- **Intentional relation**, comprising volitionarity [Vander Linden and Martin 1995], commentability [Saebo 91], communicative goals [Stede and Umbach 1998], argumentative relation [Elhadad and McKeown 1990, Elhadad 1992], etc.
- **Presupposition** as discussed in [Lascarides and Oberlander 1993], or the information structure (given/new) in [Elhadad and McKeown 1990, Moser and Moore 1995].

- **Polyphonic features** which describe whether the connected discourse segments can be attributed to the same speaker or different speakers (in [Elhadad and McKeown 1990, Elhadad 1992]).

Syntagmatic constraints. Features relating to properties of the syntactic and lexical context, i.e. structural phenomena:

- **Order** of relata, of either nucleus/satellite [Rösner and Stede 1992, Delin *et al.* 1996, Power *et al.* 1999], core/contributor [Moser and Moore 1995, DiEugenio *et al.* 1997], or -ING/-ED element [Delin *et al.* 1996, Grote 1995].
- **Clause type** relates to sentence boundaries and clause internal structuring such as choosing between coordinate or subordinate clause complexes and two independent clauses [Rey 1997, Rösner and Stede 1992, Delin *et al.* 1996, Power *et al.* 1999, DiEugenio *et al.* 1997].
- **Syntactic realization**, i.e. the syntactic properties of individual clauses, for instance, indicative or imperative mood, to-infinitives or nominalizations, etc. [Delin *et al.* 1996, Vander Linden and Martin 1995, Grote 1995].
- **Host clause**, i.e. which relatum carries the discourse marker [DiEugenio *et al.* 1997].
- **Type restrictions** regarding the realization of the two relata, for instance, with respect to tense, aspectual category, etc. [Dorr and Gaasterland 1995].
- **Cue placement**, i.e. the placement of the marker in the relatum, for instance, front, mid or end position [Schilder 1998, Stede and Umbach 1998, Power *et al.* 1999]. A related issue is the representation of the preferred position of a discourse marker [DiEugenio *et al.* 1997, Rösner and Stede 1992].
- **Scope** of discourse markers; this relates to the size of segments that can be related [Rösner and Stede 1992, Vander Linden and Martin 1995].
- **Polarity** of related propositions [Knott 1998, Stede and Umbach 1998].

Discourse structure. Features specifying the properties of the surrounding discourse, the discourse context:

- **Embeddedness in discourse**, i.e. the position of related text segments in the discourse tree (terminal/non-terminal/root) [Rösner and Stede 1992, Moser and Moore 1995]; also *below* and *above* in [DiEugenio *et al.* 1997], which encodes the number of relations that are hierarchically above/below the current relation.
- **Complexity of segments**, i.e. complexity of nucleus and satellite (minimal unit or subtree; depth of subtree) in [Rösner and Stede 1992], complexity of core (segment or minimal unit), in [DiEugenio *et al.* 1997], or single/multiple unit in [Power *et al.* 1999].

- **Segment width**, or segment size of segments on the same level; for instance, whether a core segment has one with one or more contributors [DiEugenio *et al.* 1997].
- **Adjacency** of relata [DiEugenio *et al.* 1997].

There exists no overall account of discourse marker production that takes all these features into consideration, as the studies reported on either only deal with marker occurrence and placement, or with marker selection, and investigate different groups of discourse markers.

Further evidence for factors guiding discourse marker usage comes from research on the role of connectives in text summarization and rhetorical parsing. Still, the features used to characterize marker usage in natural language understanding differ somewhat from the ones employed in NLG. This is due to a different perspective on the subject matter: text generation systems try to determine the most appropriate surface form for a given coherence relation; the text understanding task, in contrast, needs to determine the conditions for discourse marker usage from its surface form [Corston-Oliver 1998, Marcu 1998]. Hence, in the NLU context marker usage is mainly described by its orthographic and syntactic properties, these act as pieces of evidence for a particular marker reading. For instance, [Marcu 1998] takes the orthographic environment, type of usage (sentential, discourse, pragmatic), position of marker, and boundary into account. Similar features are used by [Corston-Oliver 1998]. In short, the feature sets given in these studies are only partially relevant to NLG. However, the large lists of discourse markers accumulated by [Marcu 1997, Corston-Oliver 1998] for English, and [Rehm 1998] for German are helpful as a starting point for assembling the set of discourse markers to be examined.

2.2.2.3 Representing and processing marker knowledge

If one aims to build implemented systems that support discourse marker choice, then the representation of the knowledge assembled on the usage of individual discourse markers and the processing of this knowledge become an issue. Unfortunately, not all authors that claim to have an implemented discourse markers choice module are explicit on this matter; for instance, [Delin *et al.* 1996] do not comment on the selection strategies they employ, although the texts they generate contain discourse markers.

Systems adopt quite diverse strategies. In the IMAGENE system [Vander Linden 1994, Vander Linden and Martin 1995], the system network formalism of Systemic Functional Grammar [Halliday 1994] is used to code the identified conditions of usage. Processing, i.e. marker choice, then takes place during system network traversal: realization statements are accumulated, and eventually give rise to a discourse marker and to constraints on its lexicogrammatical environment. In contrast, [Rösner and Stede 1992] use a pattern-matching algorithm to choose discourse markers in the TECHDOC system: possible realizations of an RST-relation (mainly discourse markers) are stored as patterns containing information on the orthographic environment, nucleus-satellite order and complexity of relata. Applicable patterns are retrieved for all RST-relations in a discourse tree, and a pattern-and-constraint-based procedure is applied to find the optimal realization. Similarly, [Elhadad and McKeown 1990, Elhadad 1992] have implemented connective selection

through a constraint-satisfaction algorithm, and [Power *et al.* 1999] employ constraint-logic programming to determine possible discourse markers.

Researchers advocate different ways of representing the knowledge on discourse markers. [DiEugenio *et al.* 1997] store the information on marker usage conditions in a decision tree which contains the features required to describe discourse markers as nodes, and [Elhadad and McKeown 1990, Elhadad 1992] represent connectives in the lexicon of their FUF grammar as relations between utterances. Taking a much broader view on the matter, [Stede and Umbach 1998] propose to store marker knowledge in an independent resource, a discourse marker lexicon (DIMLEX), in a uniform and application-independent way. However, their suggestions as to the shape and content of such a lexicon remain somewhat vague as no specific lexicon entries are given. Recently, there has been some work on producing complex sentences including discourse markers using lexicalized tree adjoining grammar (LTAG). [Webber *et al.* 1999a, Webber *et al.* 1999b] and [Webber and Joshi 1998] describe how lexicalized TAGs can be extended to capture relations between clauses. Likewise, [Danlos 1998] presents G-TAG as a uniform framework for expressing the linguistic knowledge needed to relate discourse markers to linguistic realizations. Finally, for the generation of German discourse markers, [Schilder 1993] represents the knowledge on temporal markers in a Prolog predicate where the body specifies the applicability conditions of the marker; this representation is similar to a lexicon entry.

2.2.2.4 Summary

To sum up, studies on discourse marker selection focus on the choice of connectives given a pair of discourse segments; additional factors considered are mostly syntactic setting and order of relata. Only a few approaches present discourse markers as one means among others to signal coherence relations, for instance, [Vander Linden 1994]. Furthermore, most work is on English connectives, and results from English are hardly transferable to German as the set of realizational means and the interactions with the linguistic context differ (see also [Rey 1997]). Multilinguality is only a marginal topic in existing studies; studies that address this issue only consider a very small number of markers. In addition, different frameworks for discourse markers representation are assumed, ranging from systemic functional linguistics [Vander Linden 1994] and FUF [Elhadad and McKeown 1990] to LTAGs [Webber *et al.* 1999a]. Finally, the studies reviewed here are usually concerned with only a small set of markers, and they are isolated studies geared towards a particular application; examples are the realization of the Generation relation in instructional texts [Delin *et al.* 1994], or the use of *since* in argumentative texts [Elhadad and McKeown 1990]. Not surprisingly, studies then differ strongly regarding the set of parameters that they assume as governing discourse marker choice.

In short, there is at present no overall framework that supports informed and motivated discourse marker selection for more than a small set of markers and relations. An exception is the work by [Stede and Umbach 1998], who propose a discourse marker lexicon as a general resource to be used in text generation and text understanding applications alike. Unfortunately, they only present an intuitive list of features that has not been

applied to discourse marker description, i.e. no analyses of discourse markers or lexicon entries for individual markers using these parameters are given, and they do not illustrate how the generation process employs such a marker lexicon. The broadest overview of discourse markers to my knowledge is the descriptive work of [Knott and Mellish 1996] and [Knott 1996], but it does not specifically address the generation task. This work will be discussed in Section 2.3. [Moser and Moore 1995] and [DiEugenio *et al.* 1997] also take a broader view on marker production in that they try to determine general factors that influence the use of markers in text, and in that they consider more complex structures than merely pairs of propositions. Yet, they are mainly concerned with marker occurrence and placement, not with marker selection.

2.2.3 Discourse marker choice in the overall generation process

While language generators were traditionally split into a content determination/*What-to-say* component and a realization/*How-to-say* component, in recent years the notion of an intermediate stage devoted to sentence planning, generally called *micro-planning*, has gained popularity, e.g., [Rambow and Korelsky 1992, Wanner and Hovy 1996]. The prime motivation for sentence planning is to relieve the text planner from language-specific knowledge, and to relieve the realization component from any planning or decision-making that potentially affects the meaning of the utterance. Hence, better control of the overall generation process is gained, and the *generation gap* identified by [Meteer 1992] can be bridged. I do not elaborate the advantages further here; see, for example, the discussion in [Panaget 1994] and the description of the three components in [Reiter and Dale 2000].

2.2.3.1 Discourse marker choice as a sentence planning task

Given the three tasks of text planning, sentence planning and sentence realization, discourse marker choice is typically regarded as a sentence planning task (see for instance [Rösner and Stede 1992, Delin *et al.* 1996, Reiter and Dale 2000]).⁸ A similar view is taken by [Wanner and Hovy 1996, Hovy and Wanner 1996], who present the following list of decisions to be made by the sentence planner:

- fine-grained discourse structuring: order related clauses, choose a discourse markers;
- sentence grouping and sentence content determination: delimit the individual sentences, aggregate propositions;
- clause-internal structuring: decide on constituent ordering and taxis;
- choice of referring expressions;

⁸Note, however, that common practise does not adhere to this theoretical assumption: Most text generation systems do *not* support discourse marker choice at sentence planning level, but treat discourse marker choice as a ‘side effect’ of grammatical decisions.

- lexical choice.

Discourse marker choice is one aspect of sentence planning; yet, it is assigned to different subtasks. In contrast to [Wanner and Hovy 1996], [Reiter and Dale 2000, p129] regard discourse marker choice as one aspect of lexicalization: “Lexicalization includes the task of choosing appropriate cue words.” In any case, discourse marker selection is not an isolated phenomenon: Several of the features used to describe the conditions of usage or the properties of discourse markers (see lists given in Section 2.2.2.2 relate to other sentence planning tasks, for instance, clause type and sentence boundaries are aspects of the sentence grouping task, aspectual categories result from lexical choice, ordering of relations is a subtask of discourse structuring. How exactly these tasks are to be accomplished depends on the nature of the input and output representations, and thus on the architecture of the generator.

The dependencies between marker choice and other generation decisions are rather intricate. The idea of avoiding dealing with these dependencies is, presumably, the reason for the simplistic treatment of marker choice in the majority of generators to date which are not explicitly concerned with discourse marker choice: they regard discourse markers as mere consequences of the structural decisions. For instance, in [Dorr and Gaasterland 1995] and [Delin *et al.* 1996] the choice of a discourse marker is subsequent to determining the order of clauses and their syntactic realization. In other words, discourse marker selection is not explicitly controlled, but follows from other sentence planning decisions. However, this imposes serious limitations on the expressiveness of the system. And even though a few systems have incorporated more sophisticated mappings for specific relations, e.g. DRAFTER [Paris *et al.* 1995], there is still a tendency to treat discourse marker selection as a task to be performed as a ‘side-effect’ of the grammar. A notable exception is [Vander Linden and Martin 1995] who take a different approach in treating discourse markers and other lexical and syntactic realizations as competing means. In their view, discourse marker choice can have consequences for other sentence level decisions, for instance, syntactic consequences, and conversely, syntactic structuring can constrain the set of available discourse markers.

Regarding research on sentence planning in general, there have been a number of studies on individual aspects of sentence planning, for instance, on aggregation [Dalianis and Hovy 1993, Dalianis 1997, Dalianis and Hovy 1997, Huang and Fiedler 1996], sentence structuring [Nicolov *et al.* 1996], choice of referring expressions [Dale 1992, Horacek 1995, Horacek 1996, Dale and Reiter 1995], and choice of lexical means [Elhadad 1992, Stede 1999]. [Reiter and Dale 2000] and [Cahill and Reape 1999] present an overview of the various aspects of sentence planning. Approaches to sentence planning that go beyond the study of individual phenomena and that claim to give a more general solution to the sentence planning issue are [Rambow and Korelsky 1992] and [Meteer 1992, Meteer 1991]. The sentence planning module of JOYCE handles the choice of lexical and syntactic realizations, and determines sentence boundaries [Rambow and Korelsky 1992]. Meteer’s work, on the other hand, is rooted in the observation that a realizer requires more information than a text planner can provide; she closes this *gap in expressibility* by means of a *Text Structure*, which unites information on lexeme choice, syntactic structure, textual decisions,

etc. However, both approaches only address a subset of the tasks ascribed to the sentence planning stage, and discourse marker choice is not among them.

Since sentence planning tasks interact, one cannot impose a strict ordering on them and simply realize discourse markers as a consequence of other choices. Hence, appropriate algorithms for sentence planning are those that take these aspects into account. Examples are the sentence planning architecture developed in the context of the DIOGENES project [Nirenburg *et al.* 1989] and the one realized in the HEALTHDOC project [Wanner and Hovy 1996]. They employ a blackboard architecture for processing the various decisions on sentence planning level, thereby making it possible to treat discourse marker choice as one aspect of sentence planning. Others realize the sentence planning phase using, for instance, constraint logic or unification.

2.2.3.2 Assumptions about the discourse level

Assuming the traditional pipeline generation architecture as most systems do [Bateman 1998, Reiter and Dale 2000] sentence planning starts from some kind of discourse representation, which is the output of the text planning stage. Generally, the discourse representation is conceived as a tree where the non-terminal nodes denote relations and the terminal ones are individual propositions.⁹ During sentence planning, this tree is transformed into a sequence of sentence-semantic specifications to be fed to the surface realization component. Since discourse marker choice is one aspect of sentence planning, discourse marker choice mechanisms operate on the discourse structure.

Given the fact that approaches to marker selection differ considerably with respect to the factors they regard as crucial in discourse marker choice and with respect to the representation of knowledge of discourse markers, one would expect an equally diverse range of positions regarding the discourse level. However, most work on discourse marker choice in MLG proceeds from an RST-like description of the discourse structure; in particular, from a specific RST relation: [Vander Linden and Martin 1995] take RST's PRECONDITION, PURPOSE and RESULT relations as a starting point; [Scott and de Souza 1990] examine possible realizations of ELABORATION and EVIDENCE; [Rösner and Stede 1992] also assume an RST representation of the discourse structure, as do [Delin *et al.* 1996, Danlos 1998, Knott 1998, Power *et al.* 1999]. [Moser and Moore 1995, DiEugenio *et al.* 1997] start from an extended RST representation: they developed *Relational Discourse Analyses* (RDA) which synthesizes ideas from RST and Grosz and Sidner's intentional approach [Grosz and Sidner 1986]. Finally, [Webber and Joshi 1998, Webber *et al.* 1999a] describe an extension to lexicalized tree adjoining grammar (LTAG) to represent discourse structure, i.e. to capture relations between trees that represent entire clauses (discourse relations). Approaches in the context of MLG have in common that they support a somewhat reduced notion of discourse structure: discourse structure amounts to the representation of coherence relations, this will be discussed in Chapter 3.

Approaches to discourse marker generation that do not investigate the realization of a

⁹Chapter 3 surveys the state of the art in discourse representation.

particular relation but examine the behaviour of a small set of semantically related markers do not assume a discourse representation. For instance, [Dorr and Gaasterland 1995] in their account of temporal markers do not relate to coherence relations at all, since they investigate how marker selection interacts with other sentence planning tasks for *pairs* of text segments only. Similarly, [Delin *et al.* 1994, Grote 1995] are not concerned with discourse structure, but with the semantic (or procedural) relations between propositions. Note that the restriction to pairs of propositions or text segments is a general tendency in the work on discourse marker choice in MLG. Even though approaches generally assume a discourse representation that combines more than two text spans, most examples given and heuristics proposed relate to pairs of text spans only. This is different for marker occurrence accounts. As structural properties of the discourse seem to be important factors in marker occurrence, this work deals with complex discourse trees [DiEugenio *et al.* 1997].

2.3 Discourse markers in descriptive linguistics

Discourse markers have not received much attention in lexical research within computational linguistics. They are usually treated like other closed-class items, which are considered to belong to the realm of the grammar rather than the lexicon. Hence, discourse markers do not occur in lexical databases such as WORDNET [Fellbaum 1998], which only deals with content words.

In contrast, descriptive linguistics provides a rich body of work on discourse markers, or connectives, for example, on individual discourse markers such as *zwischen* (between) [Habel 1989] or *although* [Sidiropoulou 1992], on marker groups such as concessive markers [König and van der Auwera 1988, König 1991], on the entire set of German connectives (IDS Projekt, [Pasch *et al.*, in prep.]) or English cue phrases [Knott 1996]; either from a functional point of view [Halliday and Hasan 1976, Martin 1992], a formal semantic approach [Lang 1984, Herweg 1990, Moens and Steedman 1988], a lexical perspective [Pasch *et al.*, in prep., Buscha 1989], or a syntactic classification (grammars such as [Helbig and Buscha 1991, Quirk *et al.* 1972]).

This section reviews a range of contributions on discourse markers from linguistics. Note that the goal of this section is not to discuss discourse marker studies exhaustively, but to briefly survey the different approaches to discourse marker description that exist, and to point out their major contributions and problems. The insights gained will be used in later chapters to motivate the decisions made regarding the approach to discourse marker description, representation and processing advocated in this thesis.

There are several ways to classify existing studies. One way is by looking at how different linguistic disciplines approach discourse markers. For example, text linguistics investigates the global role of discourse markers in signaling a coherence relation; in other words, it focusses on discourse markers as cohesive means in text, and tries to embed discourse marker description in a comprehensive model of coherence relations [Halliday and Hasan 1976, Martin 1992]. As such, it favours the ‘top-down’ approach to the matter. Grammarians, on the other hand, explore the grammatical role of, e.g. conjunctions, and to that

end propose inventories of semantic relations signaled by these conjunctions [Buscha 1989, Helbig and Buscha 1991]. They adopt a ‘bottom-up’ approach to marker description and investigate discourse markers without considering the wider discourse context. Finally, psycholinguists are concerned with, among others, the role of discourse markers in text understanding (see for instance [Wrobel 1994]), and the trade-off between reader and writer economy in discourse marker production (see [Spooren 1997]). Discussing psycholinguistic work is, however, beyond the scope of this thesis.

In discussing approaches from text linguistics and grammars, I follow the categorization proposed by [Knott 1996]: He notes that researchers are faced with a trade-off between the *accuracy* of the description they develop, and its *scope*. Here, accuracy refers to how specific the conditions under which a particular marker is used are described by a particular theory; scope refers to the number of different connectives that are accounted for. Existing functional and lexical approaches are characterized by a large scope, but are less accurate, whereas the reverse holds for studies which aim at providing formal semantic definitions of markers: The accuracy is high, but the coverage is rather small.

2.3.1 In-depth studies of small sets of discourse markers

A large number of accounts on discourse markers tend to concentrate on a particular class of markers (small scope), which they investigate in great detail (high accuracy), rather than on discourse markers in general. They aim at a formal semantic account of a small set of discourse markers, as their major concern is not a comprehensive analysis of a particular class of discourse markers, but the development a formal apparatus that allows to adequately describe meaning and syntactic properties of discourse markers. These approaches generally focus on the formal precision of their apparatus, and individual discourse markers are examined in order to demonstrate this.

The major body of work in this traditions examines causal, concessive or temporal discourse markers. For instance, discourse markers signaling causal relationships are examined for various languages; examples are [Pasch 1997] for the German *weil* and *denn*, and [Pasch 1992, Rudolph 1981]; [Degand and Sanders 1999] for the Dutch *omdat* and *want*, and [Degand 1996, Pander Maat and Sanders 1995]; [Amsili and Rossari 1998] and [Jayez and Rossari 1998] for the French *donc*, *par consequent* and *alors*. Discourse markers indicating a concessive or adversative relationship such as *although*, *despite* and *however* are investigated in, among others, [Abraham 1979, Sidiropoulou 1992] for English, in [König and van der Auwera 1988, König 1991] for German, in [Spooren 1989] and [Pander Maat 1998] for Dutch, and in [Anscombe and Ducrot 1977] for French. [Harris 1988] contains a multilingual study of discourse markers in English and Romance languages, and finally, [Rudolph 1996] presents a comprehensive study of English, German, Spanish, and Portuguese contrast constructions. With respect to discourse markers establishing a temporal link between two clauses, [Moens and Steedman 1988, Heinämäki 1978] investigate English temporal connectives, [Steube 1980, Herweg 1990, Herweg 1991b] and [Sinn 1991] discuss German temporal markers, and [Oversteegen 1993] examines Dutch temporal markers.

While all studies aim at a general model for representing discourse marker meaning, they differ with respect to what they regard as central to the meaning of discourse markers, and hence with respect to the linguistic framework they employ to describe marker properties. For instance, [Sidiropoulou 1992] and [Lascardes and Oberlander 1993] use representation languages that build on DRT [Kamp 1981] to capture marker meaning, and focus their accounts on the interaction of discourse markers and presuppositions and implicatures. In contrast, the work by [Degand 1996] is embedded in the systemic functional framework, and considers the function of discourse markers in context to explain marker usage. [Webber and Joshi 1998, Webber *et al.* 1999b] aim at a fully lexicalized semantics of connectives in the framework of lexicalized TAG. They show how lexicalized grammar can be extended in a principled way to discourse, and discuss the meaning of *for example*, *otherwise* and *then* using the three semantic mechanisms used in sentence-level grammar, namely composition, (anaphoric) presupposition, and general inference.

Various accounts focus on the semantic relation expressed by a discourse marker, and its interaction with the linguistic environment. For instance, [Herweg 1990, Herweg 1991b] apply two-level semantics (see for instance [Bierwisch 1982, Lang 1989]) to capture the underlying semantics of a discourse marker and its conceptualization when actually used in text. [Steube 1980, Buscha 1989, Schröder 1990] turn to feature sets to describe semantics and usage conditions of discourse markers. Features range from the semantic relation signaled to properties of the linguistic environment. The latter two studies are in the tradition of generative semantics: they use binary features to describe the properties of discourse markers, and give lexicon entries for individual markers based on these features. [Hitzeman 1995] also relegates discourse marker knowledge to the lexicon, but employs the HPSG framework. In contrast to these approaches, [Durrell and Bree 1993] present selection trees to describe marker properties: a path through the selection tree gives a number of features that define the discourse marker attached to a leaf node of the tree. To give another example, [Oversteegen 1993] uses TTT, a special representation language for temporal information, in her account of temporal markers. Finally, much research has been conducted in the area of psycholinguistics; examples are [Spooren 1989, Pander Maat and Sanders 1995, Pander Maat 1998].

There are numerous of these in-depth studies for most types of discourse markers in English and German, which are our present focus. Approaches to describing temporal discourse markers in English and German will be surveyed in Chapter 5, as these are the marker groups that serve as testbed for the approach to marker analysis, representation, and processing proposed in this thesis. To summarize, all the studies in the formal tradition are isolated studies of a small set of discourse markers, none of them aims at describing a comprehensive set of discourse markers. Further, multilinguality is only of minor concern, the majority of studies does not go beyond investigating a single language.

2.3.2 Accounts covering a large range of discourse markers

Accounts which aim at a (more) comprehensive coverage of discourse markers usually provide a less formal analysis (less accuracy), but cover a much wider range (large scope).

A prominent subclass is formed by text linguistic studies adopting a functional approach to discourse markers and focussing on language in use, such as [Halliday and Hasan 1976, Martin 1992, Halliday 1994] for English. In general, Systemic Functional Linguistics (SFL, see [Halliday 1994]) maintains that every linguistic surface form follows from its function in discourse, and aims at describing the precise relationship between the situational context of an utterance and its verbalization. The functional framework makes it possible to systematically represent the environments in which a linguistic form may occur; the environments are described in terms of the semantic and pragmatic conditions of usage of a surface form.

With respect to discourse markers, the emphasis in [Halliday and Hasan 1976, Martin 1992, Halliday 1994] is on producing a classification of connectives according to their function in discourse, that is, their contribution to discourse coherence. The usage conditions of discourse markers is described in terms of the different dimensions along which they can vary, such as the logico-semantic relation signaled, the type of interdependency between the relata, or the rhetorical nature of the connectives. Different approaches propose different sets. For [Halliday and Hasan 1976], connectives are linguistic devices that provide textual cohesion over successive sentences, and are classified as EXTERNAL vs. INTERNAL and according to the relation they express (ADDITIVE, ADVERSATIVE, CAUSAL vs. TEMPORAL). [Martin 1992] also regards EXTERNAL vs. INTERNAL as a major opposition; further, he proposes PARATACTIC vs. HYPOTACTIC and ADDITIVE, COMPARATIVE, CONSEQUENTIAL vs. TEMPORAL. [Halliday 1994] assumes two major dimensions, *type of expansion* with the values ELABORATION, EXTENSION, ENHANCEMENT and *functional relationship*, for instance, COHESION, INTERDEPENDENCY, etc. To give an example, consider the connective *although*: It would be classified as EXTERNAL/INTERNAL; ADVERSATIVE ‘PROPER’, SIMPLE in [Halliday and Hasan 1976]; as EXTERNAL; CONSEQUENTIAL, CONSEQUENCE, CONCESSIVE, HYPOTACTIC in [Martin 1992]; and as ENHANCEMENT; INTERDEPENDENCY, HYPOTACTIC, CONDITION in [Halliday 1994]. The dimensions that capture the conditions on marker usage can be represented at any level of detail, that is, the accuracy may vary. Yet, the majority of existing work in the systemic tradition aims at large coverage, at the cost of accuracy. [Martin 1992] is an exception: He analyses a comprehensive set of English connectives (large scope), and presents a classification that is fine-grained enough to distinguish the usage of, for instance, *although* and *even though* and *while* and *as* (high accuracy).

To my knowledge, [Knott 1996] provides the broadest survey of English discourse markers that is not in the systemic tradition. He also proposes a feature-based classification of discourse markers that can signal coherence relations based on a substitution test. Features identified this way include *semantic* vs. *pragmatic* and *positive* vs. *negative*; [Knott and Sanders 1998] extend this approach to also include Dutch discourse markers. Similarly, [Sanders *et al.* 1992] classifies discourse markers (and the coherence relations they indicate) using four major oppositions, among them *source of coherence* with the feature values *semantic* vs. *pragmatic*, and *polarity* with the values *positive* vs. *negative*. These studies differ from the functional accounts in how features and classifications are motivated. For instance, [Knott 1996] tries to infer features based on linguistic evidence alone—pursuing a data-driven approach—and performs substitution tests for hundreds

of English discourse markers, and [Sanders *et al.* 1992] ground their classification in psycholinguistic experiments. In contrast, functional accounts base their distinctions on the function of a particular lexical item in text. Further, only the functional approach makes pronouncements on *why* a particular discourse marker would be used in a particular context. Unfortunately, all studies with a large coverage examine English and Dutch connectives only; to my knowledge there exists no functional description of German discourse markers.

In terms of [Marcu 1997, p116], the approaches mentioned so far are all *local* in that they consider relations between clauses/sentences. He distinguishes between a local and global view on discourse markers; the global view is concerned with the scope and function of discourse markers at the level of text organization and text structuring. [Kintsch 1977], to give an example, examines connectives such as *so*, *but* and *and* and their contribution to marking boundaries of story parts. This global view on discourse markers will not be considered in this thesis.

Turning to descriptive linguistic studies, grammars, dictionaries and lexicons present resources for discourse marker analysis, again providing a large coverage at the cost of accuracy. For instance, in grammars such as [Helbig and Buscha 1991, Quirk *et al.* 1972] the depth of analysis is rather shallow, and the fundamental classification criteria is the word class. Likewise, lexical approaches tend to cover a large number of discourse markers; lexicons such as [Buscha 1989] for German conjunctions and [Schröder 1990] for German prepositions cover all lexical items belonging to the corresponding word class, but only give a coarse semantic characterization, and account mainly for syntactic restrictions on usage. The project ‘Handbuch deutscher Konnektoren’ (Handbook of German connectives), which is currently under way at the IDS Mannheim (see [Pasch *et al.*, in prep.] for a draft version) takes a different approach to lexicon design. The handbook assembles the lexical items in German that can connect sentences, based on the test for connectives depicted in Figure 2.1 which returns lexical items from different word classes. The lexicon aims at a characterization of syntactic properties and usage conditions for all the lexical items that pass the criteria. However, up to now, the focus has been on syntactic properties of connectives, while the description of marker meaning and semantic and pragmatic usage condition has not been addressed.

To sum up, descriptive studies on discourse markers are faced with a trade-off between accuracy and scope (see [Knott and Mellish 1996]). Studies either go into great detail with respect to a small set of discourse markers, or cover a large range of discourse markers at the cost of accuracy. The focus is still on the syntactic and semantic properties of discourse markers, only functional approaches such as [Halliday and Hasan 1976, Martin 1992] examine the function of discourse markers as conveying coherence relations in more detail, and actually look at text in contrast to the two-clause examples given in most studies. Finally, while there are numerous in-depth studies on German discourse markers, most of the large-coverage accounts are for English; there exist no functional descriptions of German discourse markers.

2.4 Conclusions: Making progress in discourse marker description and choice

The discussion in Section 2.1 to Section 2.3 has tried to make clear that current text generation systems are typically not very good at choosing discourse markers. Most systems only consider a very restricted set of discourse markers, and while a few systems have incorporated some more sophisticated mappings for specific relations, e.g. DRAFTER and IMAGENE, there is still a general tendency to treat marker selection as a ‘side-effect’, taken care of by the grammar, much like other function words such as quantifiers and determiners. In particular, shortcomings pertain to the following areas:

- Present accounts in the context of MLG are all isolated studies which first, consider only small sets of discourse markers, second, suggest different sets of parameters determining marker usage, and third, look at discourse markers but neglect competing realizational means.
- Most of them are *ad hoc* studies, which are not firmly based in a linguistic framework.
- Multilinguality is not accounted for; most work deals with English discourse markers only.
- Computational solutions are all geared towards a particular application. There is at present no overall framework that supports informed and motivated marker generation for more than a small set of markers and relations.
- They focus on marker selection and neglect marker occurrence and placement.
- Most current systems support a one-to-one mapping between discourse relation and marker choice, which limits the expressiveness of a multilingual generator.
- Discourse marker choice has no proper place in sentence planning, and is moreover treated as a consequence of other choices.

Note that different generation systems display different shortcomings, depending on the application domain and the research interests motivating the development of the generation system. Nevertheless, a general solution to discourse marker choice in text generation is required.

The research literature on discourse markers gives a wealth of information on individual markers or groups of similar markers, but, as the last section has shown, not at any uniform degree of description. Those approaches that try to analyse a wide range of markers within one framework face the problem of arriving at a sufficient degree of accuracy. Lessons learned from the discussion of descriptive research on discourse markers for the discourse marker description for MLG include:

- There is a need for standardization: Descriptive linguistics provides a large body of analyses in various linguistic frameworks, for which a common level of description is required.
- The functional approach makes it possible to represent the semantic and pragmatic conditions of discourse marker usage in a principled way, i.e. it makes statements about *why* a particular discourse marker would be used in a particular context, whereas formal approaches focus on formal semantic and syntactic properties of discourse markers. Yet, the question of when to use which discourse marker for what reason is crucial to text generation, hence the functional approach seems to be best suited for MLG purposes.
- When aiming at large scope and high accuracy, the functional approach seems to be appropriate, too. Although present studies usually examine a wide range of discourse markers at a less detailed level, the functional framework allows for any level of detail in the analysis.
- A strategy for identifying German discourse markers in unrestricted text in a reliable way is required.

The goals of this thesis regarding discourse marker description and choice can now be summarized as follows:

- Design a test for identifying German discourse markers in text that goes beyond syntactic criteria. This also serves as definition of the term ‘discourse marker’.
- Cover not only syntactic variety in discourse marker usage, but also describe the exact semantic and pragmatic conditions of usage.
- Provide an in-depth analysis of discourse markers from different groups using one linguistic framework, in my case—for the reasons given above—the functional approach. Describe the differences between similar markers precisely, building on results from previous work in descriptive linguistics and MLG.
- Perform a thorough cross-linguistic comparison to provide the ground for multilingual generation and resource sharing.
- Build a uniform representation to be used in MLG based on this analysis, that can accommodate all the knowledge relevant to marker choice and multilinguality.
- Account for dependencies of discourse marker choice and other sentence planning decisions.
- Integrate marker choice into the overall generation framework, and ensure flexibility in discourse marker selection.

Chapter 3

Current approaches to discourse representation in text generation

This chapter surveys current approaches to coherence relations and discourse representation in (multilingual) text generation. In text generation, the discourse representation is the outcome of decisions made during the text planning phase, and constitutes the input to the subsequent stage, sentence planning, of which discourse marker choice is one aspect.

I first discuss the role and definition of coherence relations in text generation (Section 3.1) before turning to the predominant approach to discourse representation in text generation: *Rhetorical Structure Theory* (RST). Section 3.2 introduces the major assumptions of RST, and surveys its application in the context of text generation. A number of controversial issues have occurred over the years; these and extensions to the RST framework and proposals of alternative accounts for discourse representation are the subject of Section 3.3. The chapter concludes with a discussion of the shortcomings of present accounts and the goals of this thesis in the realm of discourse representation (Section 3.4).

3.1 Introduction: Coherence relations in text generation

The general view in text generation is that *discourse representation* (other terms include text plan [Moore and Paris 1993] or document plan [Reiter and Dale 2000]) is the level of representation that specifies the coherence relations holding between parts of a discourse. *Coherence relations*, also referred to as discourse relations, discourse structure relations [Hovy 1993], or rhetorical relations [Mann and Thompson 1988], capture the kinds of relationships between discourse segments, i.e. between chunks of content (propositions) and/or intentions (communicative purposes). The standard practice in text generation is to define a particular set of coherence relations, and claim that a discourse is coherent if it is composed of relations within this set [Knott 1996]. [Hovy 1993] provides us with the following definition of *coherence*:

[A] discourse is coherent if the hearer knows the communicative role of each portion of it; that is, if the hearer knows how the speaker intends each clause to relate to each other clause. [Hovy 1993, p344]

The notion of coherence and coherence relations as maintained in the text generation community differs somewhat from the assumptions made in traditional linguistics. For instance, the explanation of coherence given in a standard linguistic reference book such as [Bußmann 1990] focusses on semantic relations and leaves aside the role of the discourse participants:

Kohärenz: (2) Im engeren Sinne [...] wird K. von der grammatischen Textverknüpfung (= Kohäsion) abgegrenzt und bezeichnet speziell den semantischen, der Kohäsion zugrundeliegenden Sinnzusammenhang eines Texts, seine inhaltlich-semantische bzw. kognitive Strukturiertheit.¹ [Bußmann 1990, p389]

Other linguistic definitions are more complex, as they base coherence not only on the existence or possible inference of a coherence relation but on additional factors such as thematic structure [Lewandowski 1985] and co-reference [Heinemann and Viehweger 1991]. It follows that any representation of discourse needs to comprise more than merely an account of the coherence relations, as is common practice in text generation (with a few exceptions, such as [McCoy and Cheng 1991] who relate coherence relations and focus information).

The approach to coherence adopted by the text generation community corresponds to what [Fabricius-Hansen 2000, p278] names the pragmatic-functional approach, which she presents as one possible view of discourse among others. A prominent advocator of this view is [Hobbs 1990] who defines coherence relations in terms of communicative functions and hence regards a text as coherent if all text segments are related to at least one other segment by means of one of the relations. Coherence relations now “bind contiguous segments of text into a global structure for the text of a whole” [Hobbs 1990, p83]. This understanding is very close to Hovy’s definition above. Yet, since the goal of text generation is to transform an abstract content representation into coherent text, given a set of communicative goals, it seems to be more adequate to define coherence relations as holding between *discourse segments* instead of text segments. Discourse segments are eventually transformed into a linguistic expression (i.e. text) at later stages of the generation process.

Regardless of how the terms coherence and coherence relations are defined, any proper theory of coherence relations needs “to propose a particular set of relations” [Knott 1996, p12]. However, there exists no uniform way of describing coherence relations, neither within the area of text linguistics nor in NLP. [Sanders *et al.* 1992] distinguish two major approaches to coherence relations: First, some approaches aim at *descriptive adequacy*, prominent examples are *Rhetorical Structure Theory* (RST; [Mann and Thompson 1987,

¹The English edition of Bußmann’s dictionary [Bußmann 1996] provides the English translation:

Coherence: 2. In a narrower sense, coherence is separated from grammatical **cohesion** and specifically signifies the semantic meaning and the cohesion of the basic interconnection of the meanings of the text, its semantic (content) and cognitive structure. [Bußmann 1996, p80]

Identification (class & attribute/function)
 {Analogy/Constituency/Attributive/Renaming/Amplification}*
 Particular-illustration/Evidence+
 {Amplification/Analogy/Attributive}
 {Particular-illustration/Evidence}+

Example:

Eltville (Germany) 1) An important wine village of the Rheingau region. 2) The vineyards make wines that are emphatically of the Rheingau style, 3) with a considerable weight for white wine. 4) Taubenberg, Sonnenberg and Langenstuck are among vineyards of note.

Classification:

1. Identification (class & attribute)
2. Attributive
3. Amplification
4. Particular-illustration

Figure 3.1: Identification schema, sample text and analysis [McKeown 1985, p28]

Mann and Thompson 1988]), *Relational Discourse Analysis* (RDA; [Moser and Moore 1996]), and the accounts by [Halliday and Hasan 1976] and [Hobbs 1985, Hobbs 1990], just to name a few. The second group seeks a *psychological plausible* account of coherence relations, e.g. [Sanders *et al.* 1992] derive their definitions of coherence relations from psychological experiments. A third strand has recently been established by [Knott 1996, Knott and Mellish 1996], who advocate an *empirical* approach to coherence relations. Up to now, only the descriptive approaches have been adopted by the text generation community, hence the discussion in this chapter focusses on these.

Descriptive approaches to discourse representation applied in text generation fall into two groups:

- **Schema-based** approaches use predefined stereotypical combinations of rhetorical predicates called schema to describe the structure of text. During text planning, the schema is instantiated, i.e. a discourse structure representation is a particular instantiation of the general schema, see for instance [McKeown 1985, Paris 1988, Rambow 1990]. Figure 3.1 gives a schema for *Identification* texts as defined by [McKeown 1985, p28].
- **Relation-based** approaches describe discourse structure as a tree of coherence relations that can hold between adjacent text spans. The coherence relations can be combined flexibly during text planning, examples are [Hovy 1988a, Moore and Paris 1988, Maybury 1990, Rösner and Stede 1992, Moore and Paris 1993, Vander Linden 1993, Kosseim and Lapalme 1994, André 1995, Paris *et al.* 1995].

Schemata encode static (script-like) patterns of discourse structure for a particular text type, but they do not include knowledge of how parts of the schema relate to each other nor the reasons for introducing them and the intended effect (see [Moore and Swartout 1991]). Therefore, present text generation systems mostly follow the latter approach, which supports more flexible text planning strategies and thus greater expressibility. In the majority of cases, the functionally oriented *Rhetorical Structure Theory* [Mann and Thompson 1987] is used to represent coherence. The next section introduces the RST framework and discusses its application to text generation.

3.2 Rhetorical Structure Theory

RST is the most prominent approach to discourse representation in text generation, and most of the discourse marker selection strategies also build on an RST-like discourse representation (see Chapter 2).

3.2.1 RST in text analysis

RST was developed in 1986 by Mann and Thompson as an analytical tool to be used for describing the coherence relations holding between text segments (also referred to as text spans), and to capture the discourse structure of an entire text. The set of relations and their definitions are based on an extensive analysis of hundreds of texts from different genres, and are given in full detail in [Mann and Thompson 1987, Mann and Thompson 1988]. Sets of coherence relations had been suggested earlier, for instance, by [Grimes 1975, Hobbs 1985], but RST sets itself apart from these previous attempts in several ways. First, Mann and Thompson not only suggest a set of about 25 basic relations such as CAUSE, CONCESSION, MOTIVATION, JUSTIFY, ELABORATION or CONTRAST, but moreover provide rather meticulous definitions for each relation. These definitions can be read by a text analyst as a kind of check list: if all the constraints given in the definition of an RST-relation hold for the two text spans under consideration, then this RST-relation holds between the text spans. See Figure 3.2 for an example of an RST-relation definition as presented in [Mann and Thompson 1987].

Unlike [Hobbs 1985, Hobbs 1990], who defines his relations in terms of speaker's knowledge and inferential capabilities, RST's definitions are differentiated by the kind of effect that using a particular combination of text segments has on the reader. Consider the effect field in the CONCESSION definition given in Figure 3.2: The intended effect of using a CONCESSION relation is to increase the reader's positive regard for some of the material presented; other effects of rhetorical relations include "increase reader's willingness to act" and "reader recognizes that relation holds", etc. A second distinguishing feature of RST is the assumption of *nuclearity*, i.e. the recognition that the text segments related by a relation are often of a different status or importance. The *nucleus* is the central element, indispensable for developing the argumentation in the text, whereas the *satellite* has a

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1. **relation name:** CONCESSION
 2. **constraints on Nucleus:** Writer has positive regard for the situation presented in Nucleus;
 3. **constraints on Satellite:** Writer is not claiming that the situation presented in Satellite doesn't hold;
 4. **constraints on the Nucleus + Satellite combination:** Writer acknowledges a potential or apparent incompatibility between the situations presented in Nucleus and Satellite; Writer regards the situations presented in Nucleus and Satellite as compatible; recognising the compatibility between the situations in Nucleus and Satellite increases Reader's positive regard for the situation presented in Nucleus;
 5. **the effect:** Reader's positive regard for the situation presented in Nucleus is increased
 6. **locus of the effect:** Nucleus and Satellite

Figure 3.2: Definition of the CONCESSION relation as given in [Mann and Thompson 1987]

more supportive role.² Most relations, such as the CONCESSION relation, link a nucleus to a satellite, some relations, such as SEQUENCE or CONTRAST, do not have any satellite, but two or more nuclei.

Individual coherence relations can now be uniquely described drawing on these two characteristics of RST: A relation is defined on the one hand by the constraints imposed on nucleus and satellite, and on the other hand by the pragmatic effect the relation has on the recipient. For instance, the CONCESSION relation holds between two text segments if the writer has a positive regard for the nucleus, if the writer is not claiming that the situation presented in the satellite does not hold, if nucleus and satellite are potentially incompatible, and if the reader's positive regard for the situation presented in the nucleus is increased (Figure 3.2 gives the full definition).

According to their effect, Mann and Thompson subdivide rhetorical relations into two groups: *Subject-matter* relations intend to make the reader recognize that a particular relation holds, and *presentational* relations intend to change the attitude of the reader towards the presented information in some way (increase regard, increase belief, etc.). In this light, the CONCESSION relation is a presentational relation, whereas CONTRAST or SEQUENCE are clearly subject-matter relations, indicating a semantic relationship.

RST relations can describe the links between text segments of any size, not just between clauses or sentences. The discourse structure of a text results from embedding related,

²[Mann and Thompson 1988] propose several criteria for distinguishing between the two.

[Wait]¹ until [the engine is cool]², then [turn the radiator cap clockwise]³ until [it stops]⁴. [DO NOT PRESS DOWN]⁵ [WHILE TURNING THE CAP]⁶. After [any remaining pressure has been relieved]⁷, [remove the cap]⁸ by [pressing down]⁹ and [again turning it counterclockwise]¹⁰. [Add enough coolant]¹¹ to [fill the radiator]¹², and [reinstall the cap]¹³. [Be sure to tighten it securely]¹⁴. [Fill the reserve tank up to the max mark]¹⁵ with [the engine cold]¹⁶.

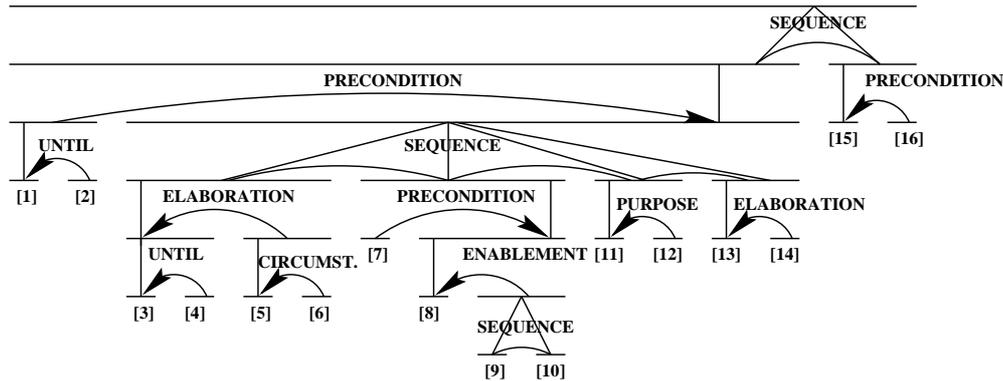


Figure 3.3: Extract from a Honda car manual and corresponding RST analysis

but always adjacent, text segments. In other words, the discourse structure is built by recursively applying RST relations to increasingly larger consecutive text spans until one relation spans the entire text. An RST analysis is successful and a discourse coherent, if all its parts can eventually be made to fit into one overarching relation. The resulting hierarchical structure can be represented as a tree structure, where elementary textual units constitute the leaf nodes, and rhetorical relations act as non-terminal nodes.

Figure 3.3 shows an extract from a Honda car manual and the corresponding RST-tree. Numbers in brackets in the text relate the text segments to the RST-tree. The discourse structure shows nested relations at various levels; the top-level relation spanning the entire text is a **SEQUENCE** relation. Leaf nodes are either related to other leaf nodes, such as the minimal units [1] and [2], or are linked to an RST-relation spanning an adjacent text span, for instance, a **PRECONDITION** relation holds between the minimal unit [7] and an **ELABORATION** spanning units [8] to [10]. Each pair of adjacent text spans can only be related by *one* relation, either from the set of subject-matter or presentational relations; the analyst has to pick a single relation in all cases. This constraint gave rise to a controversial discussion of RST, which we return to in Section 3.3 below.

Name	SEQUENCE
Results	((BMB SPEAKER HEARER (POSITION-OF ?PART ?NEXT)))
Nucleus+Satellite requirements/subgoals	((BMB SPEAKER HEARER (NEXT-ACTION.R ?PART ?NEXT)))
Nucleus requirements/subgoals	((BMB SPEAKER HEARER (TOPIC ?PART)))
Nucleus growth points	((BMB SPEAKER HEARER (CIRCUMSTANCE-OF ?PART ?CIR)) ((BMB SPEAKER HEARER (ATTRIBUTE-OF ?PART ?VAL)) ((BMB SPEAKER HEARER (PURPOSE-OF ?PART ?PURP)))
Satellite requirements/subgoals	((BMB SPEAKER HEARER (TOPIC ?NEXT)))
Satellite growth points	((BMB SPEAKER HEARER (ATTRIBUTE-OF ?NEXT ?VAL)) ((BMB SPEAKER HEARER (DETAILS-OF ?NEXT ?DETS)) ((BMB SPEAKER HEARER (POSITION-OF ?NEXT ?FOLL)))
Order	(NUCLEUS SATELLITE)
Relation phrases	(" "then" "next")
Activation question	"Could A be presented as start-point, mid-point, or end-point of some succession of items along some dimension? – that is, should the hearer know that A is part of a sequence?"

Figure 3.4: Plan operator for the RST-relation SEQUENCE as defined in [Hovy 1991, p89]

3.2.2 RST in automatic text generation

Rhetorical Structure Theory as a rather detailed proposal for coherence relations was soon taken up by research on the generation of multisentential paragraphs as the basis for strategic planning (text planning). The main reason was that RST's functional conception of relations and its intention-oriented definitions suit the demands of planning text from communicative goals. This is the objective of intention-driven text planning, which was introduced as an alternative to McKeown's schema-based approach (by, among others, [Hovy 1988a, Hovy 1991, Moore and Swartout 1991]). Further, RST-relation definitions already state in a semi-formal way their applicability conditions, i.e. the constraints that have to be satisfied by the nucleus and satellite segments for a relation to be applicable, and the effect of using that relation. Finally, an approach that supports the flexible combination of coherence relations is far more expressive than the static schema-based approach to text

EFFECT: (**PERSUADED** ?hearer (GOAL ?hearer (DO ?hearer ?act)))
 CONSTRAINTS: (AND (GOAL ?speaker ?goal)
 (STEP ?act ?goal)
 (GOAL ?hearer ?goal))
 NUCLEUS: (**FORALL** ?goal (MOTIVATION ?act ?goal))
 SATELLITES: nil

To achieve the state in which the hearer is persuaded to do an *act*,
 IF the *act* is a step in achieving some *goal(s)*,
 that the hearer shares,
 THEN motivate the *act* in terms of those *goal(s)*.

EFFECT: (**MOTIVATION** ?act ?goal)
 CONSTRAINTS: (AND (GOAL ?speaker ?goal)
 (STEP ?act ?goal)
 (GOAL ?hearer ?goal))
 NUCLEUS: (**BEL** ?hearer (STEP ?act ?goal))
 SATELLITES: none

To motivate an *act* in terms of a *goal*,
 IF the *act* is a step in achieving the *goal*,
 and the hearer shares the *goal*,
 THEN make the hearer believe that the *act* is a step in achieving the *goal*.

Figure 3.5: Plan operators for the high-level goal ‘persuade-user-to-do-an-act’ and the MOTIVATION relation reproduced from [Moore and Paris 1993, p17]

coherence, and does not restrict the set of admissible trees.

In the first attempt to plan discourse dynamically, [Hovy 1988, Hovy 1991] formalized RST-relations as plan operators (in the AI sense), defining them in terms of preconditions and postconditions, which are expressed in terms of communicative goals. Hovy used AI planning techniques to automatically construct an RST-tree starting from a set of communicative goals, thus interleaving the tasks of content selection and organization. Figure 3.4 shows such a plan operator. It is a rather straightforward formalization of Mann and Thompson’s definition of the SEQUENCE relation (see [Mann and Thompson 1987]). The plan operator names the effect on the hearer (given in the *results* slot) and specifies the constraints on nucleus and satellite, i.e. semantic preconditions on the material to be conveyed (in the *requirements* slots) using the belief terminology of [Cohen and Levesque 1985]. For instance, (BMB SPEAKER HEARER X) can be read as “achieve the state in which the speaker and the hearer mutually believe that X”. The *growth points* are additions to the original RST-relation definition. They state which other relations may be added at this point to convey additional material. Growth points are required in this formalization of RST-

relations to expand the tree and allow for a nesting of relations.

[Moore and Swartout 1991, Moore and Paris 1993] build on this initial work. They present a similar planner based on RST-relations and beliefs, but propose several improvements. Most importantly, they get rid of the growth points, which very much suggest a static, schema-based approach to text planning, and, just like schemata, restrict the set of admissible trees. This is made possible by the strict separation of intentions and rhetorical relations maintained by [Moore and Paris 1993]. They observe that presentational relations map onto intentions one by one, but that the effects of subject-matter relations are simply for the reader to recognize the relation in question, and that the mapping between deeper-level intentions and subject-matter relations is therefore a many-to-many mapping. Moore and Paris claim that this requires a distinction between rhetorical relations (or rhetorical intentions) at a lower level of abstraction, and communicative goals (or discourse purpose intentions) at a higher level of abstraction (cf. also [Bateman and Rondhuis 1997]).

Figure 3.5 shows the two types of plan operators they use. In the top operator, the effect is an intentional goal, here “to achieve a state where the hearer is persuaded to do an act”; in the bottom operator, the effect is a rhetorical relation to be achieved, such as “provide motivation for an act” (see [Moore and Paris 1993, p14]). As this example illustrates, communicative goals, or intentions, eventually trigger the choice of a particular rhetorical relation. In contrast to Hovy’s approach, RST-relations are directly related to higher-level communicative goals (via the higher-level plan operators). The resulting discourse tree therefore consists of both intentional goals and rhetorical relations, thus not only stating what is said, but also why it is said. Further, instead of having growth points, which introduce new RST relations, [Moore and Paris 1993] achieve the hierarchical structure representation of discourse and the embedding of relations by allowing communicative goals to have subgoals; these subgoals in turn can be satisfied by different RST relations.

RST has found wide application for the description of discourse structure in text generation: A large number of text generation systems employ plan operators based on RST-relations for text planning, for instance, the systems by [Maybury 1990] and [Cawsey 1991], the EES tutoring system [Paris 1991, Moore and Paris 1993, Moore 1995], the instruction generator DRAFTER [Paris *et al.* 1995], and the multimodal instruction generators WIP and PPP [Wahlster *et al.* 1993, André 1995, André *et al.* 1996]. Several other text generation systems use Rhetorical Structure Theory at the level of discourse representation, although they do not apply plan operators during text planning. For instance, the TECHDOC [Rösner and Stede 1994], EPICURE [Dale 1992], IMAGENE [Vander Linden 1993], and SPIN systems [Kosseim and Lapalme 1994] produce RST-trees by means of fairly straightforward mappings from domain relations or task representations to RST-trees without taking intentions into account, where the hierarchical structure of the text reflects the hierarchical structure of the task to be described. [Rösner and Stede 1994] encode the structure of the text to be produced, which resembles the structure of the underlying task, in a way similar to the schemata of [McKeown 1985]. Yet, this ‘domain-driven’ approach is only feasible for very restricted domains, and for highly structured texts which do not display a rich intentional structure.

To conclude, RST currently forms the most influential approach to coherence relations

found in text generation. Using RST-relations as the basis for plan operators in the intention-driven approach to text planning is clearly an improvement over the schema-based approach. Still, applying a primarily descriptive framework such as RST to the automatic production of text brings about a number of problems which are not apparent when using RST in text analysis. This gave rise to a controversial debate on the status of RST-relations and the adequacy of the entire framework for generation purposes (see, among others, [Moore and Pollack 1992, Sanders *et al.* 1992, Hovy 1993, Paris 1993, Asher and Lascarides 1994], and [Bateman and Rondhuis 1997]). The major criticisms put forward and the (still) open research issues include the following:

- **How many (RST-)relations are required to adequately describe coherent discourse?**

The initial set of RST relations turned out to be insufficient in a number of applications, which led to *ad-hoc* additions of various relations, such as PRECONDITION and RST-UNTIL [Vander Linden 1994, Rösner and Stede 1992]. This is partly due to the fact that there are gaps in the set of RST-relations standardly given—the only complete paradigm is the cause relation subset—and that there exist no well-defined criteria for inclusion in the set [Paris 1993, Bateman and Rondhuis 1997]. Further, it is not clear what the degree of granularity is that should be used in distinguishing relations (see [Nicholas 1994]).

- **What is the size of the minimal units that can partake in an RST-relation?**

If one assumes propositions as elementary units of the RST-tree, then coherence relations can also hold between textual units that are smaller than clauses (as prepositional phrases, which are common realizations of propositions in instructional texts [Rösner and Stede 1992]). The answer to this question might influence the number of relations assumed.

- **Are RST-trees language-specific representations or language-neutral? How does the RST discourse structure relate to linguistic realization?**

RST trees are sometimes described as language-independent representations of discourse structure, for instance [Rösner and Stede 1992], sometimes as language-dependent [Delin *et al.* 1994]. This is mainly determined by the assumptions about where a discourse representation is situated in the continuum between abstract representations of content, intentions and beliefs, and linguistic realization.

- **How many levels of analysis are assumed, and how do they relate to each other?**

RST definitions in their present shape are underspecified as they leave a lot of information implicit and are thus sometimes ambiguous. There is often no unique analysis possible. Also, it is claimed that subject-matter relations and presentational relations should hold simultaneously [Moore and Pollack 1992]. This is not possible in RST.

- **What is the nature of coherence relations?**

Relation definitions in RST conflate different discourse functions, for instance, the PURPOSE relation indicates a semantic relation, but also carries intentional information. The RST approach as currently defined mixes various types of relations that can exist between two segments [Paris 1993, Bateman and Rondhuis 1997].

- **What kind of approach to coherence relations can account for intention-dominated and data-dominated domains alike?**

Current RST is biased towards intentions, i.e. RST constrains primarily intentions: “The structure of discourse reflects more than anything else the intentions and goals of speakers” [Mann and Thompson 1988, p42]. Yet, in several applications, informational relations dominate.

- **What is the computational status of RST relations and trees?**

A lack of formalization of RST relations and trees has been noted by various researchers, and initial proposals regarding a more thorough formalization have been put forward by [Hovy 1991], [Marcu 1996] and [Young 1996].

3.3 Enhancing RST: New approaches to discourse representation in text generation

A number of problems encountered in deriving discourse representations automatically building on RST-relations result from these unresolved issues. This gave rise to several extensions to the RST framework and to the proposal of alternative accounts for coherence relations and discourse representation. This section discusses the different positions researchers adhere to, and examines competing proposals that arose in the context of text generation.

3.3.1 Set of relations

The question of how many relations are required to adequately describe coherent discourse, or, more particularly, which relations belong to RST, has drawn much attention in the past few years. In their original proposal, [Mann and Thompson 1987] argued that about 25 basic RST-relations suffice to represent the coherence relations that hold in English texts from different genres. They did, however, not assume that this is a closed list:

We see it as an open set, susceptible to extension and modification for the purposes of particular genres and cultural styles. [Mann and Thompson 1987, p48]

Hence, it did not come as a surprise that, when applied to text generation, the initial set of relations soon turned out to be insufficient. Using only the definitions provided,

researchers claimed that not all relationships holding between segments of the texts to be generated could be accounted for. In particular, extensions were made to encompass the relations holding in technical instructional texts, a very popular application domain of text generation. For instance, [Rösner and Stede 1992] introduced the RST-UNTIL and PRECONDITION relations, and [Vander Linden 1994] also added the PRECONDITION relation to his set of relations to be able to produce complete RST-trees for technical instructional texts. Other kinds of extensions include introducing specialisations of existing relations, such as the STEP-SEQUENCE relations by [Rösner and Stede 1992], amalgamating relations [Scott and de Souza 1990] or defining relations orthogonally to RST relations, such as the ANALOGY relation of [Hovy *et al.* 1992] (cf. [Knott 1996]).

Apart from these rather arbitrary extensions of a given set of relations, there exist in general two orthogonal views on the required number of coherence relations. [Hovy 1990] uses the terms *parsimonious* and *profligate* approaches to coherence relations to capture this opposition:

[...] what interclausal relations are there? How many are required? A fair amount of controversy exists, ranging from the parsimonious position (the two intentional relations suffice) to the profligate position (that an open-ended set of semantic/rhetorical relations is required). [Hovy 1990, p128]

A minimalistic, or parsimonious, position is maintained by [Grosz and Sidner 1986]. They object to the notion that a small set of relations can describe English discourse adequately, and therefore acknowledge only two structural relations in discourse: DOMINANCE and SATISFACTION-PRECEDENCE. Dominance means that one segment that satisfies a particular intention, or *discourse purpose*, provides part of another segment's purpose, thereby imposing a hierarchical structure on discourse representation. Satisfaction-precedence implies that one segment can only fulfill its purpose if another segment's purpose has been satisfied before.

At the other end of the scale one finds the profligate position advocated by [Hovy 1990, Maier and Hovy 1991, Maier and Hovy 1993]. They believe that coherence relations do not form a fixed, closed set, there is no 'true' set of relations, but instead the purpose and the application determine the set of relations and the granularity of the taxonomy [Hovy 1990, p134]. In his pursuit of a comprehensive set of coherence relations, [Hovy 1990] collected relations from various linguists, computational linguists, AI researchers and philosophers (see [Hovy 1990, p132] for a complete list), and organized them into a taxonomy. As top-level subcategorization, Hovy adopts Halliday's expansion types for complex clauses, ELABORATION, ENHANCEMENT and EXTENSION [Halliday 1994]. [Maier and Hovy 1991] and [Maier and Hovy 1993] carry this approach further, and address the top-level organization of Hovy's taxonomy. They claim that a functional perspective is better suited, as in their opinion, each relation fulfills one of the three metafunctions of language as introduced in Systemic Functional Linguistics (SFL, [Halliday 1994]).³ Hence, they re-organize the taxonomy under the three-way classification of IDEATIONAL (propositional content),

³SFL maintains that there exist three simultaneous, functionally differentiated perspectives on the linguistic system. These three highly generalized metafunctions are

INTERPERSONAL (interactant relationships) and TEXTUAL (presentation as text). The taxonomy again combines relation sets put forward by other researchers, and can be understood as a superset of existing sets. Note that as a truly profligate approach, the taxonomy is open to extensions at leaf nodes if the domain or the purpose requires.

Most accounts of coherence relations are, however, less ambitious in aiming neither at a minimalistic nor at a comprehensive set. Instead, they motivate their particular set of relations from properties of the domain. For instance, [Kittredge *et al.* 1991, Sibun 1990] believe that highly domain-specific relations must be available, and [Rösner and Stede 1992] and [Vander Linden 1994] take domain properties as criteria for introducing new relations. Likewise, [Moser *et al.* 1996] in their Relational Discourse Analyses (RDA) approach, which synthesizes ideas from RST and Grosz and Sidner’s intentions [Grosz and Sidner 1986], define their *informational* relations, which more or less correspond to the subject-matter idea in RST, from properties of the domain. Informational relations describe how actions in the domain are related, for instance, *Act:Side-effect* is defined as:

Side-effect is something that happens or becomes true from **act**, but is not a goal of act. Side-effects can be negative, neutral or positive. [Moser *et al.* 1996, p8]

The number of relations in these approaches ranges from about 25 in RST and RDA to [Marcu *et al.* 1999], who requires 70 rhetorical relations to describe the coherence in texts, and [Hovy *et al.* 1992] whose taxonomy contains 120 relations. However, [Nicholas 1994] questions the validity of these more inclusive approaches, which motivate relations from domain characteristics, and argues that certain relations such as temporal relations and RST-UNTIL (as defined in [Rösner and Stede 1992]) are not part of the rhetorical theory, but belong to formal semantics. Therefore, he votes to exclude the ‘merely’ semantic relations from the set of rhetorical relations. This approach is in line with [Asher and Lascarides 1994, Lascarides and Asher 1991], who distinguish between rhetorical relations which relate propositions, and coherence relations, which are based on world-knowledge, and in opposition to the approaches discussed so far [Hovy 1990, Rösner and Stede 1992, Maier and Hovy 1993, Moser *et al.* 1996], which regard semantic or informational relations as a substantial part of the set.

Accounts of coherence relations that are not geared towards text generation also postulate various sets of relations, which are motivated on different grounds. For instance, [Knott and Mellish 1996, Knott 1996] derive their set of relations from occurrences of discourse markers in a corpus and their distribution, while [Sanders *et al.* 1992] base their

-
- the **ideational metafunction**, which “provides the speaker with resources for interpreting and representing reality” [Matthiessen and Bateman 1991, p68].
 - the **interpersonal metafunction**, which “provides speakers with resources for creating and maintaining social relations with the listener” [Matthiessen and Bateman 1991, p68].
 - the **textual metafunction**, which “enables the speaker in presenting ideational and interpersonal information as text in context” [Matthiessen and Bateman 1991, p68].

set on psycholinguistic data, and [Hobbs 1985, Hobbs 1990] see relations as strategies by which speakers and hearers construct texts.

To sum up, there is at present no consensus as to what may or may not be admitted as a coherence relation; neither on the number of relations nor on how to motivate and define them. Even when agreeing upon using an RST-approach, researchers differ in the exact sets of relations adopted. As [Knott 1996, p35] notes, the RST claim that text is coherent if a discourse structure covering the entire text can be produced becomes less strong once relations can be added arbitrarily, and without a method for specifying what can count as a relation. The question of number and types of relations is closely related to the question of how many levels of analysis one assumes. I will return to this issue in Sections 3.3.4 and 3.3.5 below.

3.3.2 Minimal units

The question of what the minimal units of analysis are, i.e. of the granularity of RST analyses, has been discussed since RST was first proposed. [Mann and Thompson 1987, p6] demand that minimal units “should have functional integrity”; in their analyses, this mainly applies to clauses. Hence, they adopted clauses as the minimal units to be related by coherence relations.

Yet, once we assume a generation perspective, this criterion is no longer applicable. From a generation point of view, the leaves in the RST-tree cannot be clauses, they can only be more abstract entities such as propositions, which are eventually expressed by text.⁴ This distinction of the spans related by relations and the realization of the spans appears to have been lost in much of the discussion on ‘minimal units’. Propositions can be realized by clauses or by textual units smaller than clauses, as noted by [Scott and de Souza 1990, Rösner and Stede 1992, Vander Linden 1994]. Consider the following example from the Honda manual extract in Figure 3.3 and its variants:

(3.1)

- a. *Add coolant until the level reaches the MAX mark in the radiator.*
- b. *Add coolant until the radiator is full.*
- c. *Add enough coolant to fill the radiator.*
- d. *Add coolant up to the MAX mark.*

There will be agreement that the first example (3.1a) and its paraphrase (3.1b) realize two propositions, but what about the sentences containing an infinitive construction in (3.1c) and the prepositional phrase in (3.1d) instead of a full clause? Are there one or two propositions underlying these sentences? [Rösner and Stede 1992, Vander Linden 1994]

⁴Recall that in text generation the RST tree serves as starting point for sentence planning and linguistic realization, and thus the discourse tree links discourse segments and not yet text segments.

argue that prepositional phrases can also realize propositions, i.e. one relatum in a discourse structure. Prepositional phrases that contain a deverbalization or a gerund are frequently encountered in technical instructional texts as verbalizations of an action. Hence, from a generation perspective, the question is not to determine minimal textual units in text, but to delimit the propositions.

3.3.3 Language specificity and relation to the linguistic surface

Turning to *multilingual* text generation, another controversial issue relates to the language-specificity of RST-relations and the discourse structure based on RST, and, of course, of any kind of discourse representation. Mann and Thompson originally intended their approach to be independent of any particular realization:

The applicability of a relation definition never depends directly on the form of the text being analyzed; the definitions do not cite conjunctions, tense, or particular words. RST structures are, therefore, structures of functions rather than structures of form. [Mann and Thompson 1987, p19]

We think that rhetorical relations exist independently of any explicit signals. [Mann and Thompson 1987, p45]

In multilingual text generation systems, one encounters two opposing uses of RST. On the one hand, in conformity with Mann and Thompson's ideas, RST relations are taken to reflect domain relations and intentions, and an RST-tree is used as a language-independent intermediate representation of text structure. The same relations can be verbalized in various ways, which can be mono- as well as multilingual paraphrases (see, among others, [Rösner and Stede 1992, Bateman *et al.* 1993, Vander Linden 1994, Kosseim and Lapalme 1995, Vander Linden and Martin 1995]). In these approaches, the RST structure acts as common starting point for the language-specific processes of MLG, i.e. the sentence planning and the surface realization stages. On the other hand, an RST-based discourse tree is often perceived as the first language-specific level of representation, see for instance, [Delin *et al.* 1994, Delin *et al.* 1996, Oberlander *et al.* in press]. The assumption here is that RST relations are closely linked to the surface form. For instance, [Delin *et al.* 1994, p61] claim that different RST analyses underly the following English, French and German verbalizations of the same content, which is rejected by, for instance, [Rösner and Stede 1992, Vander Linden 1994, Kosseim and Lapalme 1995]:

(3.2)

- a. [The stepping can be altered]¹ [by loosening the locking lever]² and [changing the position of the cylinder foot]³.
- b. [Pour modifier la charge d'appui]¹, [desserrer les leviers]² puis [déplacer les pied des vérins].³
- c. [Nach Lockern der Klemmhebel]² [kann durch Verschieben des Zylinderfußes]³ [die Treibbelastung verändert werden].¹

The analyses suggested for example (3.2.) for all three languages are:

English: (MEANS [1] (SEQUENCE [2] [3]))
 French: (PURPOSE (SEQUENCE [2] [3]) [1])
 German: (CIRCUMSTANCE (MEANS [1] [3]) [2])

In brief, these competing views reflect the more fundamental question of how the discourse representation relates to a conceptual representation of content and intentions (at a level external to language) and to the linguistic realization (the indisputably language-specific level). Depending on the positioning of the discourse structure in this ‘space’, it is regarded as either language-specific or language-neutral. Further, depending on the positioning, discourse relations are either closely linked to particular realizations, or assumed to be pre-realizational. Different approaches to coherence relations differ significantly on this point.

As shown above, in the original RST consequences for linguistic realization are at best indirect, that is, an RST-tree is at a considerable distance from the text to be produced. The same holds for the accounts by [Hobbs 1990, Lascarides and Asher 1991, Moser *et al.* 1996]. However, this notion has proved problematic for text generation, where one would like to know the consequences of a particular rhetorical relation for the linguistic realization, the choice of *cohesive means*. Hence, several researchers tried to tie RST relations to particular realizations, in particular, to discourse markers or sentence structuring [Delin *et al.* 1996, Scott and de Souza 1990], thus moving RST further away from a ‘deep’ representation of propositions and intentions, and closer to the linguistic surface.

Other proposals to discourse representation such as [Knott 1996] and [Martin 1992] position themselves closer to the linguistic realization. For instance, [Knott 1996] relies on surface-observable features and takes cue phrases as direct evidence for coherence relations. [Martin 1992] systematically accounts for the use of discourse markers and other cohesive means in his classification of *Conjunctive Relations*. The close bond to the lexicogrammar makes these accounts language-specific.

[Bateman and Rondhuis 1997] argue that neither of the two views is adequate as the distance between a language-neutral discourse representation and the surface realization, or between abstract content representation and language-specific discourse structure, is stretched too far. They believe that a more abstract discourse representation such as RST should be complemented by a surface-related account, and introduce a bi-stratal discourse representation: Martin’s conjunctive relations [Martin 1992] compose the lower level of abstraction on the discourse level, they relate to the surface form and form the link between the RST-like discourse representation and the lexicogrammar. In their understanding, a discourse representation is always tailored towards a specific language, hence both strata are perceived as being specific to a particular language. Adopting this bi-stratal approach, the multilingual examples (3.2) are assigned an RST structure—incidentally the same for all three languages—and conjunctive relations, which signal the actual unfolding of a discourse in the text and determine the choice of linguistic cues.

3.3.4 Types of relations and levels of discourse representation

In their proposal, [Mann and Thompson 1987] acknowledge that there are two types of relations and distinguish between *subject-matter* and *presentational* relations, based on the effect that a relation has on the reader:⁵

Subject-matter relations are those whose intended effect is that the reader *recognizes* the relation in question; presentational relations are those whose intended effect is to *increase some inclination*. [Mann and Thompson 1987, p18]

The dichotomy of subject-matter and presentational relations is well established in research literature on coherence relations, although referred to with different terminology:

- *informational* vs. *intentional* [Moore and Pollack 1992, Moser and Moore 1995]
These relations are defined similar to Mann and Thompson's subject-matter and presentational relations:

Intentional relations describe how a contributor may effect the hearer's adoption of the core. [...] [Informational] relations describe how the situations referred to by the core and contributor are related in the domain. [Moser and Moore 1995]

- *semantic* vs. *pragmatic* [Redeker 1990, Sweetser 1990, Sanders *et al.* 1992, Knott 1996]
They all suggest that the relations differ with respect to what is related. Semantic relations (also referred to as content [Sweetser 1990] or ideational [Redeker 1990] relations) hold between the propositions (locutions) expressed by two text segments, pragmatic relations link the illocution expressed in these segments. Further, [Sweetser 1990] distinguishes between two types of pragmatic relations: EPISTEMIC relations are pragmatic relations involving the speaker's beliefs, and SPEECH-ACT relations make reference to the actual writer utterances. [Redeker 1990] follows a similar line in claiming that pragmatic relations can be of two kinds, *rhetorical relations* and *sequential relations*.
- *external* vs. *internal* [Halliday and Hasan 1976, Martin 1992]
Internal relations "obtain in the organisation of the text itself rather than in the organisation of the world the text describes", external relations "are oriented to what is going on outside the text rather than within" [Martin 1992, p180].
- *rhetorical* vs. *coherence* relation:
[Asher and Lascarides 1994, Asher 1993, Lascarides and Asher 1991] in their *Segmented discourse representation theory (SDRT)* divide discourse relations into two classes: rhetorical relations (relations over propositions) and coherence relations (based on world knowledge).

⁵[Mann and Thompson 1987, p17] also note, however, that "no single taxonomy seems suitable. Depending on one's interests, any of several features and dimensions of the relation could be made the basis for grouping them", for instance, the locus of effect, writer and reader participation, etc. They describe the subject-matter vs. pragmatic distinction as an "interesting two-way division", but not the only possible one.

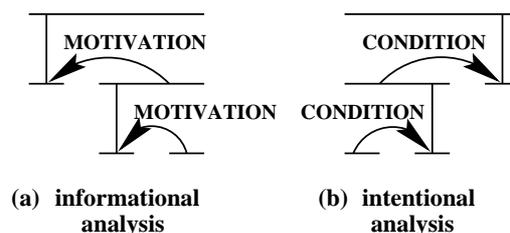


Figure 3.6: Informational and intentional analyses as given in [Moore and Pollack 1992, p543]

There is much overlap between the different definitions. [Bateman and Rondhuis 1997], after analysing several approaches to coherence relations, summarize the two positions as follows:

- “Logical”, “informational”, world-related, or natural ontological categories of the commonsense world (causal, temporal, and so forth) [...]
- Rhetorical, “intentional” goals for constructing texts concerning speakers and hearers and their interactions in the world. [Bateman and Rondhuis 1997, p25]

Apart from RST’s subject-matter/presentational dichotomy, only the informational/intentional division is applied in text generation systems.

Obviously, the controversial issue regarding RST is not the division into two types of relations, but the assumption put forward by [Mann and Thompson 1987] that for any two adjacent text segments, one rhetorical relation will be primary.⁶ In other words, the claim is that consecutive text spans are either related by a subject-matter or by a presentational relation. This has two implications which have been widely criticized, see among others, [Moore and Pollack 1992, Sanders *et al.* 1992, Paris 1993, Asher and Lascarides 1994, Bateman and Rondhuis 1997]. First, rhetorical relations such as JUSTIFY and the more semantic relations such as CAUSE are conflated into a common discourse representation, thereby mixing the different types of relations in one structure. Second, the analyst has to subscribe to one analysis, yet, as [Moore and Pollack 1992] claim, quite often no unambiguous single analysis is possible. Instead, discourse elements can be related simultaneously on multiple levels, as in the following example from [Moore and Pollack 1992, p542]:

(3.3)

- a. *Come home by 5:00.*
- b. *Then we can go to the hardware store before it closes.*
- c. *That way we can finish the bookshelves tonight.*

⁶Likewise, [Redeker 1990, p372] states that “the strongest, contextually most relevant relation is taken to be the basis of the coherence link.”

[Moore and Pollack 1992] argue that two analyses are plausible. In a purely informational account, (3.3a) can be understood as a condition for the execution of (3.3b), and (3.3b) again as a prerequisite for (3.3c). On the other hand, sentences (3.3b) and (3.3c) can also be read as providing the motivation for doing (3.3a) when focussing on the intentions underlying the discourse. Figure 3.6 gives the two conflicting RST analyses. This kind of multiple analysis is problematic from an RST point of view, where one has to opt for a single analysis. Moore and Pollack instead argue that subject-matter relations are realizable in a variety of ways depending on the speaker's intention, and accordingly adopt two classes of relations, informational and intentional. In contrast to RST, they further argue that a complete analysis of a text needs to consist of two structures, each drawing its relations from the subtypes of relations: One structure describes the semantic or informational relations (such as *CONDITION*), the other structure the intentional links (such as *MOTIVATION*). Similarly, [Moser *et al.* 1996] support parallel informational and intentional analyses of discourse structure, while [Redeker 1990], in contrast, assumes that only one relation can hold at a time; and [Sanders *et al.* 1992] also expect a decision for either a semantic or a pragmatic relation.

Another important point made by [Moore and Pollack 1992] is the observation that in some discourses, such as the one in example (3.3), informational and intentional structures are not isomorphic as both analyses assign the nucleus status to different text segments, which is again violating RST principles. [Moser and Moore 1996] resolve this problem of conflicting nuclearity assignments by removing nuclearity from the definitions of informational relations. Their argument goes as follows. Nuclearity is an implicit claim about speaker's intentions, corresponding to the dominance relation among intentions as put forward by [Grosz and Sidner 1986]. Hence, since nuclearity can only be determined by considering intentions, and since intentional and informational analyses of discourse must co-exist, the solution is to relegate information about nuclearity to the intentional analysis, and remove it from definitions of informational relations.

Others like [Paris 1993, Bateman and Rondhuis 1997] argue against a conflation of nuclearity and intentional relations, and propose a separate level of analysis where the nuclearity assignment is located, thus postulating a third determinant to discourse structure. The categorization of relations they suggest is along three metafunctional dimensions as introduced by Halliday (see [Halliday 1994]) in Systemic Functional Linguistics (see also [Maier and Hovy 1991, Maier and Hovy 1993, Degand 1998]). This categorization acknowledges a textual level in addition to the informational (ideational) and intentional (interpersonal) levels discussed so far (a definition is given above). The textual level represents relations required for organizing the text and guiding the interpretation:

Textual relations neither involve the reader or the writer nor are based on the material they relate; they serve instead to organize the text itself. [Maier and Hovy 1993, p10]

They propose textual relations such as *DISJUNCTION*, *CONJUNCTION* and *PRESENTATION-SEQUENCE*, while [Bateman and Rondhuis 1997] name, among others, *RESTATEMENT*, *SUMMARY* and *FRAMEWORK* as textual relations. Applying this three-way classification to Moore and Pollack's example above would yield three levels of analyses, one for each

metafunction (see [Maier and Hovy 1993]).

Other tripartite accounts of coherence relations are proposed by [Sweetser 1990] and [Hovy 1990], although not necessarily assuming a textual dimension as the third source of coherence. Hovy's proposal also builds on systemic ideas, but instead of taking the three metafunctions as the basic classification, he adopted Halliday's expansion types for complex clauses, i.e. ELABORATION, EXTENSION and ENHANCEMENT (see [Halliday 1994, p220]). [Sweetser 1990], in contrast, distinguishes between one semantic relation and two types of pragmatic relations (see discussion above). Finally, [Grosz and Sidner 1986] argue that "meta-level descriptions of discourse" should be recast as a combination of domain-specific information, general relations between propositions and actions, and general relations between intentions (*dominance* and *satisfaction-precedence*). However, these levels are, according to [Grosz and Sidner 1986], external to language, they provide the motivation for choosing a particular coherence relation in discourse. As such, I will not discuss them any further. At present, only the systemic classification supported by [Maier and Hovy 1993, Degand 1998] has been used in text generation, for instance, in the *komet* system [Bateman *et al.* 1993].

The partitioning of relations into different classes, and the question of how the different sets relate to each other in a representation of the coherence relations holding in a discourse are two independent matters, with the latter still being an unresolved issue. There are essentially two positions, one stating that only one link can hold at a time and that the different kinds of coherence relations are conflated in a single discourse structure (as done by [Mann and Thompson 1987]), the other, more prominent one, proposing that two text segments can be combined in more than one way, so that a multi-level discourse representation is created. Depending on the number of relation types assumed, this yields either a two-level [Moore and Pollack 1992, Moser and Moore 1995] or a three-level discourse representation [Maier and Hovy 1993].

Still, the question remains of how the different levels of analyses are related within a single discourse structure. There are, at least, two suggested models for their interaction. [Moore and Pollack 1992] argue that the resulting discourse representation, i.e. the informational and intentional representations of text, do not have to be isomorphic, but do not go any further into the problems of how to handle the non-isomorphic trees. [Korelsky and Kittredge 1993] take a different approach and suggest that, since the two levels of analyses are typically not of equal status, they should be related via interstratal mapping. They argue that the two subtypes of RST-relations should be seen in terms of *stratification*,⁷ one being the *means* of expressing the other. Semantic relations are treated as realizations of pragmatic relations. The problem is, of course, that the final discourse structure only contains semantic links between text segments, all information concerning the underlying goals is lost. Yet a different approach is taken by [Bateman and Rondhuis 1997]: Three levels of analysis yield a single discourse representation, where the relational links

⁷Stratification is another important concept of Systemic Functional Linguistics. SFL maintains that linguistic resources are organized into a number of levels, or strata, which are—in order of abstraction—semantics (the resource for meaning), lexicogrammar (the resource for wording), and finally phonology (the resource for sounding). Higher strata are realized by lower ones (see, among others, [Halliday 1994, p15] and [Matthiessen and Bateman 1991, p62]).

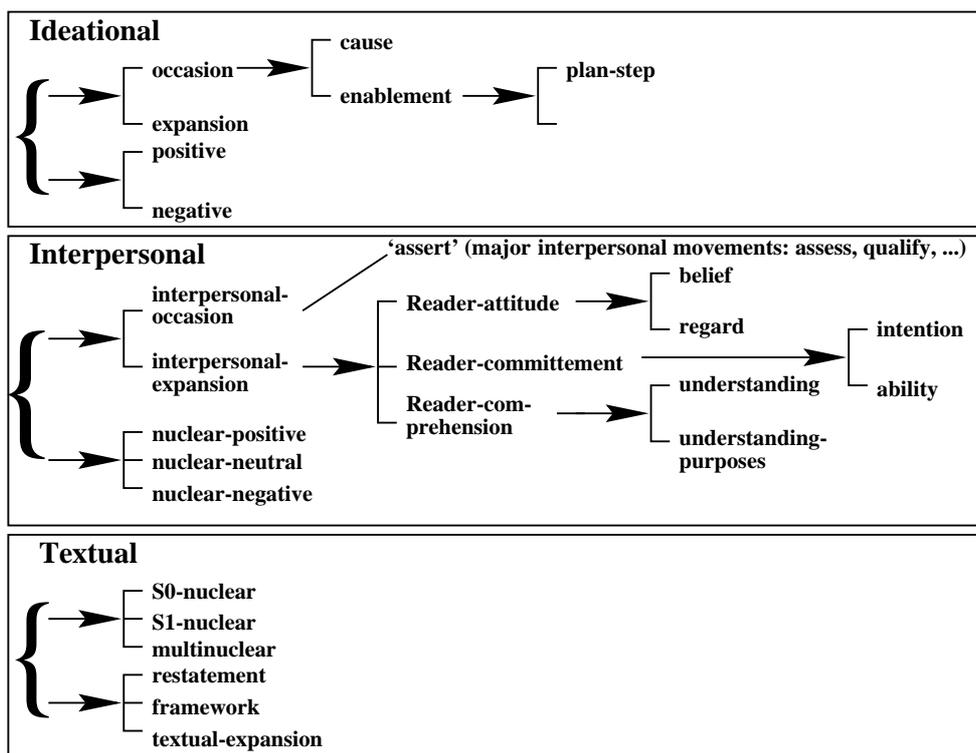


Figure 3.7: The rhetorical relation paradigmatic network as given in [Bateman and Rondhuis 1997, p38]

between text spans are complex entities containing information from all three aspects of coherence. This approach is discussed in the next section.

3.3.5 Decomposing coherence relations

The representation of coherence relations as a set of more basic features from the different levels of analysis has been proposed by [Sanders *et al.* 1992, Knott 1996] and most recently [Bateman and Rondhuis 1997]. The major advantages of this approach are twofold: it explicates all aspects of the link between two segments, and it makes the issue of how to structurally relate the different levels of analysis to each other obsolete

The basic assumption underlying all accounts of coherence relations discussed so far is that the relations assumed at the different levels all describe ‘pure’ links between text segments. For instance, [Maier and Hovy 1993] believe that each relation from their taxonomy signals exactly one function of a link between text segments in discourse, either an ideational, interpersonal or textual one. Just like RST, they suggest that a relation such as *CONDITION* is informational, a relation such as *MOTIVATION* is intentional. The same claim underlies Moore and Pollack’s two-way classification.

However, [Bateman and Rondhuis 1997] have shown that this is an oversimplification: They illustrate that RST-relations as defined in [Mann and Thompson 1987] are not unambiguous as to their contribution to the discourse. In particular, most so-called subject-matter relations contain more than ideational information. For instance, CAUSE and RESULT signal informational and textual meaning at the same time (as they differ in nuclearity assignment while indicating the same semantic relationship); the presentational MOTIVATION comprises informational meaning, too, etc. In other words, the RST relations as currently defined conflate various types of relations that can exist between two text segments, while ‘pretending’ that they are either subject-matter or presentational only.

The conclusion drawn by [Bateman and Rondhuis 1997] is not to further extend the set of relations or to add levels of representation, but to get rid of the hardcoding of certain combinations of ideational, interpersonal and textual information, and to decouple different kinds of information. This is done by organizing the discourse level according to the SFL dimensions of *metafunctionality* and *stratification* and by further introducing the dimension of *axiality* (paradigmatic and syntagmatic representation).⁸ Following the systemic tradition, Bateman and Rondhuis represent the different kinds of ‘purposes’ (or functions a coherence relation can serve) in system networks, one for each metafunction (paradigmatic representation). Figure 3.7 gives the initial network presented in [Bateman and Rondhuis 1997]. Features have mainly been derived from a re-analysis of RST-relations to uncover the ideational, intentional and textual contributions of the previously atomic relations. Selecting among the alternatives in the ideational, interpersonal and textual networks results in a ‘feature bundle’ which names the properties of a single link between two text segments (syntagmatic representation). Atomic coherence relations are thus decomposed into their contributions to the different dimensions. To give an example: RST’s PURPOSE relation indicates a causal relation (as reflected in the [cause] feature in the network in Figure 3.7), the underlying intention is to increase the reader’s ability to perform the action ([ability]), and the causing event is presented as central information ([S₀-nuclear]). From this perspective, atomic relations (as defined in the accounts discussed in this section) can be understood as ‘frozen’ syntagmatic representations in the SFL sense; the features making up the representation are then, however, no longer accessible.

Like [Korelsky and Kittredge 1993], Bateman and Rondhuis assume two strata at the discourse level, which are, however, defined differently. The ‘higher’, more abstract, stratum of coherence relations (as described in the networks) is closely related to the surface form; they adopt Martin’s conjunctive relations [Martin 1992] at this level of representation.

The advantages of the composite approach are threefold: First, the meaning of coherence relations is stated explicitly as all aspects of the relations are represented; second, a flexible combination of features is possible; and third, text segments can simultaneously be related

⁸Next to metafunctional diversification and stratal organization, axiality is a third dimension along which linguistic resources are organized. In SFL terms, axiality is the basic principle of the internal organization of each stratum. There are two types of organization—paradigmatic and syntagmatic—deploying different modes of representation, namely system networks and function structure. Syntagmatic specifications (function structures) are derived from paradigmatically organized resources (system networks) by means of realization statements associated with paradigmatic choices (see for instance, [Matthiessen and Bateman 1991, p76ff]).

in several ways. These advantages have also been observed by others: [Sanders *et al.* 1992] define a taxonomy of binary parameters to describe relations. The parameters must satisfy the *relational criterion* to be included in the taxonomy:

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 (i.e. if it is not merely a property concerning the content of the discourse segments themselves.) [Sanders *et al.* 1992, p5]

Binary parameters are of four types: *Basic operation* (causal or additive), *source of coherence* (semantic or pragmatic), *polarity* (positive or negative), *order of segments* (basic or non-basic). By combining the features values of the four primitives, 12 classes of coherence relations can be generated, for instance, the combination (causal,semantic,basic,positive) gives CAUSE-CONSEQUENCE, (causal,semantic,basic,negative) yields CONTRASTIVE CAUSE-CONSEQUENCE, and (causal,pragmatic,basic,positive) describes CONDITION-CONSEQUENCE.

[Knott and Mellish 1996, Knott 1996] arrive at 8 pairs of primitives from an empirical analysis of a large number of discourse marker usages in a corpus. Feature pairs motivated by the resulting taxonomy of markers partly overlap with Sanders' results; in addition to the source of coherence and the polarity, [Sanders *et al.* 1992] suggest the following pairs: *Pattern of instantiation* (unilateral or bilateral), *rule type* (causal or inductive), *anchor* (cause-driven or result-driven), *focus of polarity* (anchor-based or counterpart-based), *presuppositionality* (presupposed or non-presupposed), *modal status* (actual or hypothetical). Similarly to [Sanders *et al.* 1992], Knott now builds complex definitions required for relations (and cue phrases) from this basic set.

Finally, [Martin 1992] examines the relationship between discourse structures and constraints on their lexicogrammatical realization, in particular conjunctions. He recognizes four main types of what he terms *conjunctive relations*: ADDITIVE, COMPARATIVE, TEMPORAL and CONSEQUENTIAL, which are supplemented by orthogonal distinctions between INTERNAL or EXTERNAL (see [Halliday and Hasan 1976]). More fine-grained classifications of these relations are modelled as features in system networks. Traversal of the network yields a feature bundle and realization statements, which constrain the surface form of the underlying coherence relation. As opposed to [Sanders *et al.* 1992] and [Knott 1996], Martin's features do not describe aspects of coherence relations, but aspects of their realization in a single unfolding of the text. Hence, [Bateman and Rondhuis 1997] employ conjunctive relations as the 'lower' stratum in their discourse representation.

None of the approaches discussed in this section has made its way into a text generation system, even though they suggest solutions to the major problems encountered in RST-based text generation. [Bateman and Rondhuis 1997] point out the potential of their framework for text generation, but also remark that it needs considerable extension before it can be applied in the automatic production of text.

3.4 Conclusions: Coherence relations for discourse marker choice

The state of the art in coherence relations for text generation can be summarized as follows. At present, RST forms the most influential approach. However, implementing RST in text generation systems has brought up a number of problems that have not been an issue when applying RST in the manual analysis of text. These problems gave rise to critical discussions of the assumptions underlying RST, and to alternative proposals that claim to meet the demands of text generation. Major points of discussion relate to

- the number of relations required and the criteria for inclusion in the set of coherence relations,
- the size of minimal units,
- the relation between coherence relations and linguistic realization,
- the levels of analysis,
- the nature of coherence relations: atomic or composite entities.

Any approach to coherence relations and discourse representation has to position itself with respect to these open issues. Most text generation systems still build on RST as defined by [Mann and Thompson 1988] and merely extend the set of relations to suit the demands of their domain. Alternative proposals address other issues of the above list. For instance, RDA [Moser and Moore 1995] integrates RST and Grosz and Sidner's theory of intentions, thereby addressing the issue of levels of analysis. From the perspective of discourse marker choice, Bateman and Rondhuis' proposal of composite relations and two strata of discourse representation seems to be the most appealing [Bateman and Rondhuis 1997] because of the following reasons. While in RST the consequences of coherence relations for the linguistic realizations are at best indirect, Bateman and Rondhuis are explicit on the role of discourse markers in that they distinguish between a discourse representation that links into the context from a discourse representation that links into the grammar. Still, this approach has not yet been applied to text generation, and relation definitions remain very abstract.

In this thesis, I address the open issues with my particular application—discourse marker choice—and domain—technical instructional texts—in mind. In other words, coherence relations and discourse representation are predominantly examined in their role as input structures to discourse marker choice processes, which are the major concern of this thesis. Consequently, the goals with respect to coherence relations and discourse representation are less ambitious than those relating to discourse marker representation and choice. The overall goal is to arrive at a discourse representation that provides sufficient information for motivated discourse marker choice, building on the work by [Bateman and Rondhuis 1997]. This includes the following subtasks:

- Motivate the set of coherence relations from the application domain, and define criteria for what may or may not be included in the set.
- Provide definitions of coherence relations.
- Explicate the relation between coherence relations/discourse representation and linguistic realization, particularly discourse markers.
- Use coherence relations as the starting point for discourse marker choice processes.

Chapter 4

Framework and methodology

This chapter introduces the linguistic framework for describing discourse markers and the methodology applied in this thesis to compile discourse markers and arrive at an adequate description of individual markers.

In Section 4.1 I motivate my decision to adopt a functional approach to discourse marker description, and introduce Martin's Conjunctive Relations [Martin 1992] as the approach I use for representing discourse marker usage in context. Section 4.2 describes the methodology I follow in discourse marker analysis and representation. In particular, it addresses the questions of detecting discourse markers in text, assembling the set of discourse markers to be investigated, determining differences and similarities between discourse markers, and arriving at a representation of discourse marker usage that suits the purposes of text generation.

4.1 Framework

One of the goals of this thesis is to represent discourse markers for generation purposes, in other words, to provide sufficient knowledge about discourse marker usage for a text generation system to make motivated choices among alternative discourse markers. It was argued in Chapter 2 that the major function of discourse markers in text is that of signaling the discourse structure or coherence relation holding between segments of a text. From a production perspective, the central objective is therefore to describe discourse markers according to their *function* in discourse, and provide knowledge concerning when and why to use a particular discourse marker. Therefore, I concluded in Chapter 2 that it is a functional approach to language description that suits this purpose best.

As pointed out in Chapter 2, the two major studies within Systemic Functional Linguistics on cohesive resources, among them discourse markers, and their relation to coherence relations, are [Halliday and Hasan 1976] and [Martin 1992]. [Halliday and Hasan 1976] set out to describe cohesive resources in English, and present a classification of sentence conjunctions. [Martin 1992] follows Halliday and Hasan in their emphasis on explicit conjunctions,

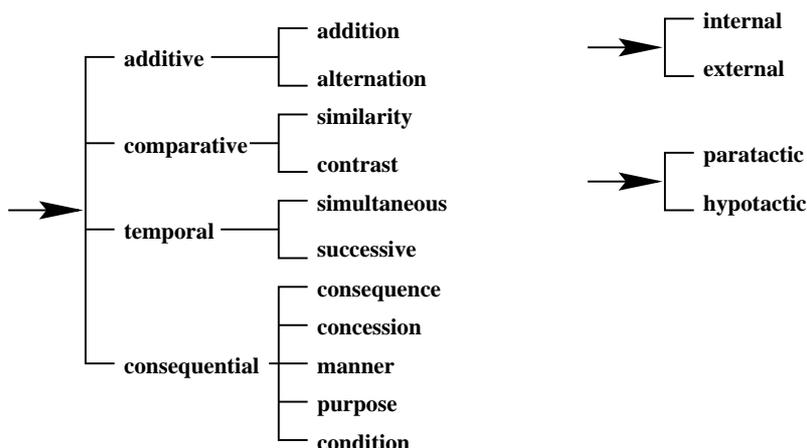


Figure 4.1: Three top-level systems of Martin's taxonomy of Conjunctive Relations

and provides an alternative taxonomy of what he terms *conjunctive relations*. His account differs in three respects from [Halliday and Hasan 1976]. First, he aims at a more comprehensive account of conjunctions by extending his analysis beyond intrasentential discourse markers; Martin thus considers intersentential markers such as conjunctives, too. Second, he maintains that explicit discourse markers are only one means among others to realize a conjunctive relation. Therefore, his taxonomy of conjunctive relations classifies various competing linguistic means; discourse markers are just one possible—although the most straightforward—realization. Third, he is more explicit on the relationship between discourse structure and lexicogrammar: Conjunctive relations belong to the *logical* resources¹ as their function is to bridge between discourse structure and lexicogrammar. They describe how a coherence relation is communicated in the ongoing construction of a text. Depending on other contextual parameters, a sequence relation can be realized in various ways (see [Martin 1992, p168]):

(4.1)

- a. *We walk the ring with our dogs. **Afterwards** we just wait.*
- b. *We walk the ring with our dogs and **then** we just wait.*
- c. ***After** we walk the ring with our dogs we just wait.*

[Martin 1992] assumes that a wide range of conjunctive relations can hold between messages; in Section 3.3.5 I already introduced the main classes. The taxonomies in Figure 4.1 depict the three top-level distinctions. The ADDITIVE, COMPARATIVE, CONSEQUENTIAL and TEMPORAL classes each show considerable internal organization. To give an

¹In SFL, the logical metafunction is a subtype of ideational function (the other is the experiential function); it describes the combinatorial relationships between constituents.

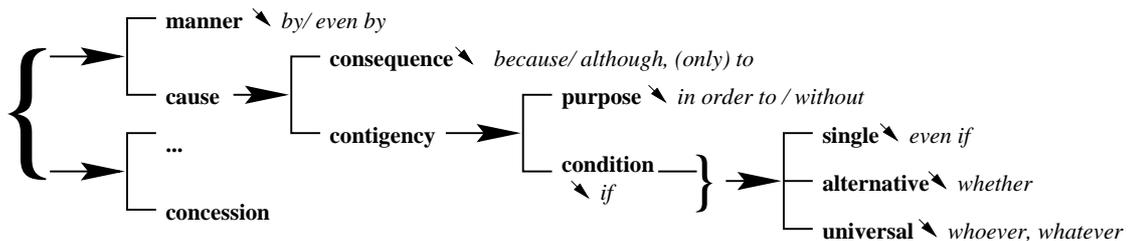


Figure 4.2: Taxonomy of external hypothetical consequential relations in English as given in [Martin 1992, p200]

example, consider the paradigmatic representation of English external, hypothetical consequential relations depicted in Figure 4.2. The system network provides a classification of conjunctive relations, which can be realized by alternative linguistic forms, among them subordinate conjunctions (see above and 4.2.1 below). These are also shown in Figure 4.2. The features on the path from the root to a terminal feature characterize the set of possible realizations for that feature. For instance, the conjunction *in order to*, attached to [purpose], is classified as [cause:contingency:purpose]. In other words, Martin's networks can be interpreted as feature classifications specifying the meaning of discourse markers (as one possible realization of conjunctive relations). However, [Oversteegen 1993] notes that Martin's networks contain no constraints on the lexicogrammatical realization of choices made; the linguistic context of the discourse markers associated with a terminal feature in the networks remains unspecified. Oversteegen enhances Martin's networks by attaching realizational constraints to the most delicate features which define the properties that must be given in the environment of a discourse marker for a particular interpretation to be available.

Figure 4.3 shows how Martin's classification of conjunctive relations is applied to the analysis of text, here to the Honda manual extract from Chapter 3. Each conjunctive relation, and thus the discourse markers that are possible realizations of the relation, can be characterized by a feature bundle, a selection expression in systemic terminology, recounting the path through one of the four major networks. Internal and external relations may hold simultaneously, as the analysis in Figure 4.3 shows. Conjunctive relations mainly link consecutive clauses to each other, that is, they describe local coherence (as opposed to RST which also captures global relations between larger text spans, compare the RST-analysis in Figure 3.3 in Chapter 3). Instead of taking a global view on the text, conjunctive relations capture how the text develops through time. It does not make statements about the hierarchical structure of discourse, as for instance, Rhetorical Structure Theory [Mann and Thompson 1988] does, but describes how such a hierarchical structure is realized in a single unfolding of the text.

To summarize, the general concern of [Martin 1992] is to describe the relationship between discourse structures and grammatical structures, and to capture the differences and similarities in discourse function over a wide range of alternative realizations in English—

[Wait]1 until [the engine is cool]2, then [turn the radiator cap clockwise]3 until [it stops]4. [DO NOT PRESS DOWN]5 [WHILE TURNING THE CAP]6. After [any remaining pressure has been relieved]7, [remove the cap]8 by [pressing down]9 and [again turning it counterclockwise]10. [Add enough coolant]11 to [fill the radiator]12, and [reinstall the cap]13. [Be sure to tighten it securely]14. [Fill the reserve tank up to the max mark]15 with [the engine cold]16.

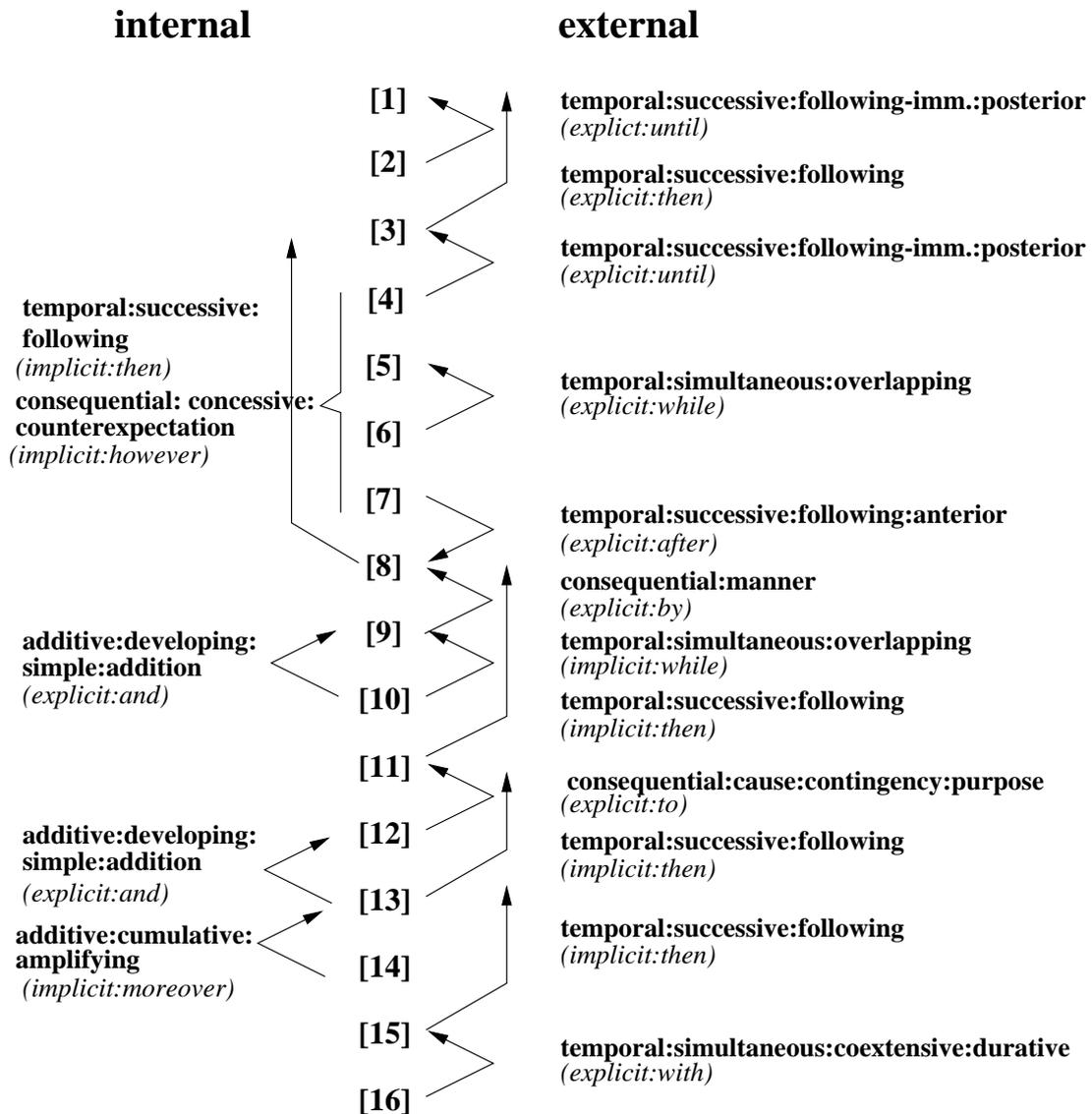


Figure 4.3: Analysis of the Honda text using Martin's Conjunctive Relations

grammatical constructions and lexical items alike. Since in my view, the set of discourse markers comprises more than merely conjunctions (which is the scope of Halliday and Hasan's study), Martin's account of alternative realizations of coherence relations is an attractive approach. Further, the functional nature of his approach meets the requirements of text generation. Therefore, in this thesis, I adopt Martin's framework to describe German discourse markers and represent their similarities and differences. The task is now to describe German discourse markers from a functional perspective, and to provide a classification similar to the English accounts; this issue will be addressed at length in Chapter 7.

4.2 Methodological issues

Methodological considerations pertain first to the task of assembling the set of discourse markers occurring in the text type under discussion, technical instructions, and subsequently to that of finding a set of features to characterize and differentiate markers (regarding form and function alike), and finally to make this knowledge available to a text generation system. This involves the following stages:

1. Compile the sets of English and German discourse markers encountered in technical instructions.
2. Extract from the existing literature an initial set of features for describing markers.
3. Perform a thorough analyses of one marker class.
4. Provide a functional description: When to use which marker?
5. Define the level of representation on which the discourse marker choice processes operate (the discourse structure).
6. Synthesize the functional description of discourse markers into a uniform level of description to be used in multilingual generation.
7. Design a prototypical architecture of a discourse marker choice module in a text generator and give examples.

In the remainder of this section, I introduce these stages in turn.

4.2.1 Stage 1: Compiling sets of discourse markers for English and German

The central concern here is to arrive at the set of lexical items that can function as discourse markers. As indicated in Chapter 2, in my understanding the class of discourse markers is a functional one, and cannot be defined in terms of clear syntactic criteria. [Martin 1992]

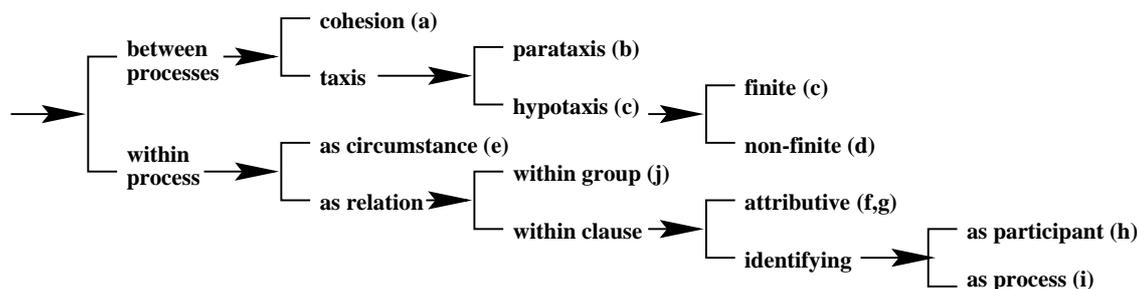


Figure 4.4: Divergent grammaticalizations of conjunctive relations, reproduced from [Martin 1992, p170]

also claims that there exists a variety of lexical means to signal coherence relations in text. The difficulty in assembling a set of markers is that the set is functionally homogeneous but syntactically heterogeneous. The task is now to define criteria for finding the ‘right’ set of discourse markers, in other words, to present a precise definition of the class of lexical items which I will consider in this thesis, and to gather a set of cue phrases covered by these criteria.

4.2.1.1 Range of discourse markers in the present study

Standard grammars and dictionaries such as [Helbig and Buscha 1991, Quirk *et al.* 1972, Cobuild 1987, Longman 1993] and research literature, for instance, [Pasch *et al.*, in prep.] and [Knott 1996] give an idea of what lexical entities can link clauses or units of any size, and hence can function as discourse markers. Conjunctives, adverbs, coordinating and subordinating conjunctions are the most frequent to be mentioned. A more comprehensive listing of the range of alternative realizations of coherence relations for English is given by [Martin 1992]. Consider the two situations *We walk the ring with our dogs* and *We just wait*, when placed in a temporal sequence relation. Examples (4.2a) to (4.2j) present different ways of grammaticalizing this relation (examples are taken from [Martin 1992, p168ff], (4.2a) to (4.2c) correspond to example 4.1):

(4.2)

- a. *We walk the ring with our dogs. Afterwards we just wait.*
- b. *We walk the ring with our dogs and then we just wait.*
- c. **After** *we walk the ring with our dogs we just wait.*
- d. **Subsequent to** *walking the ring with our dogs we just wait.*
- e. **After** *our tour of the ring with our dogs we just wait.*
- f. *Our tour of the ring is prior to our wait.*

- g. *Our tour of the ring is **before** we wait.*
- h. *Our tour of the ring is the **antecedent** of our wait.*
- i. *Our tour of the ring **precedes** our wait.*
- j. *Our tour of the ring **prior** to our wait ...*

Figure 4.4 reproduces Martin’s categorization of these possible realizations. The letter following a network feature relates to the example realizing it. The classification of types of links can easily be related to the word classes suggested in grammars. For instance, paratactic links imply the use of a coordinating conjunction, whereas cohesive means can be of various kinds: conjunctive adverbs, prepositional phrases, etc. Martin’s classification contains several realizations that involve lexical items like verbs (4.2i) and nouns (4.2h), which are content words. In this thesis, I restrict myself to the function words that belong to the word classes given in examples (4.2a-e). Or, to relate it to the taxonomy in Figure 4.4, to discourse markers indicating a relationship between processes, or between a process and a circumstance. The restriction to the “between-processes”-branch of the taxonomy is motivated by the definition of the lexems under consideration, connectives, as discussed in Chapter 2: Connectives, or *Konnektoren* are defined as holding between propositions or *Sachverhalten*. Due to the characteristics of the text type examined in this thesis, technical instructions, circumstantials are also considered because in technical instructions, circumstantials containing deverbal nominalizations are frequently used to express processes.

My study covers the following word classes, classified according to the kind of bond they create between units (the corresponding *selection expression*² from Martin’s taxonomy is given in brackets). All categories can comprise internal as well as external markers:

- **Intersentential** [between-processes:cohesion]
Discourse markers that create a cohesive bond by relating a clause to the preceding text. I assume the following classification:
 - **Conjunctive adjuncts**,³ such as *however, yet; nichtdestoweniger, jedoch*.
 - **Pronominal adverbs** (*Pronominaladverbien*, specific to German) such as *damit, dadurch, deswegen*.
 - **Prepositional phrases** such as *in spite of, in this respect, trotz alledem, in dieser Hinsicht*.
 - **Coordinating conjunctions**, when occurring in sentence-initial position, for instance, *but, and; aber, und*.

²In SFL, the term *selection expression* denotes the set of features on a path from the root, i.e. least delicate, system to a terminal node.

³The terminology with respect to this syntactic function is slightly confusing; other terms encountered in the literature are: *conjunct* [Quirk *et al.* 1972], *conjunctive* [Martin 1992], *sentence adverb* [Cobuild 1987], or *Konjunkionaladverb* [Helbig and Buscha 1991].

- **Intrasentential** or interclausal [between-processes:taxis]

Discourse markers that create a link between two clauses:

- **Coordinating conjunctions** [...:parataxis]

Markers that form paratactic clause complexes, thus creating an interdependency relation, such as *and*, *but*, *or*; *und*, *aber*, *oder*.⁴

- **Subordinating conjunctions** [...:hypotaxis:finite]

Markers that form hypotactic clause complexes. They create a dependency relation by linking two finite clauses. Examples are *because*, *after*, *although*; *weil*, *nachdem*, *obwohl*.

- **Markers introducing nonfinite clauses** [...:hypotaxis:nonfinite]

They also create a dependency relation, but link a finite independent clause and a nonfinite dependent clause such as infinitive constructions in German and English (*um ... zu*; *in order to*, *to*) or *-ing* clauses introduced by *with*, *by* in English.

- **Intraclausal:**

- **Prepositions** [within-process:as-circumstance]

Prepositions such as *after*, *with*; *nach*, *mit* which relate a clause and a phrase.

This list covers more classes than given in [Knott 1996], who only considers links between finite clauses, and comprises only a subset of the possible realizations of conjunctive relations discussed in [Martin 1992, p170], namely those that link clauses or a clause and a contracted clause. It gives the range of discourse markers examined in this thesis, and provides an initial hypothesis concerning what may act as discourse marker in a text.

The list names only candidate discourse markers insofar as not all lexical items belonging to these word classes act as discourse markers under all circumstances. For instance, I do not want to claim that a preposition such as *mit* (with) in *Sie ging mit dem Hund spazieren* (She went for a walk with the dog) acts as a discourse marker; instead, it merely introduces a circumstance. This again proves that a syntactic definition of the class of discourse markers is not sufficient. Therefore, some clear criteria are required to separate the discourse markers from all other items belonging to the different word classes—in other words, criteria that determine whether a lexical item from the word classes given above indicates a coherence link between constituents/text segments. Earlier tests for detecting discourse markers in unrestricted text provide a start, for instance [Knott 1996, Pasch *et al.*, in prep.].

4.2.1.2 A revised ‘Test for discourse markers’ for English and German

For English, [Knott 1996] developed a linguistic test that meets exactly the demands specified above. Given a lexical item such as a conjunctive adjunct or a conjunction, it deter-

⁴Note that conjunctive adjuncts can occur within a clause complex, too, but as opposed to conjunctions, they do not create any kind of dependency relation between the clauses involved.

mines whether this item is a discourse marker or not (cf. Chapter 2, Figure 2.2). However, I argued in Chapter 2 that neither this test nor the test for connectives proposed in [Pasch *et al.*, in prep.] are applicable to German texts as they stand. Pasch's test for German connectives is syntactically motivated and defines a class that is broader than conjunctions. It defines a clear boundary around the class of connectives they want to examine, but deliberately leaves out lexical items that I believe can indicate a coherence relation. In particular, prepositions are excluded as they assign case to the constituent they are governing (see criteria M2 and M5 in Chapter 2, Figure 2.1). Further, infinitive constructions with *um ... zu* are excluded.

The test by [Knott 1996], who takes a functional approach to marker definition, also has several drawbacks. Like Pasch's test, it covers only items relating clauses; in *Trotz des Regens gingen wir spazieren* (Despite the rain we went for a walk) or *Drehen Sie die Schraube, um den Dichtungsring zu lösen* (Turn the screw in order to loosen the washer), it would not detect a cue phrase (see Knott's test in Figure 2.2). However, signaling coherence relations within a process is frequent in German and English texts, and even more so in instructional texts. More significantly, Knott formulated his test on the basis of English data; when applying this test to German data, for instance, to German hypotactic clauses, the test always fails in Step 3:

3. If the candidate phrase is indeed a relational phrase, the resulting text should appear **incomplete**. An incomplete text is one where one or more extra clauses are needed in order for a coherent message to be framed. [...] (cf. Figure 2.2 in Chapter 2).

In German, a subordinate host clause is in any case incomplete, i.e. cannot stand on its own, given the particular word order of subordinate clauses, which is not dealt with in Step 2 of Knott's procedure. In short, the word order in German subordinate sentences differs from the one in the main clause (4.3a); in the subordinate clause, the finite verbs take the clause-final position (4.3b), and if the main clause comes second, we also observe subject-finite inversion in the main clause (4.3c):

(4.3)

- a. *Es regnet in Strömen.*
It rains in streams.
'It is pouring with rain.'
- b. *Wir gehen spazieren, obwohl es in Strömen regnet.*
We go for a walk although it in streams rains.
'We go for a walk, although it is pouring with rain.'
- c. *Obwohl es in Strömen regnet, gehen wir spazieren.*
Although it in streams rains, go we for a walk.
'Although it is pouring with rain, we go for a walk.'

Hence, a more complex ‘repair’ step (Step 2) is required before Step 3 to 6 of Knott’s test can be performed: Step 3 of Knott’s test relies on the notion of full, independent clauses, which only become incomplete when a discourse marker is added. In German, this independence is not given for subordinate sentences, hence, one has to introduce additional steps to make sure that the ‘incompleteness’ of a clause is not just due to syntactic properties of the host clause. In the following, I discuss the applicability of Knott’s test to German data for each word class in turn, and describe my extensions to and modifications of the test required to accommodate German data. Finally, I present an addition to Knott’s test so as to account for the full range of English discourse markers, too.

Within processes: Prepositions. Let us first consider realizations within a process (intraclausal), as prepositions are not accounted for in the current version of Knott’s test. Recall that the central idea of Knott’s test is that cue phrases (or discourse markers) cannot make sense when associated with one clause in isolation, since they have a function which extends beyond a single clause. This works well for discourse markers linking clauses, but is a problem for realizations within processes:

- (4.4) *Drehen Sie den Kühlerdeckel bis zum Anschlag.*
 Turn you the cap until to the resting position.
 ‘Turn the cap until it stops.’

In this example, the PP *bis zum Anschlag* cannot be understood without prior context (as required by Knott’s test), but unfortunately, the second condition is not met: *zum Anschlag* is only a sentence fragment, and cannot stand alone. Hence, in order to make the test work for prepositions, different criteria are required. Note that this discussion relates closely to the debate on the nature of minimal units in discourse analysis, which is centered on the question whether phrases can count as elementary units in discourse analysis, and whether coherence relations can apply between clauses and phrases (cf. Section 3.3.2). In the following, I show that not all occurrences of prepositions in a text act as discourse markers, and provide criteria for distinguishing between those that can and those that cannot.

It can be observed that some prepositional phrases (henceforth PPs) can be ‘expanded’ into a clause by deriving a verb from the complement of the preposition, and—if required—by adding the elided subject. This works for PPs where the prepositional complement is a deverbalized noun, as in example (4.4) above. Here, the related subordinate clause can be built in two steps: First, derive the verb *anschlagen* from its nominalization *Anschlag*, and second, add the subject *Kühlerdeckel* (which is left implicit in the above clause: *der Anschlag des Kühlerdeckels*).⁵ The resulting clause looks like this:

⁵I am not going into detail on where the potential subjects come from. The general rule seems to be: Either use the genitive object of the deverbalized noun, as in example (4.4), or take up the subject of the main clause as in example (4.12).

- (4.5) **bis** *der Kühlerdeckel anschlägt.*
 until the cap stops.
 ‘until the cap stops.’

In other cases, the subject is already given in the PP, and reconstructing the clause only requires transforming the deverbalized noun into the verb it stems from, as in:

- (4.6) **Während** *des Sonnenuntergangs* → **Während** *die Sonne untergeht*
 During the sunset → While the sun sets
 ‘During sunset → While the sun sets’

These transformations are not possible with all PPs. This is due to the fact that the noun in the PP is not always a deverbal nominalization, as in example (4.7). Hence, the PP does not relate a ‘contracted clause’⁶ and a clause.

- (4.7) **Zuleitung** **in** *benötigter Länge abwickeln.*
 Cable in required length pull out.
 ‘Pull out the cable in the required length.’

Likewise, in the following example, *nach* (after) does not function as a discourse marker:

- (4.8) **Nach** *Mitternacht war es still in der Stadt.*
 After midnight was it quiet in the town.
 ‘After midnight, it was quiet in town.’

Transforming this into a clause would require the addition of a verb (signaling a process), therefore, this PP does not count as a contracted clause, even though it realizes a circumstance constituent. Applying these ‘rules’, the instances of prepositions in examples (4.7) and (4.8) can be excluded from the set of discourse markers.

A borderline case is the use of *mit* (with) in the following utterance:

- (4.9) **Mit** *den Tasten 6 und 7 Stunde und Minute einstellen.*
 With the buttons 6 and 7 hour and minute set.
 ‘Set hours and minutes with buttons 6 and 7.’

Instead of the deverbal nominalization denoting an action, we have a noun that denotes an object, which is ambiguous in that the object can realize either the actee or the instrument role. The noun group *mit den Tasten* (with the buttons) can be paraphrased as a prepositional phrase containing a deverbal nominalization denoting an action: we have

⁶This term is borrowed from SFL, which maintains that phrases are contracted clauses; yet I use it differently in that I only apply it to those prepositional phrases that can actually be expanded to clauses without introducing new verbal material.

a noun that denotes an object, which is, e.g. *durch Drücken der Tasten* (by pressing the buttons). This might suggest that constructions such as these can be regarded as linguistic expressions of coherence relations, even though they do not include a verb, which I argued above is required for a PP to count as a ‘contracted clause’. On the other hand, *mit+noun* is the typical realization of an instrument as in *Mit dem Hammer schlug sie den Nagel in die Wand* (With the hammer, she drove the nail into the wall). The question is how to distinguish between simple instruments and those that suggest an implicit action, since they do not differ with respect to the surface form *mit+noun*. One does not want to claim that all markers of the instrument role act as discourse markers. However, there seems to be a difference between *mit dem Hammer* (with the hammer) and *mit den Tasten* (with the buttons). When paraphrasing the former phrase one gets a formulation such as *durch Schlagen mit dem Hammer* (by hitting with the hammer). Here, the instrument is still explicitly indicated by the preposition *mit*, whereas one could not say **durch Drücken mit den Tasten*. While the former seems to be an expression of the instrument role, the latter is obviously not. The difference is that between *acting on something* (*der Taste* (the button), which has the semantic role of patient, actee) or *acting with something* (*mit dem Hammer* (with the hammer), which has the instrument role). This paraphrase can serve as a linguistic test to decide whether the prepositional phrase is an expression of an instrument or a shorthand of an action. The latter does not allow the paraphrase with *durch*; this resolves the potential ambiguity of the phrase *mit+noun*.

Testing for subtleties such as these will complicate the test for German discourse markers even further, at the cost of transparency. And since PPs of this type are fairly rare, and their assessment requires a lot of world knowledge, I decided not to account for these instances in the test. That is, only prepositional phrases containing a deverbal nominalization are considered as candidate discourse markers. This test amounts to checking the propositional content of a phrase (see also Pasch’s M4 criteria): Those that realize an underlying process count as minimal units.

To make the matter even more complicated, one observes examples such as the following which require a third step—in addition to deriving the verb and reconstructing the subject—in expanding the phrase into a clause:

- (4.10) **Nach** *Ablauf der Toastzeit* → **Nachdem** *die Toastzeit abgelaufen*
 After end of the toasting time → After the toasting time run out
ist
 is.
 ‘After the end of the toasting time’ → ‘After the toasting time is completed’

Here, the German preposition and the corresponding subordinating conjunction differ; so what are the criteria for introducing a subordinate conjunction? A number of German prepositions that have discourse marker potential have a lexically related subordinating conjunction. Either preposition and subordinate conjunction are homographs, as is the case for *während*, *bis* and the English *after*, *before*, *until*, etc., or the preposition is a somewhat abbreviated form of the conjunction. Examples from [Bäuerle 1995] are: *vor* (before, P) and *bevor* (before, sub.conj.), *nach* (after, P) and *nachdem* (after, sub.conj.).

[Bäuerle 1995] further notes that pronominal adverbs also derive from the same stem, for instance, *davor*, *danach*, *währenddessen* (before that, afterwards, meanwhile), etc. This helps with less straightforward cases such as the following:

- (4.11) **Mit** *dem Herunterdrücken der Aufzugstaste* *schaltet sich der Toaster ein.*
 With the pressing down of the lever switches itself the toaster on.
 ‘With pressing down the lever the toaster switches on.’

Paraphrases comprising two clauses, i.e. indicating a link between two processes, could be:

- (4.12)
- a. *Die Aufzugstaste herunterdrücken.* **Damit** *schaltet sich der Toaster ein.*
 The lever press down. With that switches itself the toaster on.
 ‘Press down the lever. This switches the toaster on.’
- b. **Wenn/Sobald** *die Aufzugstaste heruntergedrückt wird,* *schaltet sich der Toaster ein.*
 When/As soon as the lever pressed down is, switches itself the toaster on.
 ‘When/As soon as the lever is pressed down, the toaster switches on.’

How can we justify classifying *mit* as discourse marker in this example? Surely, there is no corresponding subordinating conjunction, but a related conjunctive, the pronominal adverb *damit*. In the absence of an unambiguous conjunction, the PP can be expanded to a clause which can stand alone, moving the discourse marker to the second clause. Consider a second example and its rephrasing as two clauses:

- (4.13)
- a. **Durch** *einen Schlag auf den Griff* *die Schraube lösen.*
 By means of a hit on the handle the screw loosen.
 ‘Hitting the handle loosens the screw.’
- b. *Schlagen Sie auf den Griff.* **Dadurch** *löst sich die Schraube.*
 Hit you on the handle. By means of this loosens itself the screw.
 ‘Hit the handle. This loosens the screw.’

Unfortunately, in these cases the discourse marker and its original host clause are separated, as the discourse marker is moved to the second clause. A positive effect is that now Knott’s Step 3 can be applied without further complications: *Dadurch löst sich die Schraube* is a syntactically complete sentence, but requires additional context to be understood, while *Die Schraube löst sich* is perfect on its own. Hence, *dadurch* counts as cue phrase, and the preposition *durch* in the original example, too.

Similar observations can be made for English:

- (4.14) **After** *the arrival of the train, we all went home.*
 → **After** *the train had arrived, we all went home.*

Here, the noun *arrival* stems from the verb *arrive*, the subject is explicitly given in the genitive modifier, and the preposition *after* possesses a corresponding conjunction. In contrast to German, Step 3 of Knott's test can be applied to the expanded phrase without further alterations, since *The train had arrived* is an independent sentence; only if the discourse marker *after* is added, does it become incomplete.

To sum up, two criteria have to hold for a preposition to be classified as a discourse marker: 1. A verb must be derivable from the prepositional complement, i.e. the deverbal nominalization; 2. the PP must act as a circumstance in the clause.⁷ This test works for those prepositions for which a semantically equivalent conjunction or conjunctive exists. Still, this test only checks for the propositional complexity of a phrase, it does not yet—at least in the case of hypotactic clauses—give an independent sentence to which Knott's Step 3 to Step 6 can be applied. This is due to the grammatical influence a German subordinating conjunction exerts on the clause, and will be discussed below.

Between processes/nonfinite: infinitives etc. Let us now turn to the hypotactic constructions with a nonfinite verb. In German, this is the *erweiterer Infinitiv* (an infinitive construction with *um ... zu* (in order to)). According to [Helbig and Buscha 1991, p659], the *um...zu*-construction corresponds to a subordinate clause introduced by *damit* in that they both express a goal or a purpose. Moreover, if the syntactic subjects of the main clause and the subordinated clause are the same,⁸ then the *damit*-clause can actually be substituted by an *um...zu* infinitive, as illustrated by the following example:

(4.15)

- a. *Das Gerät im Gefäß herumführen, um alle Zutaten gut zu vermengen.*
 The device in the dish move around to all ingredients well to mix.
 'Move the mixer around in the dish to mix all ingredients well.'
- b. *Das Gerät im Gefäß herumführen, damit alle Zutaten gut vermengt werden.*
 The device in the dish move around, so that all ingredients well mixed will be
 'Move the mixer around in the dish so that all ingredients are well mixed together.'

English has two options: to-infinitive constructions, and clauses introduced by *by* or *with* followed by a gerund. (4.16) and (4.17) are examples of discourse markers in nonfinite hypotactic constructions (from [Knott 1996, p65]):

⁷This is to exclude PPs that are used as qualifiers of a noun group.

⁸This is not the entire story: Additionally, the subordinate clause should not contain any modal or auxiliary verbs, etc., see [Grote 1995, p13].

(4.16) *Bob used the crowbar **to** lever open the window.*

(4.17) *Bill escaped from prison **by** bribing the guard.*

None of the host clauses is a full clause and can stand alone. Again, reconstruction and expansion steps are required. These utterances are not covered by the English test. [Knott 1996, p65] admits himself that his test is overly restrictive in, for instance, leaving out *-ing* constructions, but argues that confronted with the trade-off between coverage of the test and simplicity he opted for the latter. Yet, following this approach excludes several discourse markers which are frequent in technical instructional texts, and so seems inappropriate when aiming at a comprehensive test.

Between processes/finite: subordinating conjunctions. German subordinating conjunctions in finite clauses also pose problems for the test as, in German, matters are complicated by the differences in word order between main and subordinate clause:

(4.18) *Suchlauf-taste so oft drücken, **bis** der gewünschte Sender gefunden ist.*
 Search buttons as often press until the desired channel found is
 ‘Repeatedly press the search button until the desired channel is found.’

(4.19) **Bevor** *Sie die Waffel backen, muss das Gerät aufgeheizt werden.*
 Before you the waffle bake must the device preheated be
 ‘Before you make waffles, the device has to be preheated.’

Again, the host clauses do not comply with Knott’s Step 3 criteria that they must be full sentences. Standardizing over the grammatical influences of subordinate conjunctions only requires word order modification, i.e. changing it from finite-final to finite-second position:

(4.20) **bis** *der gewünschte Sender gefunden ist*
 → bis (der gewünschte Sender ist gefunden)
 → der gewünschte Sender ist gefunden

(4.21) **Bevor** *Sie die Waffel backen*
 → Bevor (Sie backen Waffeln)
 → Sie backen Waffeln

Between processes: coordinating conjunctions and cohesive means. Finally, for coordinating conjunctions and for most of the intersentential discourse markers, Knott’s test works for German texts in its present form.

(4.22) *Rechten Schalthebel in der oberen Position festhalten **und** Stunde und Minute [...] einstellen.*
 Right switch lever in the top position hold and hour and minute [...] set
 ‘Hold the switch lever in top position and set hour and minute.’

(4.23) *Setzen der Uhrzeit. Dazu die Taste 9 UHRZEIT drücken.*
 Setting of the time. For that the button 9 TIME press.

‘Setting the time. In order to do that, press button 9 TIME.’

(4.24) *Auf den Griff schlagen. Dadurch löst sich die Schraube.*
 On the handle hit. By means of this loosens the screw.

‘Hit the handle. This loosens the screw.’

Word order changes are also required with some of the cohesive means to yield a syntactically complete clause. For instance, in example (4.24) the pronominal adverb *dadurch* takes a clause with clause-initial verb; standardization steps work here similarly to subordinate clauses:

(4.25) **Dadurch löst sich die Schraube.**
 → Dadurch (die Schraube löst sich).
 → Die Schraube löst sich.

I therefore modify Knott’s test according to the discussion above. The revised test now accounts for these German-specific phenomena, and detects discourse markers in German texts. The ‘Test for discourse markers in German texts’ is given in Figure 4.5.⁹ This test fuses ideas from [Pasch *et al.*, in prep.] and [Knott 1996], and goes beyond them in describing explicit expansion/reconstruction steps to reconstruct clauses from phrases. By doing this, we have a straightforward test for the clausal potential of PPs. Further, we can keep Knott’s criteria of discourse markers as links between clauses, and apply Step 3 to Step 6 from Knott’s test without modification. Compared to Knott’s original version, Step 1 is extended to include prepositions and nonfinite hypotactic constructions as well, which are, as they stand, not full clauses. Note that this extension takes up (and extends beyond) the (M5) criteria of [Pasch *et al.*, in prep.] which states that “The realizations of the arguments of the relational meaning of X can be sentence structures”, using ‘can’ not to exclude nonfinite clauses. Further, (M1) relates to this step as it also excludes material like comparative forms of adverbs (see [Pasch *et al.*, in prep.]).

Step 2 is still a **reconstruction** step, meaning that missing lexical information is reconstructed, either by removing ellipses or resolving references. Step 3 has been added as a complex **expansion** step that expands reduced clauses (PPs and infinitive constructions). The expansion step amounts to testing for Pasch’s (M4), which says that the arguments of a coherence relation have to be propositional structures. Step 3 yields complete clauses, which are not yet independent clauses, due to peculiarities of German such as verb movement in subordinate clauses. An additional step of **standardization** is introduced to standardize over grammatical peculiarities, which produces full, independent clauses plus the original discourse marker candidate, which are passed on to a slightly modified version of Knott’s Step 3 (here: Step 5). Step 6 to Step 8 can be applied to the results of steps 4 and 5; they correspond to Knott’s steps 4 to 6, and have been omitted in the figure for

⁹Adding glosses and translations for the German examples into the boxes would impair the readability of the test. Here is the complete set of glosses (given first) and translations:

- 1. Identification:** First, isolate the candidate discourse marker and its **host** constituent. The host is the clause or the phrase with which the discourse marker is immediately associated syntactically. In the sentence

(4.26) Kühlmittel nachfüllen, *bis* der Tank voll ist.

the isolated discourse marker and its host clause are:

(4.27) *bis* der Tank voll ist.

In the example

(4.28) Den Kühlerdeckel im Gegenuhrzeigersinn drehen *bis* zum Anschlag.

the isolated discourse marker and its host phrase are:

(4.29) *bis* zum Anschlag.

- 2. Reconstruction:** Substitute any anaphoric or cataphoric terms in the resulting text with their antecedents, and include any elided items as in:

(4.30)

a. Zuleitung in benötigter Länge abwickeln *und* einklemmen.

b. Zuleitung in benötigter Länge abwickeln *und* die Zuleitung einklemmen.

(4.31)

a. Den Kühlerdeckel im Gegenuhrzeigersinn drehen *bis* zum Anschlag.

b. Den Kühlerdeckel im Gegenuhrzeigersinn drehen *bis* zum Anschlag des Kühlerdeckels.

- 3. Expansion:** For all prepositional phrases test whether they can be expanded to a clause performing the following steps:

If the prepositional complement is a noun, which in turn is a deverbal nominalization, then

1. reconstruct the subject,
2. derive the verb from the deverbal nominalization,
3. choose a conjunction (one that expresses the same meaning as the preposition) to link between clauses
4. and adjust the word order

to expand the phrase to a clause. If this is possible, then the preposition counts as a discourse marker.

In the reconstructed PP *bis zum Anschlag des Kühlerdeckels*, the (elided) subject is *Kühlerdeckel*, the infinitive *anschlagen*. The subordinate clause (host clause) and the original discourse marker candidate are:

(4.32) *bis* der Kühlerdeckel anschlägt (bis)

In all other cases, remove this particular occurrence of a preposition from the class of discourse markers.

Further, for all non-finite hypotactic constructions, build the corresponding finite version by replacing *um...zu* with *damit* and introducing the elided subject.

- 4. Standardization:** This step takes care of the grammatical peculiarities of German subordinate clauses and clauses introduced by conjunctives (either given in the text, or resulting from Step 3) and returns an independent clause:

(4.33) *bis* der gewünschte Sender gefunden ist
 → bis (der gewünschte Sender ist gefunden)
 → der gewünschte Sender ist gefunden

(4.34) *Dadurch* löst sich die Schraube.
 →Dadurch (die Schraube löst sich)
 →Die Schraube löst sich.

- 5.** If the candidate phrase is indeed a discourse marker, the text resulting from Step 2 and Step 3 should appear *incomplete*. An incomplete text is one where the host clause without the discourse marker is a self-contained unit (syntactically complete after the standardization step), but where one or more clauses are needed for the host clause plus the discourse marker in order for a coherent message to be framed. The clause

(4.35) *nachdem* die Toastzeit abgelaufen ist

in its standardized form

(4.36) nachdem (die Toastzeit ist abgelaufen)

is incomplete in this sense; it requires at least one other clause to make a self-contained discourse.

- 6 to 8.: Knott's Step 4 to Step 6.

Figure 4.5: Test for discourse markers in German texts

reasons of space. Note that Step 4 also mirrors Pasch's (M3) condition which says that "X expresses a specific two-part relation."

For detecting English cue phrases, I rely on Knott's test, except that I extend it to include prepositions and nonfinite hypotactical constructions, too. Additions to Knott's Step 2 are given in Figure 4.6.

4.2.1.3 Extending the set of discourse markers

Using these tests, one can gather a collection of discourse markers occurring in German and English technical instructional texts. Recall that these are the discourse markers that I eventually want to be able to generate (cf. Chapter 1). Since I only deal with data from a particular text type, this set is only a subset of all discourse markers that are encountered in natural language, and as such does not give a full picture. For the purpose of analysing and describing particular groups of discourse markers, such as temporal or concessive connectives, and pinning down the exact conditions of usage, a more comprehensive coverage seems to be more appropriate. Hence, two tasks have to be addressed: First, discover groups of functionally equivalent discourse markers from the set of markers identified in

-
- (4.26) Coolant add until the tank full is.
Add coolant until the tank is full.
 - (4.27) until the tank full is
until the tank is full
 - (4.28) The cap counterclockwise turn up to the resting position.
Turn the cap counterclockwise until it stops.
 - (4.29) up to the resting position
until it stops
 - (4.30) a. Cable in required length pull out and secure.
Pull out the cable in the required length and secure it.
 - (4.30) b. Cable in required length pull out and the cable secure.
Pull out the cable in the required length and secure the cable.
 - (4.31) a. The cap counterclockwise turn up to the resting position.
Turn the cap counterclockwise until it stops.
 - (4.31) b. The cap counterclockwise turn up to the resting position of the cap.
Turn the cap counterclockwise until the cap stops.
 - (4.32) until the cap stops (until)
until the cap stops
 - (4.33) until the desired channel is found
→ until (the desired channel is found)
→ the desired channel is found
 - (4.34) This loosens the screw.
→ This (loosens the screw).
→ The screw loosens.
 - (4.35) after the toasting time run out is
after the toasting time is completed
 - (4.36) after (the toasting time is run out)
after (the toasting time is completed)

For all prepositional phrases test whether they can be expanded to a clause performing the following steps: If the prepositional complement is a noun, which in turn is a deverbal nominalization, then

1. reconstruct the subject,
2. derive the verb from the deverbal nominalization,
3. choose the corresponding connective that links between clauses

to expand the phrase to a clause. If this is possible, then the preposition counts as a discourse marker.

In the PP

(4.37) *after* checking the oil level

the (elided) subject is *you*, the infinitive *check*. The subordinate clause (host clause) and the original discourse marker candidate are:

(4.38) *after* you have checked the oil level (after)

In all other cases, remove the preposition from the class of discourse markers.

Further, for all non-finite hypotactic construction, build the corresponding finite version by introducing the elided subject and replacing the *-ing* form with a finite verb.

Figure 4.6: Additions to Step 2 of Knott's test for English relational phrases

technical instructional texts (they will be listed in Chapter 5), and second, obtain a broader coverage of particular marker groups than is given in my text corpus.

To organise the set of discourse markers into groups of functionally equivalent markers, I use results from research literature on semantic classes of discourse markers, for instance, Martin's top-level classification (given in Figure 4.1 above, and also in Chapter 2), and Knott's 'Test for Substitutability' to determine synonymous or near-synonymous markers (cf. [Knott 1996, p71]). Actually, I use Knott's test in two ways: to find sets of equivalent markers, and, more importantly, to detect differences in marker usage, as an initial step to determine relevant descriptive dimensions. Therefore, I will discuss the test in Section 4.2.3 below.

To add further functionally equivalent markers to the set of discourse markers encountered in technical texts, I worked with traditional dictionaries and with grammars like [Quirk *et al.* 1972] and [Helbig and Buscha 1991], which provide syntactic and semantic classifications of connectives. Dictionaries (mono- and bi-lingual) also help in finding equivalence classes of discourse markers, and give synonyms and hyponyms. In this way, one can ensure a broad coverage of the discourse marker group which is investigated more closely in this thesis: temporal discourse markers (see Part II). Finally, corpora of English and German (COBUILD, DIE ZEIT, and LIMAS, described below) are checked for occurrences of these newly introduced items, and my 'Test for discourse markers' and Knott's enhanced 'Test for relational phrases' are applied in order to determine whether these items really belong to the set of discourse markers, and to collect examples for discourse marker usage.

Unlike Stage 1, the remaining stages in discourse marker analysis and representation will only be introduced briefly; they are dealt with at length in the remaining chapters of this thesis.

4.2.2 Stage 2: Providing hypotheses on relevant features

In the second stage, I try to determine the dimensions of discourse marker analyses, i.e. the parameters that have to be considered in a comprehensive account of discourse marker usage. This serves as starting point for the in-depth analyses of sets of discourse markers, of their meanings and the contexts in which they assume a particular meaning (see Stage 3 below).

The research literature gives a wealth of information on individual markers or groups of similar markers. It provides an initial set of features for describing markers. In particular, *text linguistics* considers markers as a means to signal coherence, and provides insights on the semantic and pragmatic properties of marker classes. On the other hand, *grammars* and *style guides* provide syntactic, semantic and stylistic properties of individual markers. Further, research on discourse markers in the context of text generation proposes several features influencing marker usage. These features have been discussed at length in Chapter 2.

Initial hypotheses derived from the literature survey are the following: Dimensions relate

to the semantics of markers (the semantic relation and the intention signaled) and to properties of the context, both pragmatic and syntactic. There exist some general features, mostly structural ones, that apply across marker groups, and a large range of properties that are specific to a single marker group, and which capture the more fine-grained semantic and pragmatic differences.

To sum up, the goal of this stage is to construct an inventory of properties that can be used to characterize discourse markers belonging to a semantic class. Note that this stage only yields an initial set which will be expanded and modified in the steps following. Stage 2 is discussed in detail in Chapter 5 of this thesis.

4.2.3 Stage 3: Analysing individual discourse markers

The next stage is to actually describe the meaning and usage conditions of individual discourse markers and of marker classes. Starting with the inventory of features already known (as derived in the preceding stage), I extend the feature inventory in the course of analysis. The goal is to provide an account of individual markers, their properties, and their interaction with the context and their constraints on usage by means of a detailed study, and also to contrast them with related markers. Chapter 6 addresses this task.

Specifying the distinctions within sets of similar markers is a subtle task. I draw on two sources for acquiring knowledge of individual discourse markers: corpus analysis and existing research. The results from the corpus analysis are complemented by insights from the literature in the discussion of individual markers, and by contrastive studies on the differences in marker usage in different languages. Extracting features in this way seems justified since at this stage I am—unlike [DiEugenio *et al.* 1997]—not concerned with the predictive power of individual features but rather with decomposing markers into features that adequately describe their function and form, and that support the motivated choice of discourse marker as one task of the overall generation process.

For the corpus analysis, I employ techniques such as paraphrasing and Knott's substitution test [Knott and Mellish 1996, Knott 1996] to analyse the typical distributions of discourse markers in corpora. The goals of the corpus study are twofold: First, to determine differences between markers, and second, to find out about the interdependencies of marker usage and properties of the context. In particular, I used the following resources and tools.

Corpora. The different corpora employed in this thesis are:

- A small self-compiled corpus of German and English *technical instructions* (25 texts), mostly operating instructions for household-appliances and car manuals (see Appendix A for details).
- The LIMAS corpus 'Linguistik und Maschinelle Sprachbearbeitung', German), developed in 1975, which contains written text from various genres (size: 1 Million words) [Glas 1975].

- The online corpora maintained by the *Institut für deutsche Sprache*, (IDS), Mannheim, in particular, the public corpus of written German (PUBLIC, size: 533.53 Million word forms (on Aug. 23rd, 2001)).
- Two year's issues (1996/97) of the German weekly quality paper **DIE ZEIT**, which contains articles on politics, literature, financial matters, education, science, travel, and life style.
- An early version of the COBUILD corpus (English), used only for concessive markers.

Corpus analysis tools. I use three corpus analysis tools:

- **COSMAS:** An on-line 'Corpus Storage, Maintenance and Access System' (1992) developed by IDS Mannheim and Makrolog GmbH Wiesbaden, and accessible via the IDS web pages (<http://www.ids-mannheim.de/kt/cosmas.html>).
- **Tree-tagger:** A tagger developed at the IMS Stuttgart [Schmid 1995], and which can be obtained from <http://www.ims.uni-stuttgart.de/Tools/DecisionTree-Tagger.html>. It annotates English and German text with part-of-speech information, using the PennTreebank tagset for English, and the Stuttgart-Tübingen tagset [Schiller *et al.* 1995] for German. The tagger is used to detect discourse markers in text, and to determine syntactic properties (and even patterns) in the environment of a particular discourse marker.
- **Kwic:** A keyword in context tool written by Oliver Mason, Birmingham University. This tool is used for identifying the contexts in which particular discourse markers are used.

Substitution tests. Substitution tests, including syntactic adjustments, help in grouping markers together according to their function in discourse, and to determine minimal differences in meaning and to deduce semantic and pragmatic features. They are used to determine synonyms or near-synonyms, much in the way [Knott 1996] has done it. Knott's test has been designed for English text; a slightly modified version, adjusted to German, is given in Figure 4.7.¹⁰

¹⁰Glosses and translations:

- (4.39) After completion the toasting time switches the device automatically off.
 After the toasting time has been completed, the device switches off automatically.
- (4.40) Before completion the toasting time switches the device automatically off.
 Before the toasting time has been completed, the device switches off automatically.

1. Consider any discourse marker from the corpus in a text where it naturally occurs.
2. Remove the discourse marker from its host clause, and insert any other phrase from the corpus (**the candidate phrase**) into the same clause, at the appropriate position.
3. If need be, the punctuation and the word order of the new discourse can be altered to make it more suitable for the candidate phrase. For example, if the phrase *obwohl* (although) is being replaced by the phrase *dennoch* (still), it may be necessary to replace a comma with a full stop and create a new sentence.
4. If need be, the new discourse can be supplemented with additional or alternative discourse markers in other clauses/phrases. Sometimes there are dependencies between the cue phrases in a text (for instance, between *wenn* (if) and *dann* (then), or between *entweder* (either) and *oder* (or)), so changing one phrase might also require changes to the other.
5. If it is possible to use the resulting discourse in place of the original discourse, then the candidate phrase is said to be substitutable to the original phrase in that context.

The notion of “being able to use one discourse in place of another” implies:

- The new discourse must describe the same set of events in the world as the old discourse, and moreover ensure that it achieves the same goals as the old discourse achieved. Hence, the sentences:

(4.39) *Nach* Ablauf der Toastzeit schaltet das Gerät automatisch ab.

(4.40) *Vor* Ablauf der Toastzeit schaltet das Gerät automatisch ab.

are not substitutable.

- Some differences between discourse markers are of stylistic nature, for instance, *obwohl* (although) and *obzwar* (although, arch.). They are not relevant for describing the function in discourse, hence they can be overlooked for the time being.
- Different discourse markers are appropriate for linking portions of text of different sizes (see discourse marker test above). For instance, *nach* (after, P) links phrase and clause within a clause, *nachdem* (after, conj.) links clauses within a compound sentence, and *danach* (afterwards) links whole sentences. Such differences can be overlooked in the test. Required alternations to punctuation and syntactic structure have to be performed to accommodate the candidate phrase.
- A final factor to be disregarded is the amount of *background knowledge* the reader is assumed to possess.

Figure 4.7: Abridged German version of Knott’s test for substitutability, adopted from [Knott 1996, p71]

4.2.4 Stage 4: Describing marker usage—a functional approach

A functional account of discourse markers represents the differences and commonalities of discourse markers by sets of features organized in system networks, similar to the conjunctive relation networks by [Martin 1992] (see Section 4.1).

The analysis phase (Stage 3) provides detailed descriptions of individual discourse markers, which are neither related to each other nor embedded into a particular linguistic framework. In Stage 4, the results from the analyses are merged into a single functional representation of discourse marker function and usage. To arrive at such a description, common parameters in the analyses have to be extracted, and markers realising minimal oppositions in meaning have to be identified. As system networks present functional classifications of linguistic means, relevant parameters are those that refer to the meaning of a discourse marker, such as aspects of the type of relationship indicated by the marker, and not of the syntactic or lexical context it appears in. Parameters are then classified to arrive at a hierarchy of features, which represents aspects of the meaning of discourse markers. In brief, individual discourse marker descriptions are conflated to arrive at Martin-style system networks for conjunctive relations in German.

The resulting system networks give the possible interpretations of a discourse marker, in other words, the semantic environments in which a marker may occur. This is given by the selection expression that leads to the realization of a particular marker. Following Oversteegen's extensions to Martin's representation [Oversteegen 1993], my account additionally describes the lexical and syntactic constraints a discourse marker imposes on its linguistic environment, that is, it gives details on what the context must be like in order to have a certain interpretation available. For instance, a resultative tense used with *nachdem* (after) signals an anterior interpretation, while the use of the same tenses in both clauses indicates a simultaneous reading.

In this thesis, system networks will be developed for a specific group of discourse markers: German temporal discourse markers. The resulting networks will be compared to existing English and Dutch descriptions, as I aim at a multilingual account of discourse markers. Stage 4 is subject of Part II of the thesis.

4.2.5 Stage 5: Defining the input structure to marker choice processes

Given a detailed linguistic analysis of the discourse markers under consideration, the next stages are concerned with making this knowledge available to a text generation system. In the fifth phase, I clarify the shape of the discourse representation level which serves as input to discourse marker choice strategies.

As argued above, one central goal of this thesis is to design a framework that enables motivated discourse marker choice in the automatic production of multilingual text. Discourse markers are one means of bridging between discourse representation and the linguistic surface. In current systems, discourse marker selection mechanisms operate on RST trees;

this would imply that the meaning of discourse markers has to be described in terms of the information available in an RST tree alone. Since this is not feasible, as RST conflates different types of information (see discussion in Chapter 3), a different approach to discourse representation is also required to make discourse marker choice work. The methodology applied to arrive at a set of coherence relations will be introduced in Chapter 8.

4.2.6 Stage 6: Resource for representing discourse marker knowledge

In this phase, a resource for storing the knowledge that has been acquired on discourse markers in the preceding stages is developed. The major decision to be made relates to the format of this resource. This decision is influenced by two factors: First, by my assumptions on the ‘linguistic’ status of discourse markers, and second, by the application in mind.

The analysis stage (Stage 4) yields a representation of discourse markers in a framework that meets the informational demands of multilingual text generation as it highlights the function of discourse markers, while at the same time making statements concerning the form, the linguistic realization. This description is neutral with respect to any particular application. In the application I target, text generation, discourse markers are regarded as one aspect of bridging between discourse representation and surface realization. Given my specific assumptions about the generation process, a lexicon is the adequate means for marker representation (this will be motivated in detail in Chapter 9). This involves a move from a paradigmatic description in system networks to a syntagmatic representation in a lexicon. Exploiting the insights from stages 2 and 3, the shape of a discourse marker lexicon and of individual lexicon entries are defined. In particular, the features and the constraints given in the functional description are used in the definition of lexicon entries, which also links into the discourse representation that results from Stage 5.

4.2.7 Stage 7: Selecting discourse markers

In the final stage, knowledge sources and data structures resulting from the preceding stages are tested for their adequacy. This requires first of all to provide a generation architecture that makes use of a discourse marker lexicon, and into which procedures for discourse marker selection can be embedded. Second, it demands that we impose a generation perspective on the—so far neutral—lexicon. Third, lexicon entries have to be specified for individual German and English temporal discourse markers. To achieve this, I take the knowledge on semantic relations, on structural and lexical contexts of a discourse marker made available by the functional classifications to derive the values for the features specified in Stage 6.

Using the selection procedures, discourse markers will be chosen for coherence relations as defined in Stage 5. This final stage serves as a testbed for the functional description, the lexicon and the choice procedures. It helps to determine whether the proposed set of lexicon features is sufficient to ensure informed discourse marker choice, and whether the

individual lexicon entries—and hence the functional description they are derived from—contain sufficient and accurate information on marker usage to select the most appropriate discourse marker. In case inappropriate discourse markers are chosen, the preceding stages will be iterated until discourse marker choice succeeds. Examples will be presented in Chapter 10.

Part II

Linguistic analysis of German temporal discourse markers

Chapter 5

Prerequisites and dimensions

Having outlined the general approach to analysing discourse markers, I now turn to a detailed study of one marker group: *German temporal discourse markers*. The goal of this chapter is to arrive at a set of parameters that have to be considered in a comprehensive account of temporal marker meaning and usage.

To achieve this, I follow the approach outlined in the last chapter. Section 5.1 introduces the discourse markers occurring in technical instructional texts, and motivates the choice of the marker group to be investigated. Next, Section 5.2 provides the background for the temporal marker description: After determining the set of temporal markers to be studied (Section 5.2.1), the state of the art in temporal marker description for German is briefly surveyed, with some mention of English studies insofar as they are relevant to the analysis (Section 5.2.2). In Section 5.3, I discuss the interactions between temporal marker usage and properties of the linguistic context. This yields the dimensions of marker analysis, which form the basis for the detailed discussion of German temporal discourse markers in Chapter 6.

5.1 Discourse markers in technical instructional texts

Following the procedure described in Stage 1 of the methodology (see Chapter 4), I gathered the set of discourse markers in German and English technical instructional texts. The analysis builds on a sample of monolingual and bilingual texts. (See Appendix A for a description of the corpus.) I first identified all lexical items belonging to the word classes listed in Section 4.2.1, and then applied the ‘Test for relational phrases’ by [Knott 1996] (Figures 2.2 and 4.6) to the English items, and my ‘Test for discourse markers in German texts’ (Figure 4.5) to the German discourse marker candidates. Thus, I compiled the set of discourse markers occurring in the text type under consideration. See Tables 5.1 and 5.2 for a complete list, organized by word classes.

A coarse classification of discourse markers according to the kind of relationship they indicate is given in Tables 5.3 and 5.4, cross-classified with the word classes. This ini-

preposition	als, bei/beim, bis, durch, für, mit, nach, trotz, vor, während, wegen, zu/zum/zur
subordinating conjunction	als, auch...wenn, aufgrund von, bevor, bis, da, damit, dass heißt, falls, indem, je...desto, nachdem, ob, obwohl, so, sobald, so dass, sofern, solange, solange...wie, sondern, sondern, sooft, sowie, trotzdem, um...zu, während, weil, wenn, wie, zumal
coordinating conjunction	aber, denn, entweder ... oder, jedoch, oder, sowie, und
conjunctive etc.	außerdem, dabei, dadurch, dafür, daher, damit, danach, dann, daraufhin, davor, dazu, denn, dennoch, deshalb, hierdurch, hierfür, hiermit, hierzu, so, somit, trotzdem, währenddessen, zuvor
phrase	in diesem Fall(e)

Table 5.1: Set of German discourse markers in technical instructional texts

preposition	after, before, by, during, for, to+inf, with
subordinating conjunction	after, as, because, before, by means of, even if, even though, even when, if, in order to, now, once, since, so, so that, such as to, unless, until, when, whenever, while, whilst,
coordinating conjunction	and, as well as, but, either...or, nor, or, then
conjunctive etc.	also, even, however, next, otherwise, then, thereafter, thereby, therefore, thus
phrase	as a consequence, as a result, for this reason, this may cause

Table 5.2: Set of English discourse markers in technical instructional texts

tial semantic categorization follows the classes introduced by [Helbig and Buscha 1991] for German, and [Quirk *et al.* 1972] for English. Note that several discourse markers are ambiguous as to the relation they can indicate. For instance, *während/while* can have an adversative or a temporal reading, and hence we find a larger number of tokens in Tables 5.3 and 5.4 when compared to Tables 5.1 and 5.2.

The tables show that discourse markers involving causality (including resultative (final), conditional, concessive, purposive, and causal markers) and temporal discourse markers display the widest variety in form; several alternative realizations can be observed in the corpus. This is not surprising, as causal and temporal relationships are also the most common relations in these kinds of texts. This is in line with the observations made in previous studies on coherence relations and discourse markers in technical instructional texts, for instance, [Vander Linden 1994, Delin *et al.* 1994, Grote 1995].

In the remainder of this chapter, German temporal discourse markers will be examined in depth. This marker group is selected because temporal markers are, next to causal ones, the most frequent ones in the present text type. However, in contrast to causal markers which have been the concern of most work on discourse markers in text generation (see among others [Vander Linden 1994, Vander Linden and Martin 1995, Delin *et al.* 1994, Delin *et al.* 1996], and cf. also Chapter 2), temporal markers have not received much attention so far. In this thesis, I am focussing on the function and form of *German* temporal connectives. An analysis of *English* temporal discourse markers in a functional framework is made available by [Martin 1992, Hitzeman 1995]—hence the restriction to German at this point.

I take the temporal marker group as a kind of testbed for the approach to discourse marker analysis and representation proposed in the last chapter, and for the generation approach discussed later on. Yet, the present study will not be solely restricted to the temporal markers encountered in the corpus of technical instructional texts (given in Tables 5.3 and 5.4). Markers that occur with high frequency in corpora that are not genre-specific (such as the LIMAS and PUBLIC corpora) are added to the set of markers to be investigated, as I am aiming at a broader coverage and more general account of the function and form of temporal discourse markers.

5.2 German temporal discourse markers: Prerequisites

This section provides the prerequisites for marker analysis: First, the set of temporal markers to be examined, the scope of the study, is determined, and second, existing research is surveyed.

	preposition	subord. conj.	coord. conj.	conjunctive	phrase
adversative		sondern während	aber jedoch		
alternative			entweder...oder oder		
final	für zu/m/r	damit um...zu	denn	dafür dazu deshalb hierfür hierzu	
causal	wegen	aufgrund von da weil zumal	denn	denn	
conditional	bei/m mit	bevor falls sofern wenn	und	dabei dann	in diesem Fall(e)
purposive		so so dass um...zu		daher deshalb so somit	
concessive	trotz	auch...wenn obwohl trotzdem		dennoch trotzdem	
copulative		sowie um...zu	sowie und	außerdem	
modal	als durch	als dass heißt indem je...desto wie		dadurch damit hierdurch hiermit	
temporal	bei bis nach vor während	bevor bis nachdem sobald solange solange...wie sooft während wenn		danach dann daraufhin davor währenddessen zuvor	

Table 5.3: Classification of German discourse markers in technical instructional texts

	preposition	subord. conj.	coord. conj.	conjunctive	phrase
additive			and as well as either...or nor or	also	
cause		as because since			for this reason
concession		even if even though even when	but	even however	
condition		if unless when			
contrast		while	but	otherwise	
purpose	for to+inf	in order to so so that such as to		thus	
result		so that		therefore thus	as a consequence as a result this may cause
manner and comparison	by with	as by means of		thereby	
time	after before during with	after before now once until when whenever while whilst	then	then next thereafter	

Table 5.4: Classification of English discourse markers in technical instructional texts

part of speech	temporal marker
preposition	ab, bei, bis, mit, nach, seit, vor, während
subordinating conjunction	als, bevor, bis, ehe, kaum dass, nachdem, seitdem, sobald, solange, sooft, sowie, während, wenn
conjunctives	danach, dann, daraufhin, davor, währenddessen, zuvor

Table 5.5: German temporal discourse markers examined in this work

5.2.1 Scope of study

Table 5.3 gives those German temporal markers that occur in my corpus of technical instructional texts. Following the final phase of the marker-assembling stage (see Chapter 4), frequent temporal markers that have not been considered so far are added to arrive at a more comprehensive set of German temporal discourse markers. Table 5.5 lists the German temporal markers that I examine in this chapter; additions to the temporal markers given in Table 5.3 are: the prepositions *ab* and *mit*, and the subordinating conjunctions *als*, *ehe*, *kaum dass*, *seitdem* and *sowie*.

Table 5.5 contains only a subset of German temporal prepositions, namely those that locate the main clause situation in relation to the temporal event given in the PP, establishing a *relative* temporal reference. Yet, German has a second type of temporal preposition which locates an event within the framework of a given reference system, for instance, the calendar system, and thus gives an *absolute* temporal reference, as *um* (at) in *Wir treffen uns um 18:00 Uhr* (We meet at 6 pm) does. In this thesis, I am only concerned with prepositions marking relative temporal relations, as the ‘absolute’ prepositions do not pass the ‘Test for discourse markers in German texts’. Note further that the set of discourse markers given in Table 5.5 includes *external* temporal markers only; internal temporal markers cannot be observed in the present text type at all; internal relations are left *implicit* (see [Martin 1992]). As a consequence, they are neglected for the time being. Further, I will not address the non-temporal readings of temporal markers and counterfactual interpretations of temporal markers, such as in

- (5.1) *Paul verließ den Saal, bevor die Schlägerei losging.*
 Paul left the hall before the fighting started.
 ‘Paul left the hall before the fighting started.’

This sentence has a temporal and a counterfactual reading: The temporal reading implies that Paul left the room before the fight did actually start, the counterfactual that Paul left the room before a fight could start, i.e. the fight did not take place. The latter reading is not included in the present study. Finally, I do not claim to capture all (potential) usages of a particular marker, that is, all their meaning variants and conditions of use. Instead, I focus on the more frequent ones, in particular those usages that can be observed in the corpora.

5.2.2 Earlier research: Descriptive studies on temporal discourse markers

Most research regarding the expression of temporality is concerned with grammatical means for explicating temporal relations, such as tense and aspect; lexical means such as temporal discourse markers or temporal adverbs receive considerably less attention. In other words, few studies are explicitly dedicated to the analysis of temporal marker meaning and usage. The dichotomy of scope and accuracy introduced in Chapter 2 also applies to the majority of temporal marker studies: They are either detailed studies of a particular connective, or consider a broad range of markers at the cost of accuracy. In the discussion that follows I focus on research on German temporal connectives, as they are the subject of my study, and only briefly mention studies in other languages.

Major studies on the meaning and usage of individual German temporal markers include [Clement and Thümmel 1996] and [Lutzeier 1981] on the subordinate conjunction *während*, [Gelhaus 1974] on *nachdem* (after), [Zschunke 1982] and [Voronkova 1987] on *als* and *wenn* (as, when), and [Spenter 1977] on *bevor* and *ehe* (before, before (*archaic*)). At the other end of the scale one finds grammars such as [Helbig and Buscha 1991, Eisenberg 1994] which cover a wide range of markers, but only present a rather superficial analysis. Of interest to me are those few studies that investigate several temporal markers in greater detail. They again fall into two groups, depending on the perspective they adopt: [Buscha 1989, Schröder 1990, Pasch *et al.*, in prep.] take a *lexical approach* and present lexicon entries for, among others, temporal discourse markers, where marker meaning and usage is described by a set of (binary) features. The focus is, however, on properties of the syntactic and lexical environment; aspects of marker meaning receive less attention.

The second category comprises studies that aim at a general model for describing the *semantics* of temporal discourse markers, such as [Neumann 1972, Steube 1980, Herweg 1990, Sinn 1991, Durrell and Bree 1993, Bäuerle 1995]. They all agree on the assumption that semantically, temporal connectives establish a temporal relation between two situations, but differ regarding their assumptions on the additional temporal knowledge expressed by temporal connectives, and with respect to the linguistic framework they adhere to. For instance, [Steube 1980] maintains that temporal connectives impose restrictions on the internal temporal structure of a situation—in other words, she highlights the interaction with *Aktionsart*—whereas [Herweg 1990, Herweg 1991] and [Sinn 1991] emphasize the role of temporal connectives in establishing different perspectives on situations with the same internal structure, and hence focus on the interdependencies between temporal markers and aspect (see below for a discussion). In brief, Herweg and Sinn both apply the two-level approach put forward by [Bierwisch 1982, Bierwisch and Lang 1987] to temporal connectives and thus distinguish between a semantic level that captures the central meaning of a lexical item, and a conceptual level that comprises the context-specific aspects of marker meaning which result from incorporating non-linguistic knowledge. Both views are challenged by [Bäuerle 1995], who claims that the major contribution of temporal connectives is that of localizing a situation, i.e. of establishing a reference point, and who discusses the interaction of temporal discourse markers and pragmatic phenomena such as presupposition. In contrast, [Durrell and Bree 1993] believe that all the aspects mentioned so far

influence marker usage, and present selection trees for German temporal prepositions that take into account these aspects; their work is similar to the systemic functional descriptions that exist for English temporal discourse markers, but restricted to prepositions only. Finally, German temporal discourse markers are examined within research on automatically producing temporal connectives, such as [Klenner 1991] and [Schilder 1993]. However, as these studies build on Herweg's analysis of German temporal markers, they do not add new information, and hence can be neglected.

The picture is quite similar for English: While there exist various studies on individual temporal discourse markers, and more general accounts given in grammars such as [Quirk *et al.* 1972], studies that examine several markers in more detail are rare; examples are [Heinämäki 1978, Moens and Steedman 1988, Dorr and Gaasterland 1995] and [Bree *et al.* 1990]. Of interest to me are studies that take a functional perspective on the matter, as no such account exists for German temporal connectives. Here, the work by [Martin 1992] in the systemic-functional tradition is fundamental: He presents a comprehensive analysis of the function and form of English subordinating conjunctions, among them temporal connectives, and characterizes meaning contributions and usage conditions of temporal markers. [Oversteegen 1993], for Dutch temporal markers, and [Hitzeman 1995], for English temporal connectives, build on and extend his work by placing special emphasis on the properties of the linguistic context a marker can occur in.

Existing work on temporal connectives strongly influences my work: As I aim at a rather comprehensive description of meaning and usage of German temporal connectives, that is, at increasing the scope, I will exploit results from existing studies to ensure a sufficient level of accuracy. Note that I do not aim at a re-analysis of German temporal discourse markers, but that my goal is to integrate the various isolated studies into a larger whole, which ultimately forms the basis for a functional classification of German temporal discourse markers similar to Martin's classification for English and Oversteegen's description of Dutch connectives. In a nutshell, the major contribution of my work is to incorporate the results from isolated studies into a uniform description, and to present a functional classification of German temporal discourse markers, which has not been available so far.

5.3 Dimensions of temporal marker description

This section introduces the major properties of temporal discourse markers and explores the correlations between temporal markers and other linguistic means that indicate temporal organization. Following Stage 2 of the methodology outlined in Chapter 4, I propose initial hypotheses on dimensions relevant to temporal marker description. The account is based on three sources:

- descriptive linguistic studies, mainly [Bäuerle 1995, Sinn 1991, Herweg 1991, Herweg 1990, Buscha 1989], and [Steube 1980], and grammars such as [Eisenberg 1994, Jung 1971] and [Helbig and Buscha 1991];
- my own analysis of temporal marker usage in the technical texts corpus, the German

LIMAS corpus [Glas 1975], the ZEIT corpus, and the PUBLIC portion of the IDS corpus;

- substitution tests along the lines of [Knott and Mellish 1996].

Descriptive work on German temporal discourse markers suggests that quite diverse factors influence the use of a particular marker. These factors can be divided into two groups. The first group relates to the meaning of markers (mainly the temporal relation holding between two events):

Man muß die Temporalkonjunktionen semantisch als temporale Relation des NS [Nebensatz] in bezug auf den HS [Hauptsatz] begreifen. Die Bedeutung jeder Konjunktion besteht dann darin, Bedingungen für das temporale Vor-, Mit- oder Nacheinander der durch sie in Verbindung gebrachten Sachverhalte und für deren interne Beschaffenheit anzugeben.¹ [Steube 1980, p35]

The second group relates to the interaction of temporal markers with the lexical and syntactic context. Especially when expressing several events in the same sentence, marker choice interacts with other linguistic means that express temporal meaning, such as tense, aspect, Aktionsart, temporal adverbs, etc. On the one hand, temporal markers impose particular constraints on the linguistic environment they can occur in, for instance by expecting a particular Aktionsart with the verb. On the other hand, these linguistic contexts may restrict the possible semantic interpretation of (polysemous) temporal markers. A particular marker in a particular meaning is only applicable in a particular linguistic environment. For instance, a number of temporal markers (such as *als*, *wenn*, *sobald*, *seitdem* (as, when, as soon as, since)) can all signal several temporal relations (see Table 5.6 below), but depend on their syntactic and lexical contexts to receive an unambiguous interpretation (see also [Steube 1980, Bäuerle 1995]). Traditional grammars usually list aspect, Aktionsart and tense as constraining parameters on marker choice. Yet, although there is general agreement on the interaction between marker meaning and linguistic environment, no consensus has been reached on the role of these parameters, as Bäuerle [Bäuerle 1995] notes:

die temporalen Subjunktionen für sich allein nicht immer dazu geeignet sind, zeitliche Relationen in eindeutiger Weise zu bestimmen. [...] Über die Quelle der zusätzlichen Informationen besteht jedoch zumindest in der Nomenklatur kaum Einigkeit.² [Bäuerle 1995, p156ff]

¹English translation: One can understand the temporal conjunctions semantically as the way in which the subordinate clause relates temporally to the main clause. Then, the meaning of each conjunction is defined by the conditions on the temporal link between the related propositions, and on their internal properties.

²English translation: the temporal conjunctions taken by themselves are not always suited to determine a temporal relation unambiguously. [...] There is, however, at least in terminology, hardly any agreement as to the source of the additional information.

He even goes one step further and claims that a conjunction such as *als* (as) has no inherent meaning whatsoever, but depends on the context to receive its meaning, i.e. to be conceived as signaling a particular temporal relation (see below).

In the remainder of this section, I introduce the different dimensions by which the function and form of German temporal discourse markers can be characterized, and establish the terminology that is used in describing the properties of individual temporal markers in Chapter 6. Sections 5.3.1 to 5.3.4 relate to the ‘meaning’ of temporal markers, Sections 5.3.5 to 5.3.12 are concerned with structural properties and the interactions of marker choice and other linguistic means. Most dimensions are relevant for discourse markers realizing a temporal relationship within one sentence (subordinating conjunctions and prepositions); conjunctives are less constrained as to their linguistic environment. The dimensions and the terminology used to describe marker properties form the basis for the lexicon definition proposed in Chapter 9.

5.3.1 Temporal relations

External temporal discourse markers are generally acknowledged as conjoining two situations where the *situation*³ depicted in the subordinate clause (example 5.2a), the PP (5.2b) or the first sentence (5.2c) provides the temporal framework for interpreting the situation in the main clause or the second clause:

(5.2)

- a. **Bevor** *Sie den Toaster reinigen, den Netzstecker ziehen.*
Before you the toaster clean, the plug pull.
‘Before you clean the toaster, unplug the device.’
- b. **Vor** *dem Reinigen des Toasters den Netzstecker ziehen.*
Before the cleaning of the toaster the plug pull.
‘Unplug before cleaning the toaster.’
- c. *Den Toaster reinigen.* **Zuvor** *den Netzstecker ziehen.*
The toaster clean. Before, the plug pull.
‘Clean the toaster. Before, unplug the device.’

The semantics, i.e. the meaning of temporal markers, is usually described by the kind of temporal link they establish between two situations. Two classifications of the meaning of temporal discourse markers exist:

Temporal relation. Temporal discourse markers signal one of three broad classes of temporal relations: The literature states that two situations either overlap (*simultaneity*),

³I borrow the term *situation* from [Stede 1999] to denote the content representation underlying an utterance, subsuming both states and events. Other terms encountered in literature are, for instance, *event* [Dorr and Gaasterland 1995] or *main eventuality* [Lascarides and Asher 1991] to refer to content structures. See Chapter 10 for a discussion of the term *situation*.

	simultaneity	anteriority	posteriority
preposition	bei mit während	ab nach seit	bis vor
subordinating conjunction	als nachdem seit(dem) sobald solange sooft sowie während wenn	als kaum dass nachdem seit(dem) sobald sooft sowie wenn	als bevor bis ehe wenn
conjunctive	währenddessen	danach dann daraufhin	davor zuvor

Table 5.6: German temporal discourse markers cross-classified by temporal relation and word category

or the situation in the main clause either succeeds (*anteriority*) or precedes (*posteriority*) the situation depicted in the subordinate clause, the prepositional phrase, or the main clause containing the temporal conjunctive [Helbig and Buscha 1991, Bäuerle 1995, Quirk *et al.* 1972, Martin 1992].

Temporal extension. Temporal discourse markers indicate that a situation is iterated (*iterative*), holds for a particular length of time (*durative*), or is punctiliar (*temporal*)⁴ [Herweg 1990, Herweg 1991, Steube 1980].

In fact, these classifications are not competing, but are orthogonal to each other. For instance, the simultaneity markers listed in Table 5.6 can be subdivided into iterative ones (such as *sooft*), duratives ones (such as *solange*, *während*) and punctiliar ones (such as *als*, *wenn*). Yet, none of the classifications on its own is sufficient to capture all the meaning distinctions signaled by a temporal marker, neither are both classifications in combination. Table 5.6 groups temporal connectives by temporal relations. Alternatives within a class differ in that they realize additional meaning aspects other than the temporal extension. Consider the markers of simultaneity: *Solange* (as long as), for instance, conveys the idea of a strict simultaneity where two events have the same start and end time, and is more specific than *während* (while); *sooft* (whenever), to give another example, highlights the concurrence of two events. Hence, we can say

⁴This is a far more restricted use of the term ‘temporal’, which I will not adopt in this thesis. Instead, I continue to call the entire class of discourse markers indicating a temporal link *temporal*, and the subset of punctiliar markers *punctiliar*.

(5.3)

- a. **Während** *er arbeitete, spielte das Radio.*
 While he worked, played the radio.
 ‘While he was working, the radio was playing.’
- b. **Solange** *er arbeitete, spielte das Radio.*
 As long as he worked, played the radio.
 ‘As long as he was working, the radio was playing.’
- c. **Sooft** *er arbeitete, spielte das Radio.*
 Whenever he worked, played the radio.
 ‘Whenever he was working, the radio was playing.’

because the kind of simultaneity is not further specified by additional information; still, the examples suggest different temporal relations. Example (5.4) shows that simultaneity markers are not always substitutable:

(5.4)

- a. **Während** *er arbeitete, spielte kurzzeitig das Radio.*
 While he worked, played temporarily the radio.
 ‘While he was working, the radio played temporarily.’
- b. **?Solange** *er arbeitete, spielte kurzzeitig das Radio.*
 As long as he worked, played temporarily the radio.
 ‘?As long as he was working, the radio played temporarily.’

Here, the simultaneity relation is further specified by introducing a temporal adverb indicating different start or end times of the intervals. In this case, *solange* cannot be used anymore, because it indicates a correspondence of start and end time of the two intervals. Clearly, the three temporal relations given in Table 5.6 alone cannot reflect these differences in meaning.

To give another example, *nachdem* (after) and *sobald* (as soon as) both signal anteriority, but differ in that the latter requires both events to have a time point in common, as the use of a temporal adverbial (the prepositional phrase *seit einiger Zeit* (for some time)) indicating a temporal distance between the first and the second event shows:

(5.5)

- a. **Nachdem** *die Sonne seit einiger Zeit aufgegangen war, ging er baden.*
 After the sun since some time risen had, went he swimming.
 ‘After the sun had been up for some time, he went swimming.’
- b. **?Sobald** *die Sonne seit einiger Zeit aufgegangen war, ging er baden.*
 As soon as the sun since some time risen had, went he swimming.
 ‘?As soon as the sun had been up for some time, he went swimming.’

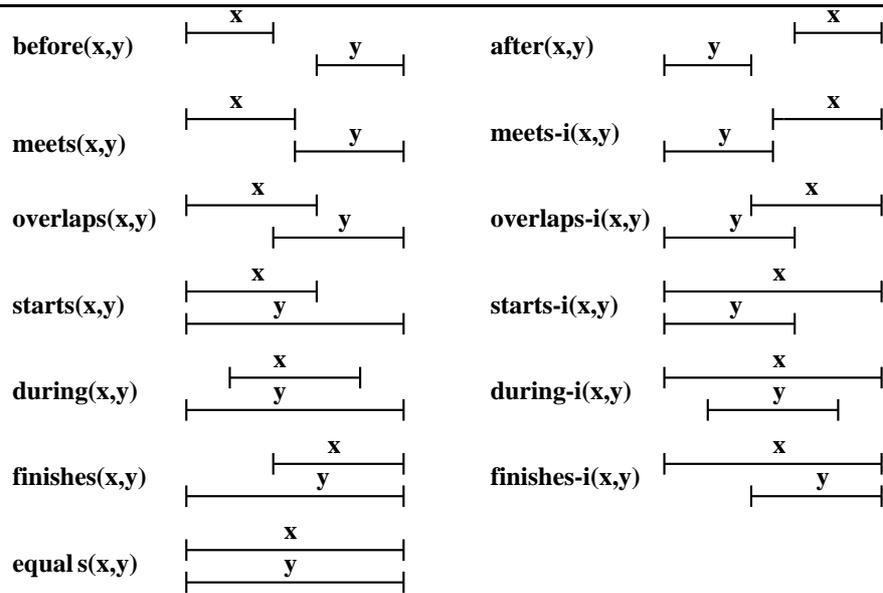


Figure 5.1: Interval relations as defined by [Allen 1984]

A number of researchers concerned with the semantics of temporal connectives argue that Allen's temporal interval relations [Allen 1984] provide an adequate framework to capture exactly these meaning differences, among others [Dorr and Gaasterland 1995, Hitzeman 1995, Klenner 1991]. Allen introduces seven basic temporal interval relationships, namely *equals* (=), *after* (>), *during* (d), *overlaps* (o), *meets* (m), *starts* (s), *finishes* (f)—and their inverses *<*, *di*, *oi*, *mi*, *si*, *fi*—that may possibly exist between two intervals. The relation between the two intervals, in this case, two situations extending over some time span, can be described in terms of the start and the end points of the intervals. For instance, *equals* implies that start and end point of both intervals are the same. Figure 5.1 shows a graphical representation of the 13 interval relations by Allen. In this thesis, I use the terms *Sit_m* and *Sit_s* to refer to the two situations, where *Sit_s* refers to the situation that acts as temporal anchor for *Sit_m*. Syntactically, *Sit_m* represents the situation verbalized in the main clause or the clause containing the conjunctive, and *Sit_s* the situation expressed in the subordinate clause, the PP, or the sentence that the cohesive items refers to. Hence, *overlaps*(*Sit_m*, *Sit_s*) as in example (5.4a) states that there is an intersection between the time at which *Sit_m* occurs and the time at which *Sit_s* occurs, but that neither situation is a subset of the other.

Each temporal relation corresponds to one or several German temporal markers. For instance, *overlaps* may be expressed by the entire range of simultaneity markers given in Table 5.6, except for *solange* (as long as) and *kaum dass* (no sooner than). Conversely, the majority of temporal markers can signal several temporal interval relations, as shown by, for instance, [Klenner 1991] and [Freksa 1992] for German temporal markers, and [Dorr and Gaasterland 1995] for English temporal connectives. These meanings of a

temporal marker are represented as a disjunction of Allen's basic relations. Take the connective *nachdem* (after) as in example (5.5a), which can express the following temporal relations:

$$\textit{after}(\textit{Sit}_m, \textit{Sit}_s) \vee \textit{meets-i}(\textit{Sit}_m, \textit{Sit}_s)$$

Während as in example (5.3a) allows for the following interpretation:

$$\begin{aligned} &\textit{equals}(\textit{Sit}_m, \textit{Sit}_s) \vee \textit{during}(\textit{Sit}_m, \textit{Sit}_s) \vee \textit{starts}(\textit{Sit}_m, \textit{Sit}_s) \vee \textit{finishes}(\textit{Sit}_m, \textit{Sit}_s) \\ &\vee \textit{overlaps-i}(\textit{Sit}_m, \textit{Sit}_s) \end{aligned}$$

In contrast, *solange* in example (5.3b) has only one reading:

$$\textit{equals}(\textit{Sit}_m, \textit{Sit}_s).$$

As the discussion has shown, Allen's framework is widely used in natural language processing, and in this thesis, I will also employ Allen's set of temporal relations for describing the relations signaled by a temporal discourse marker. However, some researchers have argued that this approach is not suitable for representing the meaning of temporal linguistic constructs, but the problems they address do not pertain to the research presented in this thesis.

[Freksa 1992] believes that Allen's relations are too specific and lead to two undesired effects: First, all discourse markers turn out to be extremely ambiguous. For instance, he identifies five readings for *after* in *X died after Y*, and eleven readings for *before* in *X was born before Y's death* using Allen's framework (see [Freksa 1992, p203]). Second, Allen's relations require a precise description of a temporal relationship, whereas in Freksa's view, natural language is by nature less specific and often leaves either start or end points of temporal intervals unknown. For instance, *sobald* (as soon as) only signals a correlation between the beginnings of two intervals, but remains implicit regarding the end points. Similarly, [Gagnon and Lapalme 1993] argue that Allen's approach is not well suited for natural language generation, because natural language expresses temporal concepts only approximately, whereas in Allen's account, they must be expressed with precision. To solve these problems, and in particular to address the issue of dealing with incomplete knowledge, [Freksa 1992] proposes semi-intervals, which indicate either start or end times of an interval, and conceptual neighbourhood relations as an alternative to the interval representation, and [Gagnon and Lapalme 1993] turn to Discourse Representation Theory (DRT) [Kamp 1981] to represent temporal relationships.

However, this criticism does not affect my choice. For once, Freksa's proposal is mainly motivated by cognitive adequacy, and by the need for reasoning with incomplete knowledge and for reducing the reasoning effort. This does not impair the present study of German discourse markers, because my major goal is descriptive adequacy. Further, coarse knowledge of a temporal relation and potential ambiguities of temporal discourse markers can

also be represented within Allen's framework by giving a disjunction of temporal interval relations. And finally, using Allen's framework makes my account compatible with the work on English temporal markers by, for instance, [Dorr and Gaasterland 1995] and [Hitzeman 1995].

Nevertheless, [Herweg 1991] suggests that some additions to Allen's framework are required. He observes that—despite the 13 relations—Allen's framework is not yet specific enough to account for all meaning differences encountered. Although it adequately captures the difference in meaning between, for instance, *solange* and *während*, which was not possible using the three-way classification of temporal relations given above, it cannot explain the use of temporal markers in the example (5.6) below. Consider two situations in an anterior relation (example 5.6a) and some variants:

(5.6)

- a. **Nachdem** / **Sobald** *die Sonne aufgegangen war, ging er (kurz darauf) baden.*
 After / As soon as the sun risen had, went he (shortly after) swimming.
 'After / As soon as the sun had risen, he went swimming (shortly after).'
- b. **?Nachdem** *die Sonne aufgegangen war, ging er baden. Vorher war die Sonne wieder untergegangen.*
 After the sun risen had, went he swimming. Earlier had the sun again set.
 'After the sun had risen, he went swimming. Earlier the sun had set again.'
- c. **Nachdem** *die Sonne aufgegangen war, ging er baden. Vorher schlief er aber noch.*
 After the sun risen had, went he swimming. Earlier slept he but still.
 'After the sun has been risen, he went swimming, but first, he took a nap.'
- d. **?Sobald** *die Sonne aufgegangen war, ging er baden. Vorher schlief er aber noch.*
 As soon as the sun risen had, went he swimming. Earlier slept he but still.
 '?As soon as the sun had risen, he went swimming, but first he took a nap.'
- e. **?Sobald** *die Sonne aufgegangen war, ging er eine Stunde später baden.*
 After the sun risen had, went he an hour later swimming.
 'After the sun had risen, he went swimming an hour later.'

In all five examples (5.6a-e), the situation in the main clause follows the situation in the subordinate clause. To be more precise, both situations are in an *after* relation, as the discourse markers *nachdem* and *sobald* in example (5.6a) suggest. Yet, the picture looks different when adding a third clause which reverses the state induced by the subordinate clause, as in example (5.6b). Now, using *nachdem* to indicate the temporal relation yields a

semantically ill-formed sentence. [Herweg 1991] argues that this is due to the fact that the situation denoted by the subordinate clause, which temporally precedes the main clause situation, does not hold anymore when the main clause event takes place. In contrast, examples (5.6c) and (5.6d) introduce a third event which does not interfere with the effect of the subordinate clause situation, but which is simply situated in between the two original situations. This poses no problem for *nachdem*, but does not allow for the use of *sobald*. Likewise, example (5.6e) is questionable: The time-span between the two events (*eine Stunde später*, one hour later) is too long for *sobald* to be a realization of the temporal relation. In short, Allen's *after* and *meets* relation cannot account for these more fine-grained differences in meaning.

To capture these phenomena, [Herweg 1991] introduces additional constraints on temporal relations describing the proximity and adjacency of situations. Informally, the *proximity* relation says that the state induced by a situation in the subordinate clause still has to hold when the main clause situation takes place. In other words, the 'proximate state' of Sit_s must have a point in common with Sit_m :

Zunächst einmal lassen sich zu einem Ereignis dessen Vor- und Nachzustände assoziieren. Diese sind als Mengen von Zeiten vor bzw. nach dem Ereignis definiert, die zu diesem proximal sind.⁵ [Herweg 1991, p65]

Der Komplementsatz der Konjunktion muß ein Ereignis mit proximalem Nachzustand bereitstellen, in den *nachdem* die Zeit [...] des Hauptsatzes einordnet.⁶ [Herweg 1991, p72]

Herweg defines *proximity* as holding between an event and its proximal time spans [Herweg 1991, p64]: $Prox(e,t)$ means that the time t is proximal to the event e . He distinguishes two proximity relations: $Prep(e,t)$ gives the proximal states preceding an event and $Perf(e,t)$ those that follow an event [Herweg 1991, p65]. My definition of proximity differs from Herweg's in that I assume a proximity relation holding between two situations Sit_1 and Sit_2 . Hence, a situation Sit_2 is proximal to a situation Sit_1 ($prox(Sit_1, Sit_2)$) if it is located either in the pre- or post-state of Sit_1 . These states are given by Herweg's $Prep(e,t)$ and $Perf(e,t)$ functions. Herweg discusses the proximity relation as holding between the events and states depicted in complement and main sentence, but naturally, it also applies to the states induced by situations expressed in the PP or a conjunctive clause. The proximity constraint is satisfied in example (5.6a): Here, $prox(Sit_s, Sit_m)$ is true. However, it is violated in (5.6b), and hence *nachdem* cannot be used. Yet, the proximity relation still cannot explain the ill-formedness of example (5.6e) where the main clause situation is proximal to the subordinate clause situation. [Schilder 1993, p46] therefore argues that an *immediacy* constraint (*imm*) is required, which is a more specific case of the proximity relation. It captures the idea of 'temporal adjacency' between two situations: Some temporal discourse markers only allow a very restricted time span in between two situations in a precedence relation, which is not the case in (5.6e). Therefore *sobald* cannot be used.

⁵English translation: First, pre- and post-state can be associated with events. These are defined as sets of time spans before or after the event to which they are proximal.

⁶English translation: The complement sentence of the conjunction must provide an event with a proximal post-state in which *nachdem* locates the time of the main clause.

The second relation introduced by [Herweg 1991] is that of *adjacency* (or *next* in Herweg's terminology), which holds if there is no other situation located between the two situations that are to be temporally related. This is part of the meaning of *sobald*:

Durch *sobald* wird e_2 ⁷ in eine besondere Relation der proximalen Nachzeitigkeit zu e_1 gesetzt: Zwischen e_1 und e_2 liegen keine weiteren Ereignisse, die in der Perspektive, die der Darstellung des Geschehens zugrunde liegt, gleiche oder höhere Relevanz einnehmen als e_1 und e_2 .⁸ [Herweg 1991, p78]

The constraint $next(Sit_s, Sit_m)$ is required by *sobald* but is not present in example (5.6d). In contrast, example (5.6c) is acceptable, because *nachdem* does not require two situations to be adjacent.⁹ We thus conclude that the more fine-grained meaning differences within the set of temporal markers signaling precedence can be captured by drawing on Herweg's relations in addition to Allen's interval relations (see also [Herweg 1990, Sinn 1991, Herweg 1991]). The 'revised meaning' of *nachdem* thus reads:

$$(after(Sit_m, Sit_s) \wedge prox(Sit_s, Sit_m)) \\ \vee meets-i(Sit_m, Sit_s)$$

Further, consider the difference in usage of *nachdem* and *seitdem* in the same context:

(5.7)

- a. **Nachdem** / **Seitdem** *er baden gewesen war, schien die Sonne.*
 After / Since he swimming been had, shone the sun.
 'After / Since he had been swimming, the sun had shone.'
- b. **Nachdem** *er baden gewesen war, schien die Sonne. Jetzt regnet es*
 After he swimming been had, shone the sun. Now rained it
aber.
 however.
 'After he had been swimming, the sun has shone. However, now it's raining.'
- c. **?Seitdem** *er baden gewesen war, schien die Sonne. Jetzt regnet es*
 Since he swimming been had, shone the sun. Now rained it
aber.
 however.
 '?Since he had been swimming, the sun has been shining. However, now it's raining.'

⁷Herwegs e_2 corresponds to my Sit_m , e_1 to Sit_s .

⁸English translation: By means of *sobald*, e_2 is placed in a special relation of proximal posteriority with respect to e_1 : No further events are situated in between e_1 and e_2 that have a similar or greater relevance than e_1 and e_2 in the perspective which underlies the presentation of events.

⁹Note that these differences cannot be accounted for by Freksa's conceptual neighbourhood relations, either.

According to [Allen 1984], subordinate and main clause situation are in an *after* relation. This again does not explain the difference between example (5.7a) and its variants. The additional clause in (5.7b) and (5.7c) suggests that the situation in the main clause does not extend to speaking time.¹⁰ Now, *seitdem* cannot be used anymore. A fourth constraint by Herweg [Herweg 1991] captures this phenomenon: *durativity* (*dur*):

Die Hauptsatz-Situation muß ein Zustand S_2 sein, und die durationalen Nebensätze legen die Mindestdauer von S_2 fest, indem sie eine Periode definieren, zu der S_2 kontinuierlich herrscht.¹¹ [Herweg 1991, p80]

Depending on the connective, different aspects of the period are specified: In the case of *seit* (since) the period extends from Sit_s to speaking time S, in the case of *solange* (as long as) from the beginning of Sit_s to the end of Sit_s , and in the case of *bis* (until), the beginning is undefined, and the end given by Sit_s . Thus, an adequate account of the semantics of *seitdem* in example (5.7c) would have to include the notion of durativity.

To sum up, I use a combination of Allen's 13 temporal interval relations and the *prox*, *imm*, *next* and *dur* constraints adopted from [Herweg 1991] to characterize the 'semantics' of German temporal markers, i.e. the exact nature of the temporal relation signaled by a connective.

5.3.2 Intentions

Temporal discourse markers are mainly *semantic* and relate events in the world, as compared to predominantly pragmatic markers, such as concessives (see [Knott and Mellish 1996, Sanders *et al.* 1992]). Therefore, communicative goals, or intentions, are only of minor importance; the major goal expressed is that of informing the reader about some subject matter. Yet, one can observe examples such as the following which cannot be explained in terms of the semantic relation alone:

(5.8)

- a. *Ich war todmüde. Kaum dass ich eingeschlafen war, klingelte das Telefon.*
 I was dead tired. No sooner than I fallen asleep had, rang the phone.
 'I was dead tired. No sooner than I had fallen asleep, the phone rang.'
- b. *Ich war todmüde. Nachdem ich eingeschlafen war, klingelte das Telefon.*
 I was dead tired. After I fallen asleep had, rang the phone.
 '?I was dead tired. After I had fallen asleep, the phone rang.'

¹⁰'Speaking time' is used in the sense of Reichenbach's Basic Tense Structure [Reichenbach 1947], which distinguishes between Event Time (E), Reference Time (R), and Speaking Time (S); see Section 5.3.7 below.

¹¹English translation: The main clause situation has to be a state S_2 , and the durational subordinate clauses determine the minimal duration of S_2 by defining a period in which S_2 holds continuously.

It is often noted that *kaum dass* (no sooner than) indicates the speaker's (negative) attitude towards the kind of temporal relation holding between two situations [Steube 1980, Buscha 1989]. In other words, in the speaker's judgement, the second situation follows too quickly, as in example (5.8a). In contrast, example (5.8b) does not reinforce this negative interpretation. Hence, some account of intentions or communicative goals is needed to capture the semantics of temporal discourse markers. Various sets of communicative goals have been suggested in the literature, see [Hovy 1988, Moore and Paris 1993]; for the time being I assume the following two goals taken from [Hovy 1988, p24]:

- affect the hearer's knowledge (inform)
- affect the hearer's opinion of topic (convince)

Utterance (5.8a) aims at affecting the hearer's opinion, while utterance (5.8b) simply informs about a state of affairs.

5.3.3 Focus and Presuppositions

The choice of a particular marker to express a temporal relation between two situations interacts with the focus structure of a text as in:

(5.9)

- a. **Bevor** *ihr Mann das Haus verließ, ging sie zur Arbeit.*
 Before her husband the house left, went she to work.
 'Before her husband left the house, she went to work.'
- b. **Nachdem** *sie zur Arbeit gegangen war, verließ ihr Mann das Haus.*
 After she to work gone had, left her husband the house.
 'After she had gone to work, her husband left the house.'

Alternatives (5.9a) and (5.9b) both express that the event of 'going to work' precedes the event of 'leaving the house'. They differ in that they focus on different situations: In (5.9a) the earlier situation is presented as major information, in (5.9b) the later one, assuming that the matrix sentence is more prominent. The importance of temporal focus has been discussed, among others, in [Maybury 1990] and [Hitzeman *et al.* 1995].

This phenomenon closely interacts with other discourse phenomena, for instance, given and new information, and—when placed in a larger discourse context—with presuppositions and their accommodation [Lascarides and Oberlander 1993]. Lascarides and Oberlander maintain that sentences containing temporal connectives are presuppositional. In short, the temporal clause introduces a situation, an eventuality in their terminology, that must be presupposed to have occurred: It must either already be introduced to the discourse, or must be added to it by accommodation. Only if this holds, can a situation act as temporal anchor of another situation.

5.3.4 Situation type

The general dichotomy between states and events is well known. Yet, [Sinn 1991] notes that it is not sufficient to describe constraints on the situation type with general categories such as state or event, as is often done (see [Steube 1980, Moens and Steedman 1988, Herweg 1991, Dorr and Gaasterland 1995]), since these cannot explain the following examples (examples (5.10b) and (5.10c) are reproduced from [Sinn 1991, p140]):

(5.10)

- a. **Nachdem** *der Tank leer gewesen war, ...*
 After the tank empty been had, ...
 ‘After the tank was empty, ...’
- b. **?Nachdem** *John Lennon ein alter Mann gewesen war, ...*
 After John Lennon an old man been had, ...
 ‘?After John Lennon had been an old man, ...’
- c. **?Nachdem** *John Lennon tot gewesen war, ...*
 After John Lennon dead been had, ...
 ‘?After John Lennon had been dead, ...’

Apparently, *nachdem* (after) can only be used if the state expressed in the subordinate clause has a right boundary, as with examples (5.10a) and (5.10b). This constraint already rules out example (5.10c), but is not sufficient to account for the ill-formedness of (5.10b). [Sinn 1991, p146] introduces the notion of *Nicht-egressive Rechtstemporarität* (non-egressive right-temporarity) to explain the difference: Both states in (5.10a) and (5.10b) have a right boundary, and hence a point in time where the state does not hold anymore. The difference between the two is, however, that the state in (5.10a) can be followed by its contrary state (not being empty with its maximal state of being full), while this is not true for the state in (5.10b): Not being old in the sense of being young can never hold again [Sinn 1991, p146], i.e. the state is not reversible. In Sinn’s terminology, (5.10a) denotes an *egressive* state, (5.10b) a *non-egressive* state.

Likewise, the following examples are odd (reproduced from [Sinn 1991, p140]):

(5.11)

- a. **?Bevor** *die Erde rund war, ...*
 Before the earth round was, ...
 ‘?Before the earth was round, ...’
- b. **?Bevor** *Maria jung war, ...*
 Before Mary young was, ...
 ‘?Before Mary was young, ...’

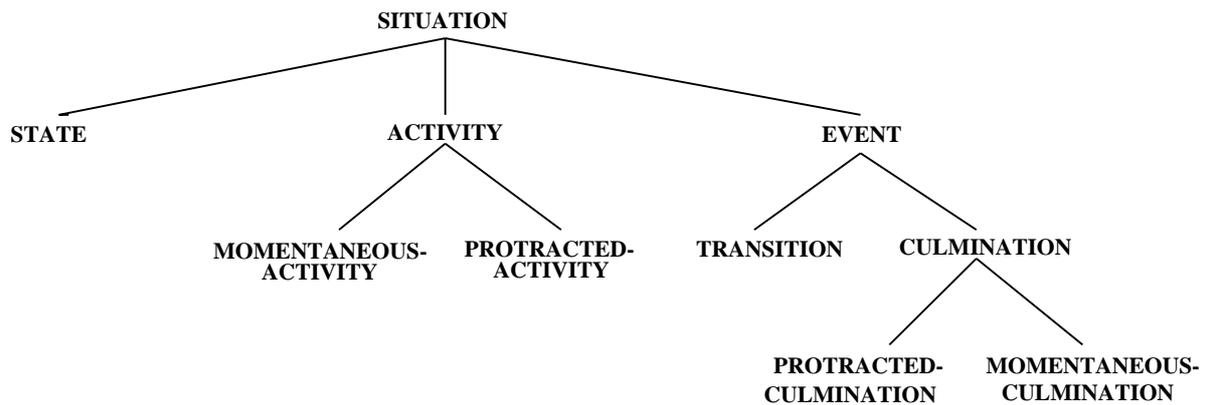


Figure 5.2: Situation types as defined in [Stede 1999, p51ff]

In example (5.11a) the state depicted in the subordinate clause does not have a left boundary, i.e. no beginning, and hence the connective *bevor* (before) cannot be used in this context. The state denoted by sentence (5.11b) has a left boundary, but as one cannot imagine the contrary state holding before this state occurs, it is ill-formed, too. Following Sinn, example (5.11a) depicts an *ingressive* state, and (5.11b) a *non-ingressive* state.

To capture these constraints on temporal marker usage, I distinguish four types of states in the discussion of temporal markers, which conflate the notions of boundedness and egressive/ingressive interpretation introduced by [Sinn 1991]: Reversible states that have a left and a right boundary (lr-bounded), those having only a left (l-bounded) or a right boundary (r-bounded), and those that are either unbounded or non-reversible (unbounded). Most German temporal markers are sensitive to the boundedness of situations, as Chapter 6 will show.

So far, the discussion has focussed on states. To represent the entire range of possible situation types I turn to [Stede 1999]. He proposes a hierarchy of SITUATIONS, shown in Figure 5.2. The hierarchy is a variant of the ontological categories proposed by [Vendler 1967] and developed further, *inter alia*, by [Bach 1986]. It distinguishes between three major types of situations: STATE, ACTIVITY and EVENT. [Stede 1999] sees STATES much in the same way as Bach sees them: Something is attributed to an object for some period of time, and the object is not perceived as ‘doing’ anything. *The bottle is empty* is true for the bottle without it doing anything about it. ACTIVITIES are quite similar to states, but there is always something ‘going on’, as in *The water was flowing toward the sea*. Stede distinguishes two subtypes here: PROTRACTED ACTIVITIES take place over an extended period of time, whereas MOMENTANEOUS ACTIVITIES occur in an instant. Adverbials denoting a point in time, such as *at noon* serve as linguistic tests.

Finally, EVENTS are occurrences that have a structure to them; in particular, their result, or their coming to an end is included in them: *to destroy a building*, *to write a book*. As their central feature [Stede 1999] takes them to always involve some change of state: the building loses its integrity, the book comes into existence, or gets finished. He takes any EVENT as

involving a state change, while the activity responsible for the change can *optionally* be present. A plain TRANSITION is necessarily momentaneous (*The room lit up*), whereas a transition-with-activity inherits its protracted/momentaneous feature from the embedded activity. [Stede 1999] calls these tripartite events CULMINATIONS.¹² They are composed of a pre-state (holding before the event commences), a post-state (holding when the event is over), and an activity that brings the transition about. In the discussion of individual temporal markers (next section), I use the distinctions introduced by [Stede 1999] and [Sinn 1991] to describe the interaction between marker usage and situation type.

5.3.5 Aktionsart

Temporal markers interact with the inherent features that characterize facets of the situation denoted by a verb, often referred to as *Aktionsart*. [Bußmann 1990] defines Aktionsart as:

verbale Kategorie, die sich auf die zeitliche Struktur oder inhaltliche Aspekte von Verbbedeutungen bezieht [...] Im Unterschied zu Aspekt wird Aktionsart als lexikalisch-semantic, in der Verbbedeutung “objektiv” verankerte Kategorie behandelt.¹³ [Bußmann 1990, p59ff]

In other words, the Aktionsart

represents a conventionally frozen or ‘canonical’ perspective, whereas aspectual information represents the actual and sometimes even personal perspective. [Ehrich 1987, p424]

For instance, a situation is an activity or a state, has a result or not, a causer or not, etc. (see among others [Bußmann 1990, Bach 1986, Moens and Steedman 1988, Bennett *et al.* 1990]). Aktionsart is not to be confused with aspect, which in my understanding refers to non-inherent grammatical features, for German in particular to the perfective/imperfective

¹²[Moens and Steedman 1988] also use this term, but they restrict it to momentaneous events. Unfortunately, the terminology used in the literature for these kinds of categories varies so much that a ‘standardization’ seems out of reach.

¹³English translation: Verbal category that relates to the temporal structure or the propositional aspects of verbal meaning. [...] As opposed to aspect, Aktionsart is defined as a lexico-semantic category which is part of the “objective” verbal meaning.

Note that the entry in the English version of Bußmann’s dictionary differs from the German definition, highlighting the German origin of this term:

Aktionsart (also manner of action) German term meaning ‘manner of action’; it is used by some linguists (especially German and Slavic) to denote the lexicalization of semantic distinctions in verbal meaning, as opposed to **aspect**, which is then used to denote the systematic grammaticalization of such distinctions. [Bußmann 1996, p14]

distinction (see next subsection).¹⁴

Two kinds of interdependencies between discourse marker usage and Aktionsart are generally acknowledged, see [Ehrich 1987, Buscha 1989, Bäuerle 1995, Dorr and Gaasterland 1995]. First, temporal markers often expect a particular Aktionsart with the verbs they connect, for instance, *während* (while) cannot be used with verbs that do not express a duration in the subordinate clause as in (5.12a), and *als* (as) is odd when used with verbs implying a result in the main clause (5.12b):

(5.12)

- a. **Während** *das Kabel schmolz / ?riss, war ich nicht im Raum.*
 While the cable melted / tore, was I not in the room.
 ‘While the cable melted / ?tore, I wasn’t in the room.’
- b. **Als** *das Kabel ?schmolz / riss, war ich nicht im Raum.*
 As the cable melted / tore, was I not in the room.
 ‘When the cable melted / tore, I wasn’t in the room.’

Second, temporal markers may shift the Aktionsart of a verb, for instance from a singular occurrence to an iterative reading, as *solange* (as long as) and *seitdem* (since) do in the following examples with *klopfen* (to knock):

- (5.13) **Solange** *es still war im Haus, klopfte Tom.*
 As long as it quiet was in the house, knocked Tom.
 ‘As long as it was quiet in the house, Tom knocked.’

- (5.14) **Seitdem** *Tom klopfte, ...*
 Since Tom knocked, ...
 ‘Since Tom knocked, ...’

There are many different approaches to describing Aktionsart, or the event type indicated by verb-inherent features. To represent Aktionsart constraints for German, I turn to [Bußmann 1990], who maintains that there are four major criteria in determining the Aktionsart: (a) whether a situation is dynamic or not, (b) the duration of a situation, (c) repetition and frequency, and (d) whether an agent is involved for not. Based on these distinctions, Bußmann [Bußmann 1990] defines the Aktionsarten for German: The major distinction in German is that between stative verbs (*wissen/to know*) and dynamic verbs. For the dynamic verbs, the basic dichotomy is that between durative verbs (*schlafen/to sleep*) on the one hand and non-duratives like iterative verbs (*flattern/to flap*) and semelfactive verbs (*klopfen/to knock*), on the other hand. Further, I distinguish between transformative verbs that involve a state change of some kind (*abkühlen/cool down*), resultative verbs that focus on the result of some activity, for instance *verbrennen/to burn up*, and finally,

¹⁴The terminology in linguistics is not very clear on this distinction: Different uses of the terms Aktionsart and aspect can be found, see in particular [Herweg 1991] and [Schilder 1993]. I follow the definitions given in [Bußmann 1990].

Bennett	Bussmann
-dynamic	stative
+dynamic,+atomic	semelfactive
+dynamic,-atomic	durative
+dynamic,+telic	transformative
	resultative
+dynamic,-telic	causative
	iterative

Table 5.7: Definition of Bussmann's Aktionsarten in terms of Bennett's dichotomies

causative verbs, for instance, *tränken/to water* as opposed to *trinken/to drink*. This is the set of features I employ in the analysis section for describing the Aktionsart constraints of temporal discourse markers.

For English verbs, similar classifications have been suggested, see for instance, [Moens and Steedman 1988] and [Bennett *et al.* 1990]. The latter is used by [Dorr and Gaasterland 1995] in their treatment of English temporal subordinate conjunctions. They suggest three major oppositions relating to (a) dynamicity (+/-dynamic), (b) extension of the situation (+/-atomic), and (c) telicity (+/-telic). The categories suggested by [Bußmann 1990] can be redefined in terms of Bennett's features (see Table 5.7), hence, her terminology can be applied to German and English verbs alike. Note that none of the approaches accounts for the boundedness of situations; this is a feature of the situation, and not of the verb denoting a situation.

5.3.6 Aspect

The reading of a temporal discourse marker interacts with the perspective a speaker adopts with respect to a situation:

(5.15)

- a. **Sobald** *es läutet, setzen sich die Kinder auf die Plätze.*
 As soon as it rings, sit themselves the children on the places.
 'As soon as the bell rings, the children go to their places.'
- b. **Sobald** *es geläutet hat, setzen sich die Kinder auf die Plätze.*
 As soon as it rung has, sit themselves the children on the places.
 'As soon as the bell has rung, the children go to their places.'

In example (5.15a), *sobald* is assigned a simultaneous reading, in (5.15b) it seems to suggest that the two situations are successive, since the situation in the subordinate clause is represented as being concluded. This is due to a difference in the *aspect*, i.e. of the

[...] verbale Kategorie, die sich auf die zeitliche Struktur oder andere inhaltl. Merkmale der Verbbedeutung bezieht, und in der Morphologie der einzelnen Sprachen grammatikalisiert ist.¹⁵ [Bußmann 1990, p103]

As opposed to English, and especially to Slavic languages, where aspect is grammaticalized morphologically, German has no elaborate aspect system. The basic dichotomy given by grammars is that of *imperfective* and *perfective*. An imperfective aspect gives expression to the internal perspective on an event, an event in progress, whereas the perfective gives an external perspective, and presents an event as temporally closed, as terminated:

(5.16)

- a. *Hans kam zurück.* ⇒ **Hans ist zurück.*
 Hans came back. ⇒ **Hans is back.*
 Hans came back. ⇒ **Hans is back.*
- b. *Hans ist zurückgekommen.* ⇒ *Hans ist zurück.*
 Hans has come back. ⇒ Hans is back.
 Hans has come back. ⇒ Hans is back.

It does not follow from example (5.16a) that Hans is really back; one only views the situation in progress without being concerned about the outcome. In contrast, one can conclude from example (5.16b) that Hans is back, hence it is resultative. In German, this aspectual distinction is grammaticalized by choosing a perfective (resultative) or simple tense, as the example illustrates. Aspect and verbal tense are not realized by different morphemes, but are jointly expressed by verb inflection. Further aspectual categories such as progressive and simple, which for instance play a major role in the English verb system, cannot be signaled by morphological features of the verb in German, but require a separate temporal adverb: A German equivalent to the progressive form *He is reading* is *Sie liest gerade* (She reads right now). The notion of aspect in German is far from clearcut: [Schilder 1997], for instance, argues that there is no such thing as aspect in German, and Herweg [Herweg 1991, Herweg 1991b] uses the term aspect to refer to the basic distinctions between state expressions and event-type expressions. For the present purposes, I adopt the definition of aspect as provided by [Bußmann 1990, p103], and use the terms imperfective and perfective to describe the two aspectual categories in German.

Aktionsart and aspect closely interact. Consider the example below where the anterior reading of *seitdem* (since) in (5.17b) (as opposed to the posterior reading in 5.17a) is due to the use of a perfective tense with a non-durative verb in the subordinate clause, which indicates that the activity has been concluded (example (5.17a) is taken from [Helbig and Buscha 1991, p465]):

(5.17)

¹⁵English translation: Verbal category that refers to the internal temporal structure or other content features of the verb meaning, and is grammaticalized in the morphology of individual languages.

- a. **Seitdem** *ich ihn kenne, ist er Nichtraucher.*
 Since I him know, is he non-smoker.
 ‘Since I know him, he is a non-smoker.’
- b. **Seitdem** *seine Frau gestorben ist, sehe ich ihn nur selten.*
 Since his wife died has, see I him only rarely.
 ‘Since his wife died, I have only rarely see him.’

5.3.7 Verbal tense

Temporal discourse markers are also selective with respect to the tense of the clauses they connect. Some markers can only be used with particular tenses, for instance, *als* (as, when, while) cannot occur with present tense in the subordinate clause, whereas *wenn* (when) in its temporal reading requires present tense in the subordinate clause; if used with past tense, it receives an adversative reading (example 5.18b):

(5.18)

- a. **Als** *er in Dresden war (*ist), traf (*trifft) er seine Freundin.*
 As he in Dresden was (*is), met (*meets) he his girlfriend.
 ‘As he was / is in Dresden, he met / meets his girlfriend.’
- b. **Wenn** *er in Dresden war / ist, traf / trifft er seine Freundin.*
 When he in Dresden was / is, met / meets he his girlfriend.
 ‘When he was / is in Dresden, he met / meets his girlfriend.’

Moreover, marker meaning, i.e. the temporal relation signaled, interacts with the tense structure of the sentence; particular readings are only possible with particular tenses:

(5.19)

- a. **Seitdem** *Manfred Masern hatte, ist er müde.*
 Since Manfred measles had, is he tired.
 ‘Since Manfred had measles, he is tired.’
- b. **Seitdem** *Manfred Masern hat, ist er müde.*
 Since Manfred measles has, is he tired.
 ‘Since Manfred has measles, he is tired.’

Using different tenses in subordinate and main clauses suggest an anterior reading of *seitdem* (example 5.19a), while when using the same tense in the both clauses, the situations are interpreted as holding simultaneously (5.19b).

Yet, tense sensitivity of temporal markers is in most cases not a matter of a particular grammatical tense form, but relates to the temporal structure of the underlying situations, and to how their temporal structures are related.¹⁶ For describing the temporal structure of a situation and its verbalization, I turn to Reichenbach's threefold distinction between Event Time, Reference Time, and Speaking Time (the Basic Tense Structure, BTS) [Reichenbach 1947]:

- **event time E:** the time of acting when the situation actually takes place;
- **reference time R:** the location of the reference point from which a given situation is viewed, with respect to which it is temporally located;
- **speaking time S:** the time at which the sentence is actually uttered by the speaker.

The basic idea now is that certain linear orderings of E,R, and S get grammaticalized into the six basic tenses. For instance, when E, R, and S are cotemporal, present tense (Präsens) is realized. A constellation where E and R are cotemporal and precede S gives rise to simple past (Präteritum). In Reichenbach's notation, a comma stands for 'is cotemporal', the underscore for 'precedes'. Thus, E,R,S is realized as simple present, and E,R_S as simple past. Any situation can now be situated on the time axis by the relation of the event time E to the speaking time S: If E,S, then the event takes place in the present; E_S indicates a past event, and S_E a future event.

Now, the constraints imposed by a temporal discourse marker on verb tense above all concern the underlying relation between E and S of both clauses: Choosing between *als* or *wenn* (see example 5.18 above) to express simultaneous situations in main (Sit_m) and subordinate clause (Sit_s) depends on whether the event times of both situations precede S ($E(Sit_m), E(Sit_s)_S$) or concur with S ($E(Sit_m), E(Sit_s), S$). In this approach, the grammatical tense eventually results from combining the E and S characteristics of the situation underlying both clauses, and the viewpoint adopted by the speaker (R) in presenting the situations, in other words, the aspectual category assumed [Bäuerle 1995, p162].

Originally, Reichenbach's BTS was developed to capture the temporal structure of single, punctiliar events. Since then, the approach has been extended in two ways: [Hornstein 1990] introduces CTS (Complex Tense Structure) to enable tense selection in clause complexes, and [Dorr and Gaasterland 1995] discuss how BTS can be applied to temporal intervals. Since tense selection is not my concern, only Dorr and Gaasterland's extensions are of importance. The main idea is that, as intervals can be described by their start and end time, which are time points, the event time of an interval can be described by the event time of its start point (s) and end point (f). Following [Dorr and Gaasterland 1995] I extend Reichenbach's notation to include E_s and E_f . These extensions are not relevant in the context of, for instance, the *after*-relation, as the intervals are strictly sequential. Yet, it is required for describing the event times of two situations in an *overlap*-relation, where it is

¹⁶See also [Bäuerle 1995, p160], who maintains that temporal markers display "eine Sensitivität für semantische Tempora [...], nicht für formal-morphologische Tempusformen" (a sensitivity for semantic tempora and not for formal-morphological tense), and demonstrates this for the conjunction *als*.

important to know that the end of one situation $E_f(Sit_1)$ occurs after the other situation has started, hence $E_s(Sit_2)-E_f(Sit_1)$, whereas the beginning of Sit_1 and the end of Sit_2 are irrelevant.

5.3.8 Ordering of relata

The syntactic units that realize each of the temporally related situations can occur in different orders with the same discourse markers. For instance, Sit_1 , *nachdem* Sit_2 (Sit_1 after Sit_2), or *Nachdem* Sit_2 , Sit_1 (After Sit_2 , Sit_1). To be precise, this only holds for subordinate clauses and prepositional phrases; the order of relata given a conjunctive and a coordinating conjunction is fixed, as these discourse markers have an anaphoric reference: The sentence hosting the discourse marker always comes second. Regarding subordinate conjunctions, [Schilder 1998, p58/9] distinguishes five possible orderings of subordinate clause and main clause in German temporal clause complexes.¹⁷ The four orderings relevant to the present study are:¹⁸

Postponed. The main clause occurs before the subordinate clause:

- (5.20) *Seidler selbst machte auf, nachdem ich geklingelt hatte.*
 Seidler himself opened, after I rang had.
 ‘Seidler opened in person after I had rang.’

Topicalised. A temporal adverb or a clause describing a salient situation is topicalised:

- (5.21) *Schon am Abend jenes ersten Tages, nachdem ich den*
 Already on the evening of the first day, after I the
Sonnenuntergang gefilmt hatte, spielten wir Pingpong.
 sunset filmed had, played we table tennis.
 ‘Already on the evening of the first day, after I had filmed the sunset, we played table tennis.’

Verb-first. The subordinate clause interjects the main clause between the verb and the objects or complements.

- (5.22) *Mazerath war im Laden und dekorierte, nachdem er das Geschirr*
 Mazerath was in the shop and decorated, after he the dishes
vom Mittagessen abgewaschen hatte, das Schaufenster.
 from lunch washed had, the shop window.
 ‘Mazerath was in the shop and decorated, after he had done the dishes from lunch, the shop window.’

Preposed. The subordinate clause succeeds the main clause:

¹⁷In fact, the list describes the possible orderings for all hypotactic clause complexes, regardless of semantic type, see [Helbig and Buscha 1991].

¹⁸I neglect the option **noun-first** as it does not occur in the technical corpus.

- (5.23) **Nachdem** *er in diesem Ort die Grundschule hinter sich gebracht*
 After he in this town the primary school completed
hatte, ging er zurück in die Großstadt zu seinem Vater.
 had, went he back in the city to his father.
 ‘After he had completed primary school in this town, he went back to his father in the city.’

Prepositional phrases can be either preposed, postponed or verb-first, whereas there is no choice for conjunctives: Here, the order of relata is always preposed, as the situation that provides the temporal anchor is given first.

[Wrobel 1994] now argues that not all orderings are equally likely for a discourse marker. She observes that the order of recounting events in texts corresponds to the order of occurrence in reality whenever possible (i.e. whenever there exist no constraints from focus structure, presuppositions, etc.), as in the following examples:

(5.24)

- a. **Nachdem** *ich das Buch ausgelesen habe, bin ich spazieren gegangen.*
 After I the book finished have, have I for a walk gone.
 ‘After I finished the book, I have gone for a walk.’
- b. *Ich habe das Buch ausgelesen, bevor ich spaziergegangen bin.*
 I have the book finished, before I gone for a walk have.
 ‘I finished the book before I have gone for a walk.’
- c. *Ich habe das Buch ausgelesen. Danach bin ich spaziergegangen.*
 I have the book finished. Then have I gone for a walk.
 ‘I have finished the book. Then, I have gone for a walk.’

The order that reflects the chronology of situations in reality (as in examples (5.24a-c)) is referred to as the ‘unmarked’ or ‘natural’ order, the other one as ‘marked’. *Nachdem* has the unmarked order subordinate clause–main clause (which corresponds to Schilder’s preposed), whereas the unmarked realization of *bevor*-clause complexes is main clause–subordinate clause (postposed). The other three possible orderings are always marked. [Wrobel 1994] further argues that psychological experiments have shown that the unmarked order is the most frequent in adult speech. This is in line with findings in the LIMAS corpus, where the sequence subordinate clause–main clause is more frequent with anterior markers such as *nachdem* (after), and the reverse order with posterior markers such as *bevor* (before). The order of clauses is a property of a discourse marker that will be described for each marker using Schilder’s five classes.

5.3.9 Position of discourse marker

Some discourse markers can occur at different positions in their host clause. Conjunctives and pronominal adverbs, in particular, can move rather freely in their host clause (example 5.25a is taken from the LIMAS corpus):

(5.25)

- a. **Danach** *ist er offenbar noch wiederholt in Athen gewesen.*
Thereafter has he obviously repeatedly in Athen been.
'After that, he has obviously been to Athens repeatedly.'
- b. *Er ist danach offenbar noch wiederholt in Athen gewesen.*
- c. *Er ist offenbar danach noch wiederholt in Athen gewesen.*
- d. *Und danach ist er offenbar noch wiederholt in Athen gewesen.*
- e. **Denn** *er ist offenbar noch wiederholt in Athen gewesen.*

Following [Eisenberg 1994, p411], the position varies between *Vorfeld* (front; examples 5.25a and 5.25d) and *Mittelfeld* (middle; 5.25b and 5.25c). Some markers occur in the *Vorvorfeld* (initial; 5.25e). Prepositions, subordinate conjunctions and coordinating conjunctions always occur in phrase- or clause-initial position in their host constituent.

5.3.10 Part of speech; syntactic structure

The most straightforward correlation is that between syntactic structure and the linguistic category, the part of speech, of the discourse marker. For clause complexes, and realizations within clauses, there exists a one-to-one mapping between syntactic structure and word class: paratactic clause complexes require a coordinating conjunction, hypotactic clause complexes a subordinate conjunction, and phrases a preposition. There is more variation regarding the cohesive means linking two sentences: Here, one finds prepositional phrases, conjunctives, and pronominal adverbs. In the analysis, I will give the part-of-speech for each discourse marker; the kind of syntactic structure can then be inferred.

5.3.11 Temporal quantifiers

With some markers, temporal adverbs can be used to further specify the temporal relation denoted by the discourse marker. [Quirk *et al.* 1972] refer to these lexical items as *temporal quantifiers*. By placing them in front of a connective, one can express the exact time span (*drei Stunden nachdem*, three hours after), a relative time span to be interpreted in a given context (*lange/kurz nachdem*, long/shortly after), or specify the temporal relation more precisely (*direkt nachdem*, immediately after). For each temporal discourse marker one therefore needs to know whether a quantifier is possible, and what type of quantifiers are permitted.

5.3.12 Style

Finally, there is the issue of style, which, however, only plays a minor role in the context of temporal markers. The major variation is that between neutral and concise style, reflected

in the choice of a conjunction vs. a preposition. Examples are *bevor* vs. *vor* (before vs. before (P)) and *obwohl* vs. *trotz* (although vs. despite). Prepositions make it possible to use a more concise nominal style, whereas conjunctions require a more elaborate verbal style [Weinrich 1993, p752]. Further variations reported in the literature are those between archaic and neutral (*da* vs. *als* (as)) and formal and neutral (*ehe* vs. *bevor* (before)).

Chapter 6

Comprehensive analysis of German temporal discourse markers

The goal of this chapter is to arrive at a comprehensive description of meaning and usage conditions of German temporal discourse markers along the dimensions proposed in Chapter 5. Temporal discourse markers will be analysed one by one to determine their paradigmatic and syntagmatic conditions of usage. For each temporal marker, a list of features, characterising its meaning and its interaction with the linguistic context, will be given. The analysis of German temporal markers presented in this chapter is not yet committed to any particular linguistic framework.

The chapter starts with a discussion of the markers signaling an anterior relation (Sections 6.1 to 6.4), followed by an analysis of posterior temporal markers (Sections 6.5 to 6.7). The chapter concludes with the description of markers of simultaneity (Sections 6.8 to 6.11).

6.1 *Nachdem*, *nach* and *danach*

The subordinating conjunction *nachdem* (after), its prepositional counterpart *nach* (after) and the corresponding conjunctive adverb *danach* (after that) are usually regarded as the ‘prototypical’ anterior markers.¹ All three discourse markers signal that the situation expressed in the subordinate clause, the PP or the first sentence (*Sit_s*) precedes the event in the main clause or the second sentence (*Sit_m*), without being specific about the temporal distance between the situations denoted by the clauses (as *sobald* and *kaum dass* are), or referring to speaking time (as *seitdem* does):

¹Frequency counts in the PUBLIC corpus using the COSMAS tool support this view: I counted 107052 occurrences of *nachdem* (after), 13435 occurrences of *sobald* (as soon as), 19680 occurrences of *seitdem* (since) (numbers acquired on Aug. 23rd, 2001).

(6.1)

- a. **Nachdem** *die Ampel grün gewesen war, leuchtete nun das rote*
 After the traffic lights green been had, shines then the red
Ampelmännchen.
 traffic light man.
 ‘After the traffic lights had been green, then the red light is on.’
- b. **Nachdem** *die Ampel grün war, fuhren die Autos.*
 After the traffic lights green were, drove the cars.
 ‘After the traffic lights were green, the cars drove.’

6.1.1 Nachdem

The standard reading of *nachdem* is illustrated in (6.1a): Sit_s is completed before the beginning of Sit_m , a strict precedence relation holds between the two situations. *Nachdem* has a second reading, given in (6.1b). Here, main clause and subordinate clause situations overlap partially, as Sit_s , which starts first, is not finished by the time Sit_m begins. Still, [Herweg 1991, Klenner 1991] and others claim that one can assign a precedence interpretation to this constellation, too: Given a partial overlap of situations, the precedence relation holds between the beginning of Sit_s (denoted by $ingr(Sit_s)$) and the entire main clause event (Sit_m). This interpretation of *nachdem* is referred to as the *ingressive* or *overlap* reading, and the precedence relation denoted holds between $ingr(Sit_s)$ and Sit_m ; the strictly anterior interpretation is referred to as *resultative* or *precedence* reading [Herweg 1991].

Figure 6.1 illustrates the discussion so far. It shows the position of Sit_m , Sit_s , and the post-state of Sit_s on the time axis, and how they relate to each other. The first row illustrates the precedence and overlap readings of *nachdem* for a Sit_m that is an interval, as in examples (6.1a) and (6.1b) above. Intervals are denoted by long grey boxes in the figure. The pre- and post-states of situations are depicted (as boxes with dotted lines) if they are relevant to the interpretation of an example; in Figure 6.1, the post-state of Sit_s is given. The second row shows the precedence and overlap reading of *nachdem* for punctiliar Sit_m s (points in time are denoted by small grey boxes). Time is assumed to increase from left to right, i.e. if a situation appears to the left of another situation, then it precedes that situation. For instance, in Figure 6.1, second column, Sit_s precedes Sit_m on the time axis. The third column, headed “overlap reading”, illustrates the ingressive re-interpretation of two situations in an overlap relation: The precedence relation now holds between the beginning of Sit_s ($ingr(Sit_s)$) and the entire main clause event (Sit_m).

To return to the example: In example (6.1a) Sit_m is located in the post-state of Sit_s (i.e. Sit_s does not hold anymore), in example (6.1b) Sit_m is located within the state denoted by Sit_s , which is brought about by an event (here, *the lights turning green*). Note that the preposition *nach* always signals temporal succession, and the ingressive reading is not available.

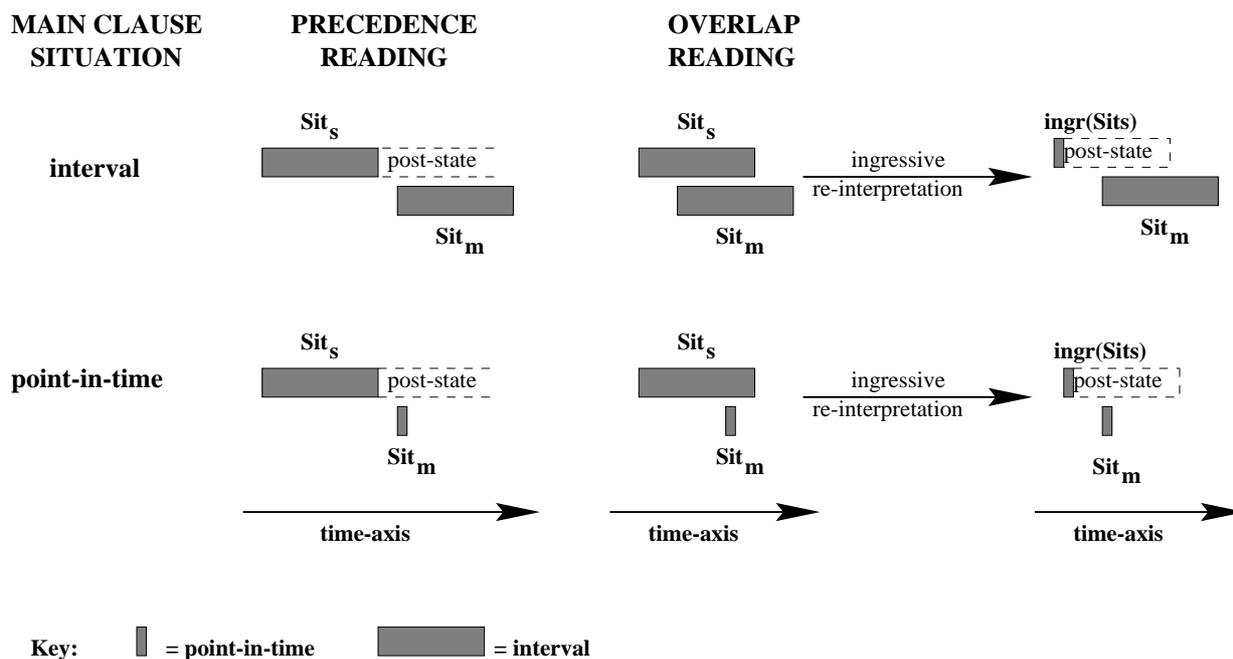


Figure 6.1: Schematic representation of precedence and overlap reading (involving ingressive re-interpretation) of *nachdem*

Precedence reading. In this reading, *nachdem* signals a strict precedence relation between situations ($after(Sit_m, Sit_s)$): Two situations follow each other with (possibly) some time span between the end of the subordinate clause situation and the main clause situation. However, [Herweg 1991, p72] argues that *nachdem* does not locate Sit_m in an unlimited time span after the completion of Sit_s :

(6.2)

- a. **?Nachdem** *die Sonne aufgegangen war, ging er baden. Vorher war die Sonne wieder untergegangen.*
 After the sun risen had, went he swimming. Earlier had the sun again set.
 ‘After the sun had risen, he went swimming. Earlier the sun had set again.’
- b. **Nachdem** *die Sonne aufgegangen war, ging er baden. Vorher schlief er aber noch.*
 After the sun risen had, went he swimming. Earlier slept he but still.
 ‘?After the sun had risen, he went swimming, but first, he took a nap.’

In both examples, a third event is located between the two situations related by *nachdem*. But only example (6.2a) is questionable, while example (6.2b) is acceptable. The difference between (6.2a) and (6.2b) is that in example (6.2a), the state resulting from the subordinate

clause situation (the post-state of Sit_s in which Sit_m is situated, compare Figure 6.1) does not hold anymore by the time the main clause event occurs (the event in the second sentence reverses the state triggered by Sit_s), while in (6.2b) it still holds. Herweg in [Herweg 1991, Herweg 1991b] claims that in this reading, *nachdem* locates the main clause situation within the post-state induced by the subordinate clause, hence the potentially bounded consequent state resulting from Sit_s must hold while Sit_m occurs. This is only true for the situations denoted in example (6.2b). Herweg's *proximity* relation captures this constraint on the use of *nachdem* (see Section 5.3); in my terminology, $prox(Sit_s, Sit_m)$ has to hold for *nachdem* to be available.

A special case of precedence relation holds when the intermediary time span is zero, that is, when Sit_s and Sit_m meet at one point in time. When using *nachdem* to convey this meaning, an additional temporal adverb such as *direkt* (immediately) has to be used:

- (6.3) **Direkt nachdem** *die Ampel rot geworden war, kam es zu einem Auffahrunfall.*
 Immediately after the traffic lights red turned had, happened a collision.
 'Immediately after the traffic lights had turned red, a collision happened.'

The examples so far show that *nachdem* can be used with different types of situations in subordinate and main clause. The only constraint on the subordinate clause situation is that it can be given a resultative interpretation, which is only available with situations that can have a right boundary (an inherent end), see for instance [Steube 1980, Herweg 1991]. Yet, this explanation falls short of accounting for the following examples ((6.4a) and (6.4c) are reproduced from [Sinn 1991, p140]):

- (6.4)
- a. **?Nachdem** *John Lennon tot gewesen war, ...*
 After John Lennon dead been had, ...
 '?After John Lennon had been dead, ...'
 - b. **Nachdem** *der Tank leer gewesen war, ...*
 After the tank empty been had, ...
 'After the tank was empty, ...'
 - c. **?Nachdem** *John Lennon ein alter Mann gewesen war, ...*
 After John Lennon an old man been had, ...
 '?After John Lennon had been an old man, ...'
 - d. **?Nachdem** *Tom Suse gekannt hatte, ...*
 After Tom Suse known had, ...
 'After Tom had got to know Suse, ...'

Example (6.4a) is not acceptable, because being dead has no end: this state is irreversible. In contrast, the states denoted in sentences (6.4b) and (6.4c) both have an ending (the tank

not being empty any more, because someone is filling it; someone not being old anymore, because he has died), yet only sentence (6.4b) is well-formed. Section 5.3 introduced the notion of *egressive* and *non-egressive* temporality. Following [Sinn 1991, p150], *nachdem* requires an *egressive* state, as in example (6.4b), where the state in the subordinate clause can be followed by its contrary state (not being empty with its maximal state of being full), while this is not true for the state in (6.4c): Not being old in the sense of being young can never hold again (see [Sinn 1991, p146]). Likewise, example (6.4d) is odd, because the state of knowing someone cannot be undone.

These constraints apply to the subordinate clause situation. The main clause situation is restricted in two ways: First, if Sit_m extends over some time span, it must have a beginning (be ingressive, see [Sinn 1991] and discussion below); otherwise it cannot be positioned after Sit_s . In examples (6.5a) and (6.5b), the main clause situations do not have a beginning that can be located after the completion of Sit_s (example (6.5b) is reproduced from [Steube 1980]):

(6.5)

- a. **?Nachdem** *die Ampel grün geworden war, war die Erde rund.*
 After the traffic lights green turned had, was the earth round.
 ‘?After the traffic lights had turned green, the earth was round.’
- b. **?Nachdem** *sie die Prüfung abgelegt hatte, sprach sie perfekt Englisch.*
 After she the exam taken had, spoke she perfect English.
 ‘?After she had taken the exam, she spoke English fluently.’

Second, *nachdem* can only be used with main clause situations that occur no more than once; with habitual situations, *wenn* has to be used [Buscha 1989, p84] (examples (6.6a) and (6.6b) are reproduced from [Buscha 1989, p84]):

(6.6)

- a. **Wenn** *er gegessen hat, macht er immer / ?diesmal einen Spaziergang.*
 When he eaten has, makes he always / ?this time a walk.
 ‘When he has eaten, he always / ?this time goes for a walk.’
- b. **Nachdem** *er gegessen hatte, setzte er sich ?immer / diesmal sofort wieder an seinen Schreibtisch.*
 After he eaten had, sat he himself ?always / this time right again at his desk.
 ‘After he had eaten, he ?always / this time went right back to his desk.’

As for the discourse context, *nachdem*, *nach* and *danach* require that the content of the subordinate clause is presupposed. Note that this requirement holds for all temporal connectives (see also [Oversteegen 1993]): Since Sit_s serves as temporal ‘anchor’ for Sit_m , i.e. the main clause situation is located relative to the subordinate clause situation, knowledge of its time of occurrence has to be presupposed.

Nachdem can occur with any Aktionsart in the main clause; this is in line with the findings in the research literature. In contrast to [Helbig and Buscha 1991, Herweg 1991b] and [Steube 1980], however, I do not restrict the Aktionsart in the subordinate clause, either. From my analyses and substitution tests, I conclude that it is sufficient to require that all non-resultative situations (such as stative or durative situations) have to be presented as complete (as being limited, see also [Klenner 1991, Steube 1980]). This can be achieved by using a perfective aspect (regardless of the Aktionsart of the verb), and thus a resultative tense in the subordinate clause, as this presents a situation as having a consequent state. Naturally, this constraint applies only to situations which have a duration, and that have a right boundary and are egressive in Sinn's sense; see also [Steube 1980, Klenner 1991, Herweg 1991]. Punctiliar events have no extension in time and are by nature 'completed'. Consider the following examples with a stative verb in the subordinate clause:

(6.7)

- a. **Nachdem** *die Ampel grün gewesen war, war die Straße wie leergefegt.*
 After the traffic lights green been had, was the street deserted.
 'After the traffic lights had been green, the street was deserted.'
- b. **Nachdem** *die Ampel grün war, sind alle Autos gefahren.*
 After the traffic lights green were, have all cars driven.
 'After the traffic light were green, all cars have been driving.'

Sentence (6.7a) uses a perfective (which gives a resultative tense) in the subordinate clause, thereby expressing that Sit_s has been completed, that is, the state 'lights are green' no longer holds. Sit_m is now located with respect to the duration of Sit_s . This gives the anterior reading of *nachdem*. On the other hand, sentence (6.7b) expressing a state with an imperfective gives the ingressive reading; it implies that with the beginning of the state 'lights are green', the action in the main clause commences (see overlap reading of *nachdem*, and Figure 6.1).

The perfective aspect in the subordinate clause leaves no choice for the main clause aspect: Due to the constraints on the combination of tenses in anterior clause complexes (see [Helbig and Buscha 1991, p159]), an imperfective has to be used in the main clause. Rules for legal complex tenses in this context are (cf. [Buscha 1989, p83]): The tense of the subordinate clause must be different from the one in the main clause (*consecutio temporum*), reflecting the fact that the event time of the subordinate clause situation precedes the event time of the main clause situation. In other words, given a perfective in the subordinate clause, possible tense combinations are (S denotes the speaking time):²

	Sit_s	Sit_m
$E(Sit_m) < S$	Plusquamperfekt	Präteritum
$S \leq E(Sit_m)$	Perfekt	Präsens/Futur

²The following notational conventions hold: < indicates precedence, = simultaneity (corresponding to Reichenbach's underscore and comma). The corresponding English tenses are: Past perfect, simple past (top row), present perfect, present (bottom row).

Hence, the following verbal tenses are possible for the precedence reading (example (6.8a) is taken from LIMAS, (6.8b) from PUBLIC):

(6.8)

- a. **Nachdem** *sie ihre Fingerspitzen abgetupft hatte, zündete sie eine Zigarette an.*
 After she her finger tips dabbed had, lit she a cigarette.

‘After she had dabbed her finger tips, she lit a cigarette.’

- b. **Nachdem** *man das Frontschutzblech abgenommen hat, drückt man mit der linken Hand leicht auf die Tastatur [...]*
 After one the front mudguard removed has, presses one with the left hand lightly on the keyboard [...]

‘After one has removed the front mud guard, one presses the keyboard lightly with the left hand [...].’

Temporal adverbs can be used with *nachdem* to specify the length of the intermediary time span (see above), for instance, *3 Stunden nachdem* (three hours after), *lange / kurz nachdem* (long / shortly after), *direkt nachdem* (immediately after).

Finally, [Steube 1980, p39] posits two further constraints on the subordinate clause introduced by *nachdem*: First, the subordinate clause cannot be hypothetical (example (6.9a)), and second, it cannot be negated, as in (6.9b). The reason is, according to Steube, that only the completion of a ‘real’ situation can serve as a temporal anchor for another situation. Further, [Herweg 1991b, p157] argues that negation results in a re-interpretation of an event as a state, which would make a precedence interpretation impossible (see 6.9b).

(6.9)

- a. **?Nachdem** *die Ampel grün werden würde, würden die Autos fahren.*
 After the traffic lights green turn would, would the cars drives.

‘?After the traffic lights would turn green, the cars would drive.’

- b. **?Nachdem** *die Ampel nicht grün geworden ist, fahren die Autos.*
 After the traffic lights not green turned has, drive the cars.

‘?After the traffic lights haven’t turned green, the cars drive.’

With respect to the ordering of subordinate and main clause, [Wrobel 1994] argues that the ordering reflecting the order of temporal occurrence in the world is the ‘unmarked’ case for *nachdem* sentences (preposed), whereas presenting the main clause first is a deviation from the expected (postponed), and is as such marked. This is in line with my observations from the LIMAS corpus: The sequence subordinate clause–main clause is more frequent. Still, since both orderings are legal, I do not posit any constraints on the ordering, but only name the preference. In addition, topicalized and verb-first positions are legal. The

discourse marker itself always occurs in clause-initial position, and is neutral with respect to stylistic preferences.

To sum up, *nachdem* signals a precedence relation if the following semantic, contextual and syntactic properties are given. The conditions listed in the table are necessary ones for *nachdem* in this particular reading:

nachdem (precedence)	
Temporal relation:	<i>after</i> (Sit_m, Sit_s) and <i>prox</i> (Sit_s, Sit_m), or <i>meets-i</i> (Sit_m, Sit_s)
Conditions of use:	<i>Sit_s</i> is presupposed <i>Sit_s</i> is r-bounded or lr-bounded (egressive) <i>Sit_m</i> is l-bounded or lr-bounded (ingressive) clause denoting <i>Sit_s</i> has a perfective aspect clause denoting <i>Sit_m</i> has an imperfective aspect tense sequence; $E(Sit_s) < E(Sit_m)$ where $E(Sit_s) \leq S$ hypotactic clause complex, subordinate conjunction preferred ordering is preposed discourse marker takes front position and can be modified clause denoting <i>Sit_s</i> is positive and not hypothetical

Overlap reading. The overlap reading has been identified as the second interpretation of *nachdem*. The main difference is that the situation in the subordinate clause does not have to be completed by the time the main clause situation begins. [Schilder 1993] argues that given two states conjoined by *nachdem*, the standard reading is that the two situations are co-extensive for some time span. Consider the following examples:

(6.10)

- a. **Nachdem** *der Tank leer war, war der Motor still.*
After the tank empty was, was the engine quiet.
‘After the tank was empty, the engine was quiet.’
- b. **Nachdem** *der Tank leer war, ging der Motor aus.*
After the tank empty was, turned the engine off.
‘After the tank was empty, the engine stopped.’

Here, the two situations overlap; the important constraint is that the beginning of *Sit_m* succeeds the beginning of *Sit_s* and precedes the end point of *Sit_s*, whereas the temporal relation of the end points of *Sit_s* and *Sit_m* is not further specified. They can either end at the same time, the situation in the subordinate clause can end before the main clause situation, or extend beyond it (in Allen’s terms: *finishes*, *overlaps* and *during*). As mentioned above, *Sit_s* undergoes an ingressive re-interpretation: Of interest is not the situation as a whole, but its beginning, which provides the temporal ‘anchor’ for *Sit_m*. The precedence relation now holds between the beginning of *Sit_s* (*ingr*(*Sit_s*)) and *Sit_m* (see Figure 6.1 above). The subordinate clause in example (6.10a) can be rewritten as

Nachdem der Tank leer geworden war (After the tank had become empty), thus establishing a precedence relation between the transition denoted by the subordinate clause and the state verbalized in the main clause.

Note that the situation type in the main clause restricts the set of possible readings: Only a durative situation in the main clause as in (6.10a) allows for all three readings (*finishes, overlaps, and during*); with a punctiliar situation (6.10b), Sit_m cannot extend beyond Sit_s , hence an overlap reading is not possible.

As with the precedence reading, additional constraints apply to the situation in the subordinate clause. However, in opposition to the precedence reading, these do not concern the ending (right boundary) but the beginning of the situation (left boundary). *Nachdem* can only signal an overlap between situations if the subordinate clause situation can undergo an ingressive re-interpretation. This rules out all punctiliar situations, which are by definition restricted to the ‘standard’ precedence reading, since their start and end points are the same, and those states which are not ingressive (see [Sinn 1991]). Ingressive left-bounded states are—in analogy to egressive ones—those states that can have their antonym state holding before their beginning. Consequently, non-ingressive ones do not have a preceding contrary state. Here are some examples to illustrate this point (reproduced from [Herweg 1991b, p158]):

(6.11)

- a. **?Nachdem** *Peter sich in seinen Sessel setzte, griff er nach der Zeitung.*
 After Peter himself in his armchair sat, reached he for the newspaper.
 ‘?After Peter sat down in his armchair, he reached for the newspaper.’
- b. **Nachdem** *Peter in seinen Sessel saß, griff er nach der Zeitung.*
 After Peter in his armchair sat, reached he for the newspaper.
 ‘After Peter sat in his armchair, he reached for the newspaper.’
- c. **Nachdem** *Peter sich in seinen Sessel gesetzt hatte, griff er nach der Zeitung.*
 After Peter himself in his armchair sat had, reached he for the newspaper.
 ‘After Peter had sat down in his armchair, he reached for the newspaper.’
- d. **?Nachdem** *Peter jung war, spielte er schon wie ein Virtuose Klavier.*
 After Peter young was, played he already like a virtuoso the piano.
 ‘?After Peter was young, he already played the piano like a virtuoso.’

The situation Sit_s in sentence (6.11a) cannot be interpreted ingressively, since it is punctiliar. The situation in (6.11b)³ allows for such an interpretation: The situation that serves

³Note that in contrast to the German original, its English translation is ambiguous as it is not clear whether Peter is still sitting or not.

as temporal locator is the ingression of the state ‘sitting’, i.e. the event of ‘sitting down’, which has as its consequential state the state ‘sitting’. In sentence (6.11c), this event is verbalized, yielding the precedence reading of *nachdem* (see above). Yet, not all states can be interpreted ingressively, as example (6.11d) shows, where the contrary state of being young does not hold before ‘being young’, hence *nachdem* cannot be selected (see [Herweg 1991b, p158]).

Regarding Aktionsart constraints for the overlap interpretation of *nachdem*, the discussion so far can be summarized as follows: *Sit_s* can be realized by stative verbs (as long as the underlying states are ingressive, i.e. left-bounded) or resultatives. No duratives are allowed in the subordinate clause, nor are transformatives. Only those situations that have an extension in time and a consequent state can occur in an overlap reading. Hence, the stative in example (6.12a)⁴ and the resultative in (6.11b) yield well-formed sentences, whereas examples (6.12b) (taken from [Steube 1980, p39]) and (6.12c) cannot express an overlap reading because of the durative and transformative verbs that realize *Sit_s*:

(6.12)

- a. **Nachdem** *die Ampel grün war, fuhren die Autos.*
 After the traffic lights green were, drove the cars.
 ‘After the traffic lights had changed to green, the cars drove.’
- b. **?Nachdem** *wir darüber nachdenken, ...*
 After we about it think, ...
 ‘?After we think about it, ...’
- c. **?Nachdem** *ich in Berlin ankam, ging ich zu Kiepert.*
 After I in Berlin arrived, went I to Kiepert.
 ‘?After I arrived in Berlin, I went to Kiepert.’

If a transformative or semelfactive Aktionsart in the main clause co-occurs with a stative in the subordinate clause, an overlap reading is only possible if *Sit_m* is interpreted as iterative. This is somewhat odd in example (6.13a) below. To avoid an iterative re-interpretation of *Sit_m*, the ingression of the state has to be verbalized using a transformative verb as in example (6.13b). However, this now gives a precedence reading of *nachdem* when used with a perfective aspect:

(6.13)

- a. **?Nachdem** *ich in Berlin bin, gehe ich zu Kiepert.*
 After I in Berlin am, go I to Kiepert.
 ‘?After I am in Berlin, I go to Kiepert.’
- b. **Nachdem** *ich in Berlin angekommen bin, gehe ich zu Kiepert.*
 After I in Berlin arrived have, go I to Kiepert.
 ‘After I have arrived in Berlin, I go to Kiepert.’

⁴The German verbal phrase *war grün* is translated as *had changed to green* to ensure a resultative reading in the English text, using “be”, as in German, does not have this effect.

The examples in this section suggest that the overlap reading is realized by an imperfective aspect in the subordinate clause: The situation has to be presented as open in order to allow for another situation to co-exist. Hence, in contrast to the precedence reading, non-egressive states in *Sit_s* can be used with this reading; here, non-ingressive states are ruled out, see above (example (6.14) is taken from [Sinn 1991, p142]):

(6.14)

- a. **Nachdem** *John Lennon tot war, ...*
 After John Lennon dead was, ...
 ‘After John Lennon was dead, ...’
- b. **?Nachdem** *John Lennon tot gewesen war, ...*
 After John Lennon dead been had, ...
 ‘?After John Lennon had been dead, ...’

Since two situations are presented as overlapping, applying the tense constraints for anterior relations would be misleading; instead, grammatical tenses in both clauses are usually the same, given that the event times are partially overlapping (example (6.15) is taken from the ZEIT corpus):

- (6.15) **Nachdem** *die Klöckner-Werke wieder rote Zahlen schreiben, muß der*
 After the Klöckner-Werke again are in the red, must the
Sanierer gehen.
 new chairman of the board go.
 ‘After the Klöckner-Werke are again in the red, the new chairman of the board must go.’

The use of temporal quantifiers is possible, too, but they differ in their scope from their use in a precedence reading: The temporal interval further specified is that between the beginning of *Sit_s* and the beginning of *Sit_m*, not between the end of *Sit_s* and the beginning of *Sit_m*:

- (6.16) **Kurz nachdem** *John Lennon tot war, gab es einen Ansturm auf seine*
 Shortly after John Lennon dead was, was there a run on his
Platten.
 records.
 ‘Shortly after John Lennon was dead, there was a run on this records.’

As for ordering, position of marker and style, precedence and overlap readings of *nachdem* correspond.

To sum up, the overlap reading of *nachdem* is given if the following semantic, contextual and syntactic conditions of use hold:

nachdem (overlap)	
Temporal relation:	<i>finishes</i> (Sit_m, Sit_s) or <i>overlaps</i> (Sit_m, Sit_s) or <i>during</i> (Sit_m, Sit_s) in terms of precedence: <i>after</i> ($Sit_m, ingr(Sit_s)$) and <i>prox</i> ($Sit_s, ingr(Sit_m)$), or <i>meets-i</i> ($Sit_m, ingr(Sit_s)$)
Conditions of use:	Sit_s is presupposed Sit_s is l-bounded or lr-bounded (ingressive) verb denoting Sit_s is stative/resultative clause denoting Sit_s has an imperfective aspect same tense; $E(Sit_s) = E(Sit_m)$ where $E(Sit_s) \leq S$ and $E(Sit_m) \leq S$ hypotactic clause complex, subordinate conjunction preferred ordering is preposed discourse marker takes front position and can be modified clause denoting Sit_s is positive and not hypothetical

6.1.2 Nach

Nach (after) is the prepositional counterpart of *nachdem*. If two situations are expressed by a hypotactic structure, a subordinating conjunction is required; yet, when a deverbal realization of the situation is possible (e.g. *treffen/das Treffen*; to meet/the meeting), the temporal ‘anchor’ is quite often realized in a prepositional phrase:

(6.17)

- a. **Nach** *Ablauf der Toastzeit schaltet das Gerät automatisch ab.*
After passing of the toasting time switches the device automatically off.
‘After the end of the toasting time, the device switches of automatically.’
- b. **Nachdem** *die Toastzeit abgelaufen ist, schaltet das Gerät automatisch ab.*
After the toasting time passed has, switches the device automatically off.
‘After the toasting time has run out, the device switches of automatically.’

Note that *nach* always has a precedence interpretation, since the prepositional phrase can only denote situations that are completed. Situation type constraints are the same as for *nachdem*. Obviously, tense and aspect constraints are not relevant; neither are Aktionsart constraints on the PP. Yet, deverbalizations used to express Sit_s in my corpora are mostly derived from semelfactive, iterative, transformative and resultative verbs, as these can be easily reduced to a point in time. The temporal quantifiers can be used with *nach* in the same way as with *nachdem*. *Nach* is preferred over *nachdem* for stylistic reasons: Only *nach* makes a concise verbalization of events possible, which is relevant if brevity is a major concern.

nach (temporal)	
Temporal relation:	<i>after</i> (<i>Sit_m</i> , <i>Sit_s</i>) and <i>prox</i> (<i>Sit_s</i> , <i>Sit_m</i>), or <i>meets-i</i> (<i>Sit_m</i> , <i>Sit_s</i>)
Conditions of use:	<i>Sit_s</i> is presupposed <i>Sit_s</i> is r-bounded or lr-bounded <i>Sit_m</i> is l-bounded or lr-bounded deverbalization possible realization within a clause (PP), preposition discourse marker takes front position and can be modified concise style

6.1.3 Danach, dann, daraufhin

Danach (after that) is the corresponding pronominal adverb; *dann* (then) and *daraufhin* (thereafter) are conjunctive equivalents (example (6.18) is taken from the technical corpus):⁵

(6.18)

- a. ... *Anschlußleitung durchtrennen. Danach das Gerät einer*
... cable cut. After that the device a
ordnungsgemäßen Entsorgung zuführen.
according to the rules waste disposal feed.
... Cut the cable. After that, recycle the device according to the rules.
- b. ... *Anschlußleitung durchtrennen. Dann das Gerät einer ordnungsgemäßen Entsorgung*
zuführen. (Then ...)
- c. ... *Anschlußleitung durchtrennen. Daraufhin das Gerät einer ordnungsgemäßen*
Entsorgung zuführen. (Thereafter ...)

In contrast to *danach* and *dann*, *daraufhin* signals additional causal meaning. Conjunctives can acquire a precedence and an overlap reading, depending on the Aktionsart in the first sentence, and on the aspectual category; compare *nachdem* for a discussion. In contrast to *nachdem*, the ordering of the related sentences is fixed—the anterior situation always comes first, whereas the position of the conjunctive is not fixed, see Section 5.3. Therefore, the properties of *danach*, *dann* and *daraufhin* are as follows (I only give those feature-value pairs that diverge from *nachdem*):

⁵Occurrences of discourse markers in the PUBLIC corpus: *danach* (afterwards) 10034, *dann* (then) 10022, *daraufhin* (thereupon) 3302.

danach (precedence)	
Conditions of use:	two independent sentences, pronominal adverb ordering is preposed discourse marker can take any position and can be modified
dann, daraufhin (precedence)	
Conditions of use:	two independent sentences, pronominal adverb ordering is preposed discourse marker can take any position and cannot be modified
danach (overlap)	
Conditions of use:	two independent sentences, conjunctive ordering is preposed discourse marker can take any position and can be modified
dann, daraufhin (overlap)	
Conditions of use:	two independent sentences, conjunctive ordering is preposed discourse marker can take any position and cannot be modified

Nachdem, *nach* and *danach* are generally acknowledged as being the most general anteriority markers in the sense that they can signal a wide range of meanings; the anterior markers discussed next (*sobald*, *kaum dass*, *seitdem*, *seit*) are far more restricted in their applicability, as substitution tests reveal: *Nachdem* is the only marker that can in most instances substitute any of the other markers, although with some loss in meaning.

6.2 Sobald and sowie

Sobald (as soon as) and *sowie* (as soon as) have much in common with *nachdem*. Yet, they differ in two ways: First, they are more restricted regarding the temporal relation they can signal, and second, they are more relaxed regarding the constraints under which an overlap reading is available. Actually, [Herweg 1991, p79] argues that in contrast to *nachdem*, the ingressive re-interpretation of *sobald* and *sowie* is conventionalized and cannot be reconstructed anymore. This is in line with grammars which usually ascribe an anterior and a simultaneous reading to *sobald*, whereas *nachdem* is always treated as an anterior marker only. To avoid redundancy, I only describe those aspects of *sobald* that differ from *nachdem*. Further, I only present examples for *sobald*; these hold for its synonym *sowie*, too.

Whereas *nachdem* can relate situations in an anterior relation regardless of the length of the intervening time span (as long as proximity of the situations is given), *sobald* (and also *kaum dass* (no sooner than), see next section) require that the situations follow each other immediately. Therefore, examples (6.19b) and (6.19c) are not well-formed, since *Sit_s* and *Sit_m* are separated by a day, whereas in examples (6.20a) to (6.20c) the use of *sobald* and

kaum dass is adequate to express an anterior relation, as the intervening time span is only small (a few minutes):

(6.19)

- a. **Nachdem** *er gestern in Berlin angekommen ist, geht er heute zum*
 After he yesterday in Berlin arrived has, goes he today for the
ersten Mal in die Stadt.
 first time into town.
 ‘After he arrived in Berlin yesterday, he goes into town for the first time today.’
- b. **?Sobald** *er gestern in Berlin angekommen ist, geht er heute zum*
 As soon as he yesterday in Berlin arrived has, goes he today the
ersten Mal in die Stadt.
 first time into town.
 ‘?As soon as he has arrived in Berlin yesterday, he goes into town for the first time today.’
- c. **?Kaum dass** *er gestern in Berlin angekommen ist, geht er heute zum*
 No sooner than he yesterday in Berlin arrived has, goes he today the
ersten Mal in die Stadt.
 first time into town.
 ‘?No sooner than he has arrived in Berlin yesterday, he goes into town for the first time today.’

(6.20)

- a. **Sobald** *er in Berlin angekommen ist, geht er zur Gedächtniskirche.*
 As soon as he in Berlin arrived has goes he to the Gedächtniskirche.
 ‘As soon as he has arrived in Berlin, he goes to the Gedächtniskirche.’
- b. **Kaum dass** *er in Berlin angekommen ist, geht er zur Gedächtniskirche.*
 No sooner than he in Berlin arrived has goes he to the Gedächtniskirche.
 ‘No sooner than he has arrived in Berlin, he goes to the Gedächtniskirche.’
- c. **Direkt** / **Kurz nachdem** *er in Berlin angekommen ist, geht er zur*
 Immediately / Shortly after he in Berlin arrived has goes he to the
Gedächtniskirche.
 Gedächtniskirche.
 ‘Immediately / Shortly after he has arrived in Berlin, he goes to the Gedächtniskirche.’

Used with a modifier like *direkt* (immediately) or *kurz* (shortly), *nachdem* can signal this immediacy, too (6.20c). Allen’s distinction between an *after* and a *meets-i*-relation is too coarse to describe the use of *sobald*, as it does not capture the meaning of *sobald* as used in example (6.20a). Here, the two situations are in an *after* relation with a small intervening time span. As discussed in Section 5.3, an additional *immediacy* constraint is required to describe this behaviour of temporal connectives. Thus, the temporal relation indicated by *sobald* needs to be described by a conjunction of *after*(*Sit_m*, *Sit_s*) and *imm*(*Sit_s*, *Sit_m*).

The examples above illustrate that while immediacy is optional for *nachdem*, it has to be given for *sobald*, *sowie* and *kaum dass* to be available. This requirement holds for the precedence and overlap interpretations of the temporal markers alike. Further, *sobald*, *sowie* and *kaum dass* all imply temporal adjacency between two situations, this is not given in the example below:

- (6.21) **?Sobald** *die Sonne aufgegangen war, ging er Baden. Vorher schlief er*
 As soon as the sun risen had, went he swimming. Earlier slept he
aber noch.
 but still.
 ‘?As soon as the sun had risen, he went swimming. But first, he took a nap.’

Herweg’s *next* constraint captures this phenomenon; thus part of the meaning of *sobald* is *next(Sit_s, Sit_m)*. Finally, some linguists argue that *sobald*, in contrast to *nachdem*, requires that some conceptual relation holds in addition to the temporal sequence [Herweg 1990, p293]:

- (6.22)
- a. **Kurz nachdem** *Maria die Lösung gefunden hatte, begann es zu regnen.*
 Shortly after Maria the solution found had, began it to rain.
 ‘Shortly after Maria had found the solution, it began to rain.’
- b. **?Sobald** *Maria die Lösung gefunden hatte, begann es zu regnen.*
 As soon as Maria the solution found had, began it to rain.
 ‘As soon as Maria had found the solution, it began to rain.’
- c. **Sobald** *Maria die Lösung gefunden hatte, war sie glücklich.*
 As soon as Maria the solution found had, was she happy.
 ‘As soon as Maria had found the solution, she was happy.’

The use of *sobald* in examples (6.22b) and (6.22c) suggests that an additional causal link has to hold between the two situations: *Sobald* can only be used if the occurrence of *Sit_m* somehow depends upon or is enabled by the occurrence of *Sit_s*, as in example (6.22c). This does not hold for *nachdem*, as example (6.22a) illustrates.

In contrast to *nachdem*, a durative Aktionsart in the subordinate clause is possible when signaling the overlap reading (see examples (6.23a) and (6.23b)), because *sobald* enforces an ingressive re-interpretation of durative verbs (see below for a comparison of *während*, *sobald* and *solange*):

- (6.23)
- a. **Sobald** *er schläft, geht sie aus dem Zimmer.*
 As soon as he sleeps, goes she out of the room.
 ‘As soon as he sleeps, she leaves the room.’

- b. **Sobald** *wir darüber nachdenken, ...*
 As soon as we about it think, ...
 ‘As soon as we think about it, ...’
- c. **?Nachdem** *er schläft, geht sie aus dem Zimmer.*
 After he sleeps, goes she out of the room.
 ‘?After he sleeps, she leaves the room.’

Likewise, semelfactive and transformative verbs in the subordinate clause can be used with *sobald* in a simultaneity reading (with *nachdem*, they correlate with perfective aspect, and then express a precedence relationship, see above). These are interpreted as ingressives, i.e. as transformatives bringing about a state as in example (6.24a):

(6.24)

- a. **Sobald** *ich vor dem Fernseher sitze, schlafe ich ein.*
 As soon as I in front of the TV sit, fall asleep I.
 ‘As soon as I sit in front of the TV, I fall asleep.’
- b. **?Nachdem** *ich vor dem Fernseher sitze, schlafe ich ein.*
 After I in front of the TV sit, fall asleep I.
 ‘?After I sit in front of the TV, I fall asleep.’

Sobald also interacts with the Aktionsart of the main clause verb. Consider the following example:

(6.25)

- a. **?Sobald** *sie die Prüfung abgelegt hatte, war sie faul.*
 As soon as she the exam taken had, was she lazy.
 ‘?As soon as she had taken the exam, she was lazy.’
- b. **Sobald** *sie die Prüfung abgelegt hatte, wurde sie faul.*
 As soon as she the exam taken had, became she lazy.
 ‘As soon as she had taken the exam, she became lazy.’

Sobald requires an event in the main clause (see [Herweg 1991, p78]); hence a stative verb as in example (6.25a) is somewhat odd, whereas its transformative correspondent in (6.25b) is fine. Apart from these differences, Aktionsart and aspect constraints are the same as for *nachdem*; likewise, tense constraints are those of *nachdem*. With one exception, though, relating to the use of anterior temporal markers with situations that are hypothetical. Take the following example:

(6.26)

- a. **Sobald** *ich in Berlin ankommen werde, werde ich zu Kiepert gehen.*
 As soon as I in Berlin arrive will, will I to Kiepert go.
 ‘As soon as I arrive in Berlin, I will go to Kiepert.’
- b. **?Nachdem** *ich in Berlin ankommen werde, werde ich zu Kiepert gehen.*
 After I in Berlin arrive will, will I to Kiepert go.
 ‘?After I will arrive in Berlin, I will go to Kiepert.’

Contrasting *nachdem*, *sobald* can be used with sentences that denote situations which have not yet taken place; this involves the use of future tense in sentence (6.26a); future tense was, however, ruled out for *nachdem* (see above).

Further differences relate to the use of temporal quantifiers and negation: Modification is not possible with *sobald* (**kurz sobald*, **direkt sowie*), yet, negation in the subordinate clause is fine. As for the lexical realization, *sobald* and *sowie* can both take a correlate in the main clause (*da*, then). This is restricted to contexts where the subordinate clause precedes the main clause:

(6.27)

- a. **Sobald** *ich in Berlin angekommen war, da ging ich zu Kiepert.*
 As soon as I in Berlin arrived had, then went I to Kiepert.
 ‘As soon as I had arrived in Berlin, then I went to Kiepert.’
- b. **?Da** *ging ich zu Kiepert, sobald ich in Berlin angekommen war.*
 Then went I to Kiepert, as soon as I in Berlin arrived had.
 ‘?Then I went to Kiepert, as soon as I had arrived in Berlin.’

In a nutshell, the two readings of *sobald* can be characterized as follows:

sobald (anteriority)	
Temporal relation:	$after(Sit_m, Sit_s)$ and $imm(Sit_s, Sit_m)$, or $meets-i(Sit_m, Sit_s)$ in both cases: $next(Sit_s, Sit_m)$
Conditions of use:	Sit_s is presupposed additional causal relation holds Sit_s is r-bounded or lr-bounded Sit_m is l-bounded or lr-bounded clause denoting Sit_s has a perfective aspect tense sequence; $E(Sit_s) < E(Sit_m)$ hypotactic clause complex, subordinate conjunction preferred ordering is preposed discourse marker takes front position and cannot be modified

sobald (simultaneity)	
Temporal relation:	$starts(Sit_m, Sit_s)$ or $starts-i(Sit_m, Sit_s)$
Conditions of use:	<p>Sit_s is presupposed</p> <p>additional causal relation holds</p> <p>Sit_s is l-bounded or lr-bounded</p> <p>Sit_m is l-bounded or lr-bounded</p> <p>verb denoting Sit_m is not stative</p> <p>same tense; $E(Sit_s) = E(Sit_m)$</p> <p>hypotactic clause complex, subordinate conjunction</p> <p>preferred ordering is preposed</p> <p>discourse marker takes front position and cannot be modified</p>

Sowie. *Sowie* is usually given as a synonym of *sobald*. Indeed, in substitution tests I encountered no instance where *sobald* could not be replaced by *sowie*, always preserving the temporal meaning. *Sowie* and *sobald* differ in the frequency of use, though: I encountered only two instances of *sowie* in the entire LIMAS corpus (using the COSMAS tool), as opposed to 54 occurrences of *sobald* (cf. also [Weinrich 1993]).

6.3 Kaum dass

Kaum dass (no sooner than) is a near-synonym to *sobald*, but differs in two respects: First, it expresses an intentional relation in addition to the temporal relation of precedence (example (6.28b) is reproduced from [Buscha 1989, p83]):

(6.28)

- a. **Sobald** *er sich hingelegt hatte, klingelte das Telefon.*
 As soon as he himself lain down had, rang the phone.
 ‘As soon as he had lain down, the phone rang.’
- b. **Kaum dass** *er sich hingelegt hatte, klingelte das Telefon.*
 No sooner than he himself lain down had, rang the phone.
 ‘No sooner than he had lain down, the phone rang.’

[Steube 1980, p41] and [Buscha 1989, p82], among others, argue that the speaker expresses a personal judgement when using *kaum dass* instead of *sobald*, the judgement being that the situation denoted by the main clause occurs too quickly (too early) after the completion of the subordinate clause situation. Others ascribe the difference to style: *Kaum dass* is supposed to be more formal than *sobald*. Second, *kaum dass* is more constrained regarding its syntactic environment as it requires past tense in the subordinate clause [Buscha 1989, p82]:

(6.29)

- (a) **?Kaum dass** *die Ampel grün ist, ...*
 No sooner than the traffic lights green are, ...
 ‘?No sooner than the traffic lights are green, ...’
- (b) **Kaum dass** *die Ampel grün war, ...*
 No sooner than the traffic lights green were, ...
 ‘No sooner than the traffic lights were green, ...’

Apart from these additional restrictions, *kaum dass* is in fact a synonym of *sobald*. The table only lists the deviations from the usage conditions of *sobald*:

kaum-dass	
Conditions of use:	negative judgement tense sequence; $E(Sit_s) < E(Sit_m)$ where $E(Sit_s) < S$ and $E(Sit_m) < S$

6.4 Seit(dem), seit and ab

Let us now consider the durational equivalents of the anterior connective *nachdem*: the subordinate conjunctions *seitdem* (since) and *seit* (since), their prepositional counterpart *seit* (since) and its near-synonym *ab* (from).

6.4.1 Seitdem and seit

The two conjunctions *seitdem* and *seit* are synonymous, although [Bäuerle 1995] notes that *seit* is preferred if the subordinate clause occurs in sentence-initial position (order: preposed), and [Weinrich 1993, p752] suggests that *seit* is the colloquial form of *seitdem*. [Durrell and Bree 1993, p316] claim that *seit* is more frequent than *seitdem*, which is confirmed by the distribution of *seit* and *seitdem* in the corpora. Still, in the examples in this section I use *seitdem* in order to avoid confusion with the homonymous preposition *seit*.

In general, durational temporal connectives signal that the main clause situation extends from the time point given by the subordinate clause situation or the PP to speaking time. Thus, durative markers express two kinds of temporal meanings [Herweg 1991, p80/81]:

- They give the temporal location of Sit_m in relation to Sit_s (as the non-durational temporal markers do).
- They additionally specify the minimal duration of Sit_m by defining the period of time in which Sit_m holds.

The latter property is captured by the *dur* constraint introduced in Chapter 5, Section 5.3, in other words, $dur(Sit_m)$ holds.

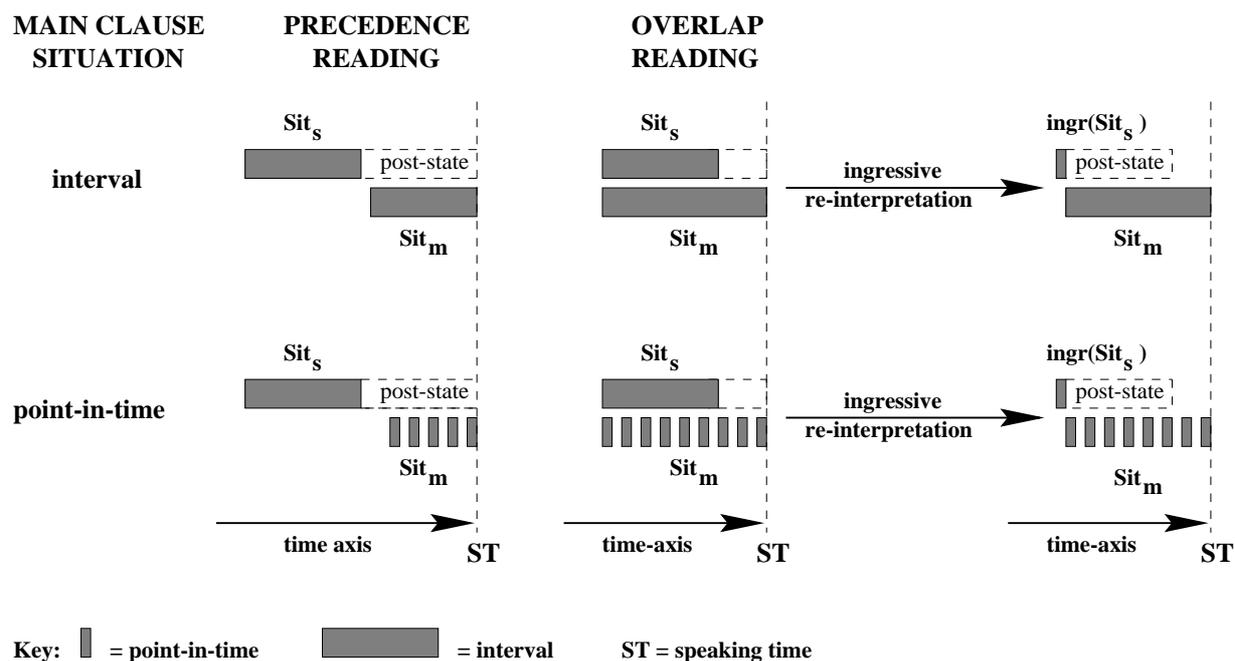


Figure 6.2: Schematic representation of precedence and overlap reading (involving ingressive re-interpretation) of *seitdem*

Similar to the non-durational anterior markers discussed so far, *seitdem* also has a precedence (resultative) and an overlap (ingressive) reading, and similar to *sobald* and *kaum dass*, the overlap reading is conventionalized. See for instance, [Bäuerle 1995, Buscha 1989, Helbig and Buscha 1991] who assign two meanings to *seitdem*: marking anteriority and simultaneity. Different from the non-durational anterior markers, *seitdem* additionally specifies the minimal duration of the Sit_m as being constrained by the speaking time S. Figure 6.2 and the examples below illustrate the precedence (6.30a) and the overlap (6.30b) reading of *seitdem* (example (6.30) is taken from [Buscha 1989, 99]).

(6.30)

- a. *Er ist Nichtraucher, seitdem er Suse getroffen hat.*
 He is non-smoker, since he Suse met has.
 'He is a non-smoker since he has met Suse.'
- b. *Er ist Nichtraucher, seitdem ich ihn kenne.*
 He is non-smoker, since I him know.
 'He has been a non-smoker since I have known him.'

In sentence (6.30a) the termination of Sit_s provides the starting point for Sit_m , in (6.30b) the beginning of Sit_s gives the beginning of Sit_m . Only (6.30b) requires that both situations

hold simultaneously for some point in time.⁶ In other words, Sit_m holds since Sit_s has taken place (precedence, (6.30a)) or has started (overlap (6.30b)) to speaking time S. Figure 6.2 shows the different readings at a more abstract level: The first row gives the precedence and overlap interpretations of *seitdem* (since) for durative main clause situations (as in example (6.30) where “being a smoker” is a state). Situations are again ordered on the time axis, the vertical bar denotes the speaking time. The second row illustrates the possible readings of *seitdem* with punctiliar main clause situations. I have argued above that *seitdem* defines the period of time in which Sit_m holds; hence, non-durative situations in the main clause (points in time) such as depicted in the second row in Figure 6.2 undergo an iterative re-interpretation to obtain a temporal extension. As with all other anterior markers, the subordinate clause situation can be presupposed, and the situations denoted by main clause and subordinate clause are egressive and ingressive respectively (see [Sinn 1991, p145] and the discussion of *nachdem* above).

Legal Aktionsarten and aspects depend on the reading intended, as is the case with *nachdem* and *sobald*. *Seitdem* departs in its constraints on the syntactic and lexical environment from *nachdem* and *sobald* in the following ways: In both readings, *seitdem* requires a durative Aktionsart in the main clause. Since it expresses the duration of Sit_m from a time point given by Sit_s to S, the main clause verb has to have a duration. Therefore, when temporally relating two non-durative situations using semelfactive or transformative verbs, *seitdem* enforces an iterative re-interpretation on the main clause verb as in (6.31a), so that a duration can be conceptualized (see also Figure 6.2); *nachdem* simply posits that the two situations are in a precedence relation (6.31b):

(6.31)

- a. **Seitdem** *die Ampel grün geworden ist, fährt das Auto an.*
 Since the traffic lights green turned is, starts the car.
 ‘In the time since the traffic lights have turned green, the car has started.’
- b. **Nachdem** *die Ampel grün geworden ist, fährt das Auto an.*
 After the traffic lights green turned is, starts the car.
 ‘After the traffic lights have turned green, the car has started.’

A further difference concerns the use of durative-resultative verbs in the main clause:

(6.32)

- a. **Seitdem** *Suse genickt hatte, goss Tom Wasser in den Tank.*
 Since Suse nodded had, poured Tom water in the tank.
 ‘Since Suse had nodded, Tom was pouring water into the tank.’
- b. **?Seitdem** *Suse genickt hatte, füllte Tom den Tank mit Wasser.*
 Since Suse nodded had, filled Tom the tank with water.
 ‘?Since Suse had nodded, Tom was filling the tank with water.’

⁶Note that similar to *nachdem*, one can also impose a precedence reading on example (6.30b): An ingressive re-interpretation of Sit_s gives the beginning of Sit_m ; the precedence relations then holds between $ingr(Sit_s)$ and Sit_m .

- c. **Nachdem** *Suse genickt hatte, füllte Tom den Tank mit Wasser.*
 After Suse nodded had, filled Tom the tank with water.
 ‘After Suse had nodded, Tom filled the tank with water.’

Example (6.32a) is well-formed (durative verb in the main clause), whereas its resultative variant in example (6.32b) is somewhat odd: Using *seitdem*, the minimal duration of Sit_m is determined by the speaking time. This conflicts with the use of a resultative verb which implies that the situation lasts until its post state has been reached. Resultatives are, however, possible with *nachdem* (6.32c). As for the subordinate clause in a precedence interpretation, the verb needs to signal a consequent state; this is achieved—in accordance with *nachdem* and *sobald*—by choosing a perfective aspect.

In analogy to *nachdem*, the overlap reading is only possible if the verb denoting Sit_s signals an extension in time; non-durative Aktionsarten suggest a precedence reading (see above). Aspect behaves in the same way as for *nachdem*: Perfective aspect in the subordinate clause correlates with the precedence reading; imperfective aspect co-occurs with an ingressive reading. Consider the following examples taken from [Bäuerle 1995, p174]:

- a. **Seit** *Minna Mumps hat, ist sie grantig.*
 Since Minna mumps has, is she grumpy.
 ‘Since Minna has mumps, she is grumpy.’
- b. **Seit** *Fritz Mumps gehabt hat, ist er ein echter Hypochonder.*
 Since Fritz mumps had has, is he a true hypochondriac.
 ‘Since Fritz has had mumps, he is a true hypochondriac.’

Note that future tense cannot be used in the subordinate clause since Sit_s has to occur before speaking time in order to locate Sit_m in-between the end of Sit_s and S (see [Steube 1980, p49]); however, present tense is possible with the overlap reading, because here Sit_s can extend to S.

As with *sobald*, modification by means of temporal quantifiers is not possible; ordering, position and part of speech characteristics are also those of *sobald*. Here are the properties of *seit(dem)* in its precedence and simultaneity reading:

seitdem (anteriority)	
Temporal relation:	<i>after</i> (<i>Sit_m</i> , <i>Sit_s</i>) and <i>imm</i> (<i>Sit_s</i> , <i>Sit_m</i>), or <i>meets-i</i> (<i>Sit_m</i> , <i>Sit_s</i>) in both cases: <i>next</i> (<i>Sit_s</i> , <i>Sit_m</i>) and <i>dur</i> (<i>Sit_m</i>)
Conditions of use:	<i>Sit_s</i> is presupposed <i>Sit_s</i> is r-bounded or lr-bounded <i>Sit_m</i> is l-bounded or lr-bounded verb denoting <i>Sit_m</i> is not resultative clause denoting <i>Sit_s</i> has a perfective aspect tense sequence; $E(Sit_s) < E(Sit_m)$ where $E(Sit_s) \leq S$ hypotactic clause complex, subordinate conjunction preferred ordering is preposed discourse marker takes front position and cannot be modified clause denoting <i>Sit_s</i> is not hypothetical

seitdem (simultaneity)	
Temporal relation:	<i>starts</i> (<i>Sit_m</i> , <i>Sit_s</i>) or <i>starts-i</i> (<i>Sit_m</i> , <i>Sit_s</i>) in both cases: <i>dur</i> (<i>Sit_m</i>)
Conditions of use:	<i>Sit_s</i> is presupposed <i>Sit_s</i> is l-bounded or lr-bounded <i>Sit_m</i> is l-bounded or lr-bounded verb denoting <i>Sit_s</i> is durative, stative or iterative verb denoting <i>Sit_m</i> is not resultative clause denoting <i>Sit_s</i> has an imperfective aspect same tense; $E(Sit_s) = E(Sit_m)$ where $E(Sit_s) \leq S$ and $E(Sit_m) \leq S$ hypotactic clause complex, subordinate conjunction preferred ordering is preposed discourse marker takes front position and cannot be modified clause denoting <i>Sit_s</i> is not hypothetical

6.4.2 Seit (preposition)

As *seitdem* is the durational variant of *nachdem*, the preposition *seit* (since) is the durational counterpart of *nach*. It shares all the properties of *seitdem* in the precedence reading, except for two divergences, which are motivated by properties of the preposition: First of all, *seit* (P) can only be used if the verb denoting a situation can be deverbalized, and second, it realizes more concise text, satisfying the stylistic demand of brevity. The preposition *seit* requires a durative or stative verb in the main clause ([Buscha 1989, p99], examples are his):

(6.33)

- a. *Er ist Nichtraucher, seitdem er Suse getroffen hat.*
He is non-smoker since he Suse met has.
'He is non-smoker since he has met Suse.'

- b. **Seit** *dem Treffen mit Suse ist er Nichtraucher.*
 Since the meeting with Suse is he non-smoker.
 ‘Since the meeting with Suse he is non-smoker.’

seit (preposition)	
Temporal relation:	<i>after(Sit_m, Sit_s)</i> and <i>imm(Sit_s, Sit_m)</i> , or <i>meets-i(Sit_m, Sit_s)</i> in both cases: <i>next(Sit_s, Sit_m)</i> and <i>dur(Sit_m)</i>
Conditions of use:	<i>Sit_s</i> is presupposed <i>Sit_s</i> is r-bounded or lr-bounded verb denoting <i>Sit_m</i> is stative, durative or iterative deverbalization possible realization within a clause (PP), preposition discourse marker takes front position and cannot be modified concise style

6.4.3 Ab

In contrast to *seit*, which specifies the duration of the main clause situation as lasting until speaking time, *ab* (from) denotes a time span that ends *before* speaking time when used with past tense, i.e. *Sit_m* does not extend to S ([Helbig and Buscha 1991, p415]):⁷

- (6.34) **Ab** *dem Treffen mit Suse war er Nichtraucher. Nachdem Suse ihn*
 Since the meeting with Suse was he non-smoker. After Suse him
verließ, fing er wieder an zu Rauchen.
 left, took he again up smoking.
 ‘After the meeting with Suse he was a non-smoker. After Suse left him, he again took up smoking.’

The meaning and the conditions of usage of *ab* can be summarized as follows:

ab (temporal)	
Temporal relation:	<i>after(Sit_m, Sit_s)</i> and <i>imm(Sit_s, Sit_m)</i> , or <i>meets-i(Sit_m, Sit_s)</i> in both cases: <i>next(Sit_s, Sit_m)</i> , <i>dur(Sit_m)</i> duration of <i>Sit_m</i> ends before S
Conditions of use:	<i>Sit_s</i> is presupposed <i>Sit_s</i> is r-bounded or lr-bounded verb denoting <i>Sit_m</i> is stative, durative or iterative deverbalization possible <i>E(Sit_m) < S</i> realization within a clause (PP), preposition discourse marker takes front position and cannot be modified concise style

⁷I am not considering the use of *ab* in examples such as *Ab 1970 ...* (From 1970 ...), *Ab morgen ...* (From tomorrow ...), etc., as they do not pass the test for discourse markers.

6.5 Bevor, vor and davor

6.5.1 Bevor

Bevor (before) is the prototypical posterior marker, such as *nachdem* is the most general anterior marker. It relates to *nachdem* in a systematic manner: Given two situations, Sit_1 and Sit_2 , in temporal succession (Sit_1 precedes Sit_2 on the time scale), *nachdem* is selected to locate the later situation with respect to the earlier one (*nachdem* Sit_1 , Sit_2), whereas *bevor* is used to locate the earlier situation relative to the later one (Sit_1 , *bevor* Sit_2). As such, *bevor* and *nachdem* are inverses of each other. The following example illustrates the relation between the two markers:

(6.35)

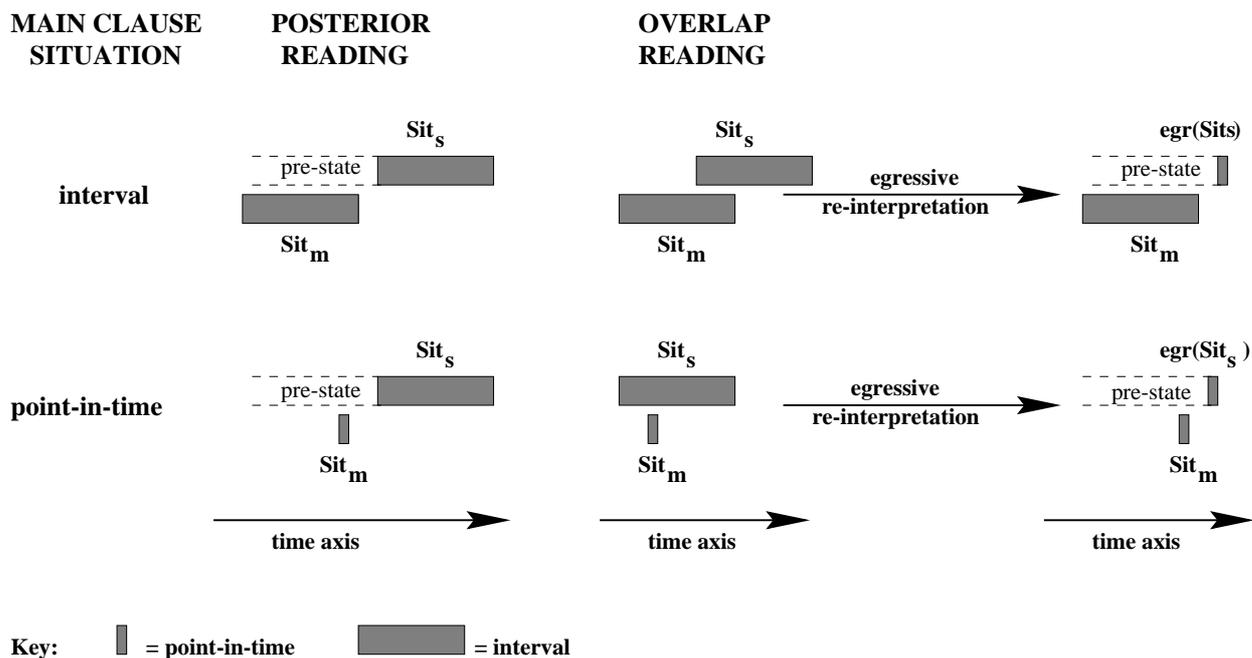
- a. **Nachdem** *Tom den Ölstand geprüft hatte, schraubte er den Tankdeckel ab.*
 After Tom the oil level checked had, screwed he the tank cap off.
 ‘After Tom had checked the oil level, he unscrewed the tank cap.’
- b. *Tom prüfte den Ölstand, bevor er den Tankdeckel abschraubte.*
 Tom checked the oil level before he the tank cap screwed off.
 ‘Tom checked the oil level before he unscrewed the tank cap.’

Deciding on the situation that acts as the ‘temporal anchor’ interacts with the larger discourse context in which two situations in a temporal relation occur, in particular, the current focus, the thematic progression of the text, and presuppositions (see the discussion in Chapter 8 and [Lascarides and Oberlander 1993]). It was claimed above that *nachdem* requires that the earlier situation can be presupposed; with *bevor* and all other posterior markers (*vor*, *ehe*, *bis* (before (P), before (arch.), until)), it is the later situation that must be presupposed.

Again in accordance with *nachdem*, I observe two types of temporal relations indicated by *bevor*, illustrated by the examples below (example (6.36) reproduced from [Klenner 1991, p74]): those signaling strict precedence and those involving overlap. Sentence (6.36a) exemplifies the ‘pure’ posterior relation holding between Sit_m and Sit_s , where the entire Sit_m takes place prior to Sit_s (i.e. is finished by the time Sit_s commences). Sentence (6.36b) illustrates an overlap relation between two situations, with the constraint being that the end of Sit_m is located before the end of Sit_s . Here, the posterior relation holds between Sit_m and the end of Sit_s ; this requires an egressive re-interpretation of Sit_s (see also [Sinn 1991, p75] and [Herweg 1991]). Now, the precedence relation signaled by *bevor* is that between Sit_m and $egr(Sit_s)$.

(6.36)

- a. **Bevor** *der VW die UB passierte, überholte er den BMW.*
 Before the VW the university library passed, overtook it the BMW.
 ‘Before the VW passed the university library, it overtook the BMW.’



s

Figure 6.3: Schematic representation of posterior and overlap reading (involving egressive re-interpretation) of *bevor*

- b. **Bevor** der VW die UB *passiert hatte, überholte er den BMW.*
 Before the VW the university library passed had, overtook it the BMW.
 ‘Before the VW had passed the university library, it overtook the BMW.’

In sentence (6.36a), the main clause situation (overtaking a car) has been completed by the time the subordinate clause situation starts (passing the library); the two events are in strict succession. In contrast, (6.36b) suggests that the passing of the library is still under way when overtaking the BMW, and only states that the overtaking has to be completed before the passing event ends. Figure 6.3 illustrates the two readings of *bevor*.

Various researchers have noted that the temporal markers *bevor* and *before* have a wide variety of non-temporal readings, for instance [Heinämäki 1978, Steube 1980, Herweg 1991b]. [Heinämäki 1978] discusses what she terms ‘counterfactual interpretations’ of *before* and arrives at a common interpretation; [Herweg 1991b, p160] lists likelihood, preference, and conditional reading as non-temporal readings of the German *bevor*. However, these will be neglected in the present analysis as my concern is the temporal readings of temporal discourse markers in German.

Posterior reading. I argued above that the posterior reading signals that the entire situation Sit_m occurs prior to Sit_s . As with *nachdem*, this specification is not sufficient, as it does not rule out sentences like (6.37a):

(6.37)

- a. *?Wir begannen mit dem Aufstieg am Abend, bevor die Sonne aufging.*
 We started with the climb in the evening, before the sun rose.
 ‘?We started the climb in the evening before the sun had risen.’
- b. *Wir begannen mit dem Aufstieg am Morgen, bevor die Sonne aufging.*
 We started with the climb in the morning, before the sun rose.
 ‘We started the climb in the morning before the sun had risen.’

The use of *bevor* in sentence (6.37a) does not make sense, because the main clause suggests that the sun is still risen; Sit_s , however, requires that the state ‘the sun is not risen’ holds. In other words, the pre-state of Sit_s and Sit_m must have a point in common to be temporally related by *bevor*. In (6.37b), this constraint is satisfied: The pre-state of Sit_s is that the sun is not risen, Sit_m occurs while this state holds, and the use of *bevor* is appropriate. In short, *bevor* does not allow for an arbitrary time span in between the end of Sit_m and the beginning of Sit_s . The notion of proximity [Herweg 1991, p65] is again crucial to the meaning of *before*, just as it is in the case of *nachdem*. Yet, *before* requires that Sit_m is situated in the proximate pre-state of Sit_s , as opposed to the post-state in the case of *nachdem* (see also Figure 6.3). Hence, a clause like the following (from [Buscha 1989, p47]) suggests that Sit_m is situated in the pre-state of Sit_s , i.e. sometime before sunrise, and not just at any time preceding Sit_s :

- (6.38) *Wir begannen mit dem Aufstieg, bevor die Sonne aufging.*
 We started with the climb before the sun rose.
 ‘We started the climb before the sun has risen.’

Like *nachdem*, the use of *bevor* is restricted to certain types of situations in the subordinate clause. Given that *bevor* realizes the inverse temporal relation of *nachdem*, the constraint on Sit_s is that it must have an inherent beginning and allow for an ingressive interpretation (as opposed to the genuine ending expected by *nachdem*). Take the following examples:

(6.39)

- a. **Bevor** *Suse studierte, machte sie eine Lehre.*
 Before Suse studied, served she an apprenticeship.
 ‘Before Suse went to university, she served an apprenticeship.’
- b. *?Bevor Suse in Berlin blieb, machte sie eine Weltreise.*
 Before Suse in Berlin stayed, makes her a world tour.
 ‘?Before Suse stayed in Berlin, she travelled around the world.’

- c. ?**Bevor** *die Erde rund war*, ...
 Before the earth round was, ...
 ‘?Before the earth was round, ...’

In example (6.39a), *Sit_s* can be interpreted ingressively in the sense of ‘bevor Suse mit dem Studium begann’ (before Suse took up her studies), and *Sit_m* can be located prior to this event. An ingressive interpretation is not possible for any of the other examples: The subordinate clause events in (6.39b) and (6.39c) have no genuine beginning.

The complementary requirement holds for the main clause situation: They need to allow for an egressive, or resultative, interpretation (and hence possess a genuine ending); otherwise, they cannot be temporally located before another situation.

(6.40)

- a. *Die Erde war mit Dinosauriern bevölkert*, **bevor** *die Eiszeit kam*.
 The earth was with dinosaurs inhabited before the Ice Age came.
 ‘The earth was inhabited by dinosaurs before the Ice Age came.’
- b. ?*Die Erde war rund*, **bevor** *die Eiszeit kam*.
 The earth was round before the Ice Age came.
 ‘?The earth was round before the Ice Age came.’

The situation type constraints are reflected in the legal Aktionsarten for the subordinate clause verb: I argued above that situations in the subordinate clause must have an inherent beginning, and must allow for an ingressive re-interpretation, see also [Klenner 1991, Herweg 1991]. Herweg claims that a state (and, I believe, any other durative situation) cannot provide the required definite position on the time axis, which is, however, needed for determining the temporal ‘location’ of *Sit_m*. In other words, if *bevor* is used with a state or another durative event, this must be re-interpreted appropriately [Herweg 1991, p75]. The following example exemplifies this re-interpretation: Sentence (6.41a) contains a stative verb to express a state, sentence (6.41b) is its ingressive counterpart using a transformative verb:

(6.41)

- a. **Bevor** *er Pensionär war*, *sang er im Chor*.
 Before he pensioner was, sang he in a choir.
 ‘Before he was a pensioner, he sang in the choir.’
- b. **Bevor** *er pensioniert worden ist*, *sang er im Chor*.
 Before he pensioner became, sang he in a choir.
 ‘Before he became a pensioner, he sang in the choir.’

This of course only applies to situations with a temporal extension and not to time points. Hence, I claim that *bevor* posits no Aktionsart constraint on the verb denoting *Sit_s*, but

that the underlying situation has to allow for an ingressive re-interpretation. i.e. be left-bounded. Then, even durative verbs can correlate with *bevor*.

As for the main clause verb, *bevor* in its precedence reading rules out the use of duratives, which are not telic (resultative) as in:

(6.42)

- a. *?Ich fuhr Auto, bevor Manfred eintraf.*
 I drove with the car before Manfred arrived.
 ‘?I drove with the car before Manfred arrived.’
- b. *Ich fuhr nach München, bevor Manfred eintraf.*
 I drove to Munich before Manfred arrived.
 ‘I drove to Munich before Manfred arrived.’

Sentence (6.42b) signals a precedence relation, whereas sentence (6.42a) is ambiguous regarding its interpretation: It is not clear when *Sit_m* ends; it could either hold prior to *Sit_s*, at the time of occurrence of *Sit_s*, or even after *Sit_s*.

Like the +/-telic opposition, the choice of aspect also helps to distinguish the precedence from the overlap reading. Consider again example (6.36): When discussing the two possible meanings of *bevor*, I already indicated that the imperfective aspect in the clause denoting *Sit_s* suggests a precedence reading, whereas the perfective aspect has to be used when aiming at the overlap interpretation. Aspect is not meaning-differentiating for situations that are not durative: Regardless of the aspect, they are always perceived as time points, and hence suggest a precedence reading.

Grammatical tense constraints interact with aspectual decisions: [Buscha 1989, p47] state that despite the difference in event times, main and subordinate clause tenses are generally the same.⁸ Given an imperfective aspect in the subordinate clause, possible tenses are simple past (*Präteritum*) or simple present (*Präsens*). Syntactically, posterior clause complexes behave like sentences that signal a simultaneity relation. Yet, different verbal tenses are also possible, now with a perfective aspect in the main clause. Its use stresses that the situation depicted in the main clause has been completed before the subordinate clause situation starts (example (6.43) is reproduced from [Buscha 1989, p47]):

- (6.43) **Bevor** *es dunkel wurde, hatten wir die Schutzhütte erreicht.*
 Before it dark turned, had we the shelter reached.
 ‘Before it turned dark, we had reached the shelter.’

Finally, a few words on ordering and quantification: The ordering of clauses is again free. Still, corpus data suggests that the ordering with the main clause in sentence-initial position is the more frequent realization (as opposed to the subordinate clause—main clause order for anterior markers). This is again in line with Wrobel’s [Wrobel 1994] observation that

⁸Recall that *nachdem* and the other anterior markers require a sequence of tenses.

speakers tend to preserve the ‘natural’ order, i.e. the ordering along the time axis, when producing text.

The use of temporal quantifiers works in the same way as for *nachdem*: Temporal adverbs and nominal expressions of time can be used to define the exact nature of the time span separating the end of Sit_m and the beginning of Sit_s :

- (6.44) **Ein Jahr** / **Kurz bevor** *Suse nach Amerika ging, wurde ihr Fahrrad gestohlen.*
 One year / Shortly before Suse to America went, was her bike stolen.
 ‘One year / Shortly before Suse went to America went, her bike was stolen.’

To sum up, the posterior reading of *bevor* is given if the following semantic, contextual and syntactic properties hold:

bevor (posteriority)	
Temporal relation:	$before(Sit_m, Sit_s)$ and $prox(Sit_s, Sit_m)$, or $meets(Sit_m, Sit_s)$
Conditions of use:	Sit_s is presupposed Sit_s is l-bounded or lr-bounded Sit_m is r-bounded or lr-bounded clause denoting Sit_s has an imperfective aspect same tense or tense sequence; $E(Sit_m) \leq E(Sit_s)$ hypotactic clause complex, subordinate conjunction preferred ordering is postponed discourse marker takes front position and can be modified

Overlap reading. The overlap reading was identified as the second type of temporal meaning conveyed by *bevor*. This reading is invoked by a particular syntactic and lexical environment of *bevor*.

But first, let us look more closely at the temporal relation itself and the situation types that can enter into this relation. [Klenner 1991, p74] and [Herweg 1991, p75], among others, argue that the overlap reading suggests that the entire Sit_m is merely prior to the post state of Sit_s , and not to Sit_s as a whole (see precedence reading above). Now, the precedence relation holds between Sit_m and the end of Sit_s (in other words, $egr(Sit_s)$). Thus, the only requirement is that Sit_m ends before Sit_s ends. Sit_s has to co-exist with Sit_m for some time span, however little this might be:

(6.45)

- a. *Suse überholte die Radfahlerin, bevor sie die Brücke überquert hatte.*
 Suse overtook the cyclist before she the bridge crossed had.
 ‘Suse overtook the cyclist before she had crossed the bridge.’

- b. *Suse überholte die Radfahlerin, kurz bevor sie die Brücke überquert hatte.*
 Suse overtook the cyclist shortly before she the bridge crossed had.
 ‘Suse overtook the cyclist shortly before she had crossed the bridge.’

In sentence (6.45a), Suse is already on the bridge when passing the cyclist; in (6.45b) she is close to the end of the bridge when passing him. In both cases the ‘passing-the-cyclist’ event (Sit_m) ends before the ‘crossing-the-bridge’ event (Sit_s) is completed. Given this overlap interpretation, there is no need to define a proximate state as is required for the precedence reading.

The examples further suggest that an overlap reading is only possible with a durative situation in the subordinate clause. If Sit_s is a time point, Sit_m cannot co-occur with Sit_s and therefore cannot end before Sit_s ends. Still, punctiliar situations that can be presented as duratives (using an appropriate Aktionsart, see below) are also possible. Since the sequence relation holds between Sit_m and $egr(Sit_s)$, Sit_s must be a situation which can be interpreted egressively. Hence, they need a genuine ending (contrasting the genuine beginning of Sit_s in the context of the precedence reading), which is not true for example (6.46):

- (6.46) *?Bevor die Erde rund gewesen war, war sie achteckig.*
 Before the earth round been had, was it octagonal.
 ‘?Before the earth had been round, it was octagonal.’

As with the precedence interpretation, main clause situations must have a genuine ending. See above for a discussion of this feature.

The Aktionsart of the subordinate clause verb has to be durative as in (6.46) or stative. A durative or stative verb can either express a durative situation, or result from the re-interpretation of a punctiliar situation. Punctiliar situations that have a pre-state can also be verbalized by a stative verb expressing the pre-state and thus yield an overlap reading of *bevor*.

As for the main clause, there is no Aktionsart constraint on the verb (see also [Herweg 1990, Herweg 1991, Klenner 1991]). Still, a non-resultative Aktionsart is preferred in order to signal the intended reading unambiguously (see discussion above). In contrast, there is no choice concerning the aspect: Only a perfective aspect in the subordinate clause can express an overlap reading, as the perfective suggests that Sit_s is completed (example (6.47) is reproduced from [Herweg 1991, p75]):

- (6.47) *Bevor Peter Hut und Mantel abgelegt hatte, klingelte das Telefon.*
 Before Peter hat and coat taken off had, rang the phone.
 ‘Before Peter had taken off hat and coat, the phone rang.’

The ringing of the phone happens while Peter is removing his hat and coat, and ends before Peter has completed this action. In other words, Sit_m occurs before $egr(Sit_s)$.

Tense constraints are the same as for the precedence reading: Either corresponding tenses are used (present perfect or past perfect in both clauses), or different tenses following the rules of tense complexes in German: past perfect in the subordinate clause expects a simple past in the main clause, and present perfect co-occurs with present. Ordering and modification need not be discussed again, see the description above. The table below summarizes the discussion so far:

bevor (overlap)	
Temporal relation:	$overlaps(Sit_m, Sit_s)$ or $starts(Sit_m, Sit_s)$ or $during(Sit_m, Sit_s)$ in terms of precedence: $before(Sit_m, egr(Sit_s))$ and $prox(Sit_s, egr(Sit_m))$, or $meets(Sit_m, egr(Sit_s))$
Conditions of use:	Sit_s is presupposed Sit_s is r-bounded or lr-bounded (egressive) Sit_m is r-bounded or lr-bounded (egressive) verb denoting Sit_s is stative/durative clause denoting Sit_s has a perfective aspect, same tense or tense sequence; $E(Sit_m) \leq E(Sit_s)$ hypotactic clause complex, subordinate conjunction preferred ordering is postponed discourse marker takes front position and can be modified

6.5.2 Vor

The prepositional counterpart of *bevor* is *vor* (before). In analogy to *nach*, *vor* inherits most of its properties from the conjunction. Its availability depends, of course, on properties of the verb: Only verbs that can be deverbalized can act as a complement in a prepositional phrase:

(6.48)

- a. *Suse kaufte ein neue Fahrrad, bevor sie nach Lettland fuhr.*
Suse bought a new bike before she to Latvia drove.
'Suse bought a new bike before she went to Latvia.'
- b. **Vor** *der Fahrt nach Lettland kaufte Suse ein neue Fahrrad.*
Before the trip to Latvia bought Suse a new bike.
'Before her trip to Latvia Suse bought a new bike.'

Note that the 'unmarked' ordering is reversed when using a prepositional phrase.

Similar to *nach* the preposition *vor* can only be used in the non-overlap reading, signaling a strict precedence relation between Sit_m and Sit_s . The proximity relation has to hold, too, as the following example shows:

- (6.49) **Vor** *dem Vortrag ging Tom noch einmal seine Folien durch.*
 Before the talk went Tom once again his slides over.
 ‘Before the talk Tom went once more over his slides.’

The only reasonable interpretation is that Tom went over his talk a few minutes or hours before his talk, but not days before. Selecting *vor* instead of *bevor* is also a matter of style: *vor* allows for a more concise verbalization of the situations.

vor (temporal)	
Temporal relation:	<i>before(Sit_m, Sit_s)</i> and <i>prox(Sit_s, Sit_m)</i> , or <i>meets(Sit_m, Sit_s)</i>
Conditions of use:	<i>Sit_s</i> is presupposed <i>Sit_s</i> is l-bounded or lr-bounded <i>Sit_m</i> is r-bounded or lr-bounded deverbalization possible realization within a clause (PP), preposition discourse marker takes front position and can be modified concise style

6.5.3 Davor, vorher, zuvor

Davor (before it) is the corresponding pronominal adverb; *vorher* (beforehand) and *zuvor* (before) are the conjunctive counterparts:

(6.50)

- a. *Gerät nur trocken oder mit feuchtem Tuch reinigen. Davor unbedingt*
 Device only dry or with damp cloth clean. Before that really
den Netzstecker ziehen (TC.12)
 the plug pull.
 ‘Clean the device only dry or with a damp cloth. Before doing so, unplug the device.’
- b. *Gerät nur trocken oder mit feuchtem Tuch reinigen. Vorher unbedingt den Netzstecker*
ziehen.
- c. *Gerät nur trocken oder mit feuchtem Tuch reinigen. Zuvor unbedingt den Netzstecker*
ziehen.

Pronominal adverbs and conjunctives can acquire a precedence and an overlap reading, depending on the Aktionsart in the first sentence, and on the aspectual category. See *bevor* for a discussion. In contrast to *bevor*, the ordering of the related sentences is fixed—the anterior situation always comes first, whereas the position of the conjunctive is not fixed, see Section 5.3. The tables give those usage conditions that differ from *bevor*:

davor, zuvor, vorher (precedence)
Conditions of use: two separate sentences, pronominal adverb/conjunctive ordering is preposed discourse marker takes any position and can be modified
davor, zuvor, vorher (overlap)
Conditions of use: two separate sentences, pronominal adverb/conjunctive ordering is preposed discourse marker takes any position and can be modified

6.6 Ehe

Ehe (before, arch.) shares all its semantic and syntactic properties with *bevor* (see also [Buscha 1989, p70] and [Steube 1980, p42]). It deviates only regarding two minor aspects: First, *ehe* cannot occur with a temporal quantifier (**kurz ehe*, **einige Stunden ehe*), and second, it has different stylistic properties. *Ehe* is usually described as the more formal, or even archaic, variant of *bevor* [Helbig and Buscha 1991, p460]. Apart from these minor differences, *ehe* is in fact synonymous with *bevor*. The table lists only the properties that differ from *bevor*; see the discussion of *bevor* above for a characterization of meaning types and other usage conditions.

ehe
Conditions of use: discourse marker cannot be modified formal and archaic style, rare

6.7 Bis and Bis (P)

6.7.1 Bis

As *seitdem* is the durational counterpart of *nachdem*, *bis* (until) presents the durational variant of *bevor*. *Bis* is complementary to *seitdem* (among others [Eisenberg 1994, p362] and [Buscha 1989, p52]): *Seitdem* indicates the beginning of a durative situation, whereas *bis* marks its ending:

(6.51)

- a. **Seitdem** *die Ampel grün geworden war, fuhren die Autos.*
Since the traffic light green turned had, drove the cars.
'Since the traffic light had turned green the cars were driving.'
- b. **Bis** *die Ampel rot wurde, fuhren die Autos.*
Until the traffic light red turned, drove the cars.
'Until the traffic light turned green the cars were driving.'

In the case of *bis*, the duration of Sit_m is restricted by Sit_s (and not by S, as is the case with *seitdem*); hence the two functions of *bis* are:

- It gives the temporal location of Sit_m in relation to Sit_s .
- It specifies the minimal temporal extension of Sit_m by relating it to the time associated with Sit_s .

Generally speaking, *bis* signals that the main clause situation holds *at least until* the situation denoted by the subordinate clause begins. The phrase ‘at least until’ already suggests that *bis* has two possible readings: The default interpretation is that of precedence, where Sit_m lasts until Sit_s takes place (6.52a). In a different lexicogrammatical context, *bis* implies that Sit_m co-exists with Sit_s over some period of time and that the duration of Sit_m is limited by the end of Sit_s (6.52b) [Bäuerle 1995]. In the former case, the precedence relation holds between Sit_m and Sit_s , in the latter case between Sit_m and the ending of Sit_s , i.e. $egr(Sit_s)$, as the examples reproduced from [Bäuerle 1995, p174] illustrate:

(6.52)

- a. **Bis** *er Mumps hat, kann er in die Schule gehen.*
 Until he mumps has, can he in the school go.
 ‘Until he has mumps, he can go to school.’
- b. **Bis** *er das Examen abgelegt hat, darf er nicht ins Kino gehen.*
 Until he the exam taken has, may he not to the cinema go.
 ‘Until he has taken the exams, he is not allowed to go to cinema.’

It follows from the fact that Sit_m is limited by Sit_s that both situations have a time point in common, that is, Sit_s or $egr(Sit_s)$ immediately follow Sit_m (see example (6.53a) below), thus contrasting *bevor* where the intermediary time span is only restricted by the proximity relation (6.53b). This implies that no third situation can occur in between the two situations related by *bis*. Herweg’s *next* constraint describes this property of *bis* [Herweg 1991, p78]; *bevor*, in contrast, is neutral with respect to this constraint:

(6.53)

- a. *Tom schlief, bis Suse kam.*
 Tom slept until Suse came.
 ‘Tom was sleeping until Suse came.’
- b. *Tom schlief, bevor Suse kam.*
 Tom slept before Suse came.
 ‘Tom slept before Suse came.’

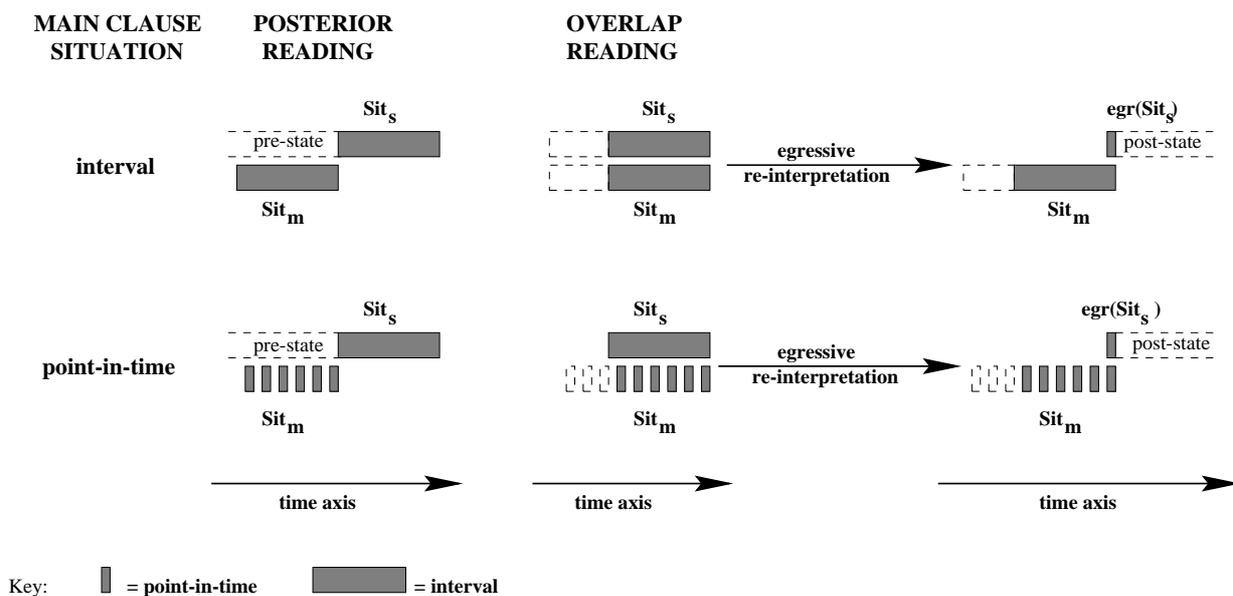


Figure 6.4: Schematic representation of posterior and overlap reading (involving egressive re-interpretation) of *bis*

As opposed to *seitdem*, *bis* does not imply any relation to the speaking time; instead, the main clause situation is limited by Sit_s . As with all other temporal connectives, the situation in the subordinate clause is presupposed. Figure 6.4 presents the temporal relations that can be indicated by *bis*. Note that like *seitdem*, *bis* also specifies the minimal temporal extension of Sit_m . Hence, punctiliar main clause situations (points in time) have to be iterated to obtain a temporal extension, as is shown in the second row of Figure 6.4.

Constraints on the situation type are the same as for *bevor*: If an overlap reading is to be expressed, the situation verbalized in the subordinate clause must have an inherent ending, to be precise, an egressive right boundary, in order to be able to locate Sit_m with respect to the ending of Sit_s (see examples (6.54a) and (6.54b)). The opposite holds for the precedence reading: Here, the situation verbalized in the subordinate clause must have an inherent beginning in the sense of an ingressive left boundary, since Sit_m ends with the beginning of Sit_s (see examples (6.54c) and (6.54d)):

(6.54)

- a. *?Suse schlief, bis Tom Ute kennengelernt hatte.*
 Suse slept until Tom Ute got to know had.
 ‘?Suse was sleeping until Tom had got to know Ute.’
- b. *Suse schlief, bis Tom das Buch gelesen hatte.*
 Suse slept until Tom the book read had.
 ‘Suse was sleeping until Tom had read the book.’

- c. *?Er hatte wenig Haare, bis er jung war.*
 He had little hair until he young was.
 ‘?He had little hair until he was young.’
- d. *Suse schlief, bis Tom anrief.*
 Suse slept until Tom called.
 ‘Suse was sleeping until Tom called.’

Finally, situations which already have an inherent ending, but that can occur only once, are ruled out in the main clause:

- (6.55) *?Maria heiratete Paul, bis sie in die Flitterwochen fahren.*
 Maria married Paul until they in the honeymoon drove.
 ‘?Maria married Paul until they went for their honeymoon.’

The argument here is that the non-durative situation in (6.55) (marrying someone) is limited in itself, and since it cannot be iterated, its duration cannot be limited by another situation.

The type of temporal relation signaled by *bis* again depends on the syntactic environment of the marker. Situation type constraints are reflected in Aktionsart restrictions: The Aktionsart in the main clause is confined to non-resultatives, since the duration of the main clause situation is terminated the subordinate clause situation and not by reaching the post-state of *Sit_m*. This constraint applies to precedence (6.56) and overlap (6.57) reading alike:

(6.56)

- a. *?Ich fuhr nach München, bis Manfred eintraf.*
 I drove to Munich until Manfred arrived.
 ‘?I was driving to Munich until Manfred arrived.’
- b. *Ich fuhr Auto, bis Manfred eintraf.*
 I drove the car until Manfred arrived.
 ‘I was driving around until Manfred arrived.’

(6.57)

- a. *?Tom füllte den Tank mit Wasser, bis Suse rief.*
 Tom filled the tank with water until Suse called.
 ‘?Tom was filling the tank with water until Suse called.’
- b. *Tom goss Wasser in den Tank, bis Suse rief.*
 Tom poured water into the tank until Suse called.
 ‘Tom was pouring water into the tank until Suse called.’

In most instances, *bis* correlates with a durative or stative verb in the main clause (6.58a); after all, *bis* is a durational temporal connective. A semelfactive or transformative verb in the main clause is interpreted iteratively (see [Steube 1980, p45] and [Eisenberg 1994, p461] and Figure 6.4), so that it can be conceived as having a temporal extension (6.58b). Not all verbs can take an iterative meaning, though (6.58c).

(6.58)

- a. *Tom schlief, bis ihn jemand weckte.*
Tom slept until him someone woke up.
'Tom was sleeping until someone woke him up.'
- b. *Tom klopfte, bis ihn jemand hereinließ.*
Tom knocked until him someone let in.
'Tom knocked until someone let him in.'
- c. *?Tom begann mit der Arbeit, bis es klappte.*
Tom started with the work until it worked.
'?Tom started the work until it worked.'

Precedence and overlap reading differ with respect to the Aktionsart of the subordinate clause verb; here, Aktionsart in combination with aspect distinguishes between the two meanings of *bis*: A non-durative Aktionsart in the subordinate clause, presenting the situation as punctiliar, always indicates a precedence reading (6.59a). With a durative or resultative, however, the meaning is not yet clear (6.59b and 6.59c):

(6.59)

- a. *Suse schlief, bis Tom anrief.*
Suse slept until Tom called.
'Suse was sleeping until Tom called.'
- b. *Suse schlief, bis Tom mit Anne telefonierte.*
Suse slept until Tom with Anne phoned.
'Suse was sleeping until Tom talked to Anne on the phone.'
- c. *Suse schlief, bis Tom mit Anne telefoniert hatte.*
Suse slept until Tom with Anne phoned had.
'Suse was sleeping until Tom had talked to Anne on the phone.'

Examples (6.59b) and (6.59c) show how Aktionsart and aspect interact: Durative situations are realized with the imperfective aspect to signal a precedence reading (the relation holds between Sit_m and the beginning of the durative Sit_s , $\text{ingr}(Sit_s)$). When used with a perfective they trigger an egressive (resultative) interpretation of Sit_s and thus express an overlap between the two situations (see also [Herweg 1991, p81]).

Bis behaves like *bevor* with respect to tense and ordering. Modification is not possible with *bis*: **kurz bis*, **eine Stunde bis* (*shortly until, *an hour until). While the main clause

can be negated (6.60a), or express a hypothetical situation, with the subordinate clause, this is only possible if the main clause is negated and at the same time unreal (6.60b and 6.60c) [Steube 1980, p145]:

(6.60)

- a. *Suse schlief nicht, bis Tom kam.*
 Suse slept not until Tom came.
 ‘Suse did not sleep until Tom came.’
- b. *?Suse schlief, bis Tom nicht kam.*
 Suse slept until Tom not came.
 ‘?Suse was sleeping until Tom didn’t come.’
- c. *Suse wird nicht schlafen, bis Tom nicht gekommen ist.*
 Suse will not sleep until Tom not come has.
 ‘Suse will not sleep until Tom has not come.’

Finally, *bis* can take the correlate *so lange* in the main clause to highlight the duration of Sit_m as in:

- (6.61) *Du überlegst so lange, bis es zu spät ist.*
 You think about it so long until it too late is.
 ‘You think about it until it is too late.’

Here are the semantic and syntactic properties of *bis* at one glance:

bis (posteriority)	
Temporal relation:	$meets(Sit_m, Sit_s)$ and $next(Sit_s, Sit_m)$ and $dur(Sit_m)$
Conditions of use:	Sit_s is presupposed Sit_s is l-bounded or lr-bounded Sit_m is r-bounded or lr-bounded verb denoting Sit_m is durative, stative or iterative clause denoting Sit_s has an imperfective aspect same tense or tense sequence; $E(Sit_m) \leq E(Sit_s)$ hypotactic clause complex, subordinate conjunction preferred ordering is postponed discourse marker takes front position and cannot be modified clause denoting Sit_s is positive and not hypothetical

bis (simultaneity)	
Temporal relation:	$equals(Sit_m, Sit_s)$ or $finishes-i(Sit_m, Sit_s)$, and $dur(Sit_m)$ in terms of precedence: $meets(Sit_m, egr(Sit_s))$ and $next(Sit_s, egr(Sit_m))$ and $dur(Sit_m)$
Conditions of use:	Sit_s is presupposed Sit_s is r-bounded or lr-bounded Sit_m is r-bounded or lr-bounded verb denoting Sit_m is stative, durative or iterative clause denoting Sit_s has a perfective aspect same tense or tense sequence; $E(Sit_m) \leq E(Sit_s)$ hypotactic clause complex, subordinate conjunction preferred ordering is postponed discourse marker takes front position and cannot be modified clause denoting Sit_s is positive and not hypothetical

6.7.2 Bis (preposition)

The preposition *bis* (until) differs from the conjunction *bis* in the following ways: It satisfies the stylistic constraint of brevity; it can only realize a strict precedence relation; the order is more often contrary to the order of occurrence in reality, that is, the PP usually occurs in sentence initial position; aspect and tense constraints for the Sit_s verbalization cease to apply. Further, a constraint specific to prepositions holds: The verb expressing Sit_s must have a nominal counterpart in order to take the complement position in a prepositional phrase. An example of two corresponding realizations is:

(6.62)

- a. *Suse schlief, bis Tom anrief.*
Suse slept until Tom called.
'Suse was sleeping until Tom called.'
- b. *Suse schlief bis zu Toms Anruf.*
Suse slept until to Tom's call.
'Suse slept until Tom's call.'

bis (temporal)	
Temporal relation:	$meets(Sit_m, Sit_s)$ and $next(Sit_s, Sit_m)$ and $dur(Sit_m)$
Conditions of use:	Sit_s is presupposed Sit_s is l-bounded or lr-bounded Sit_m is r-bounded or lr-bounded verb denoting Sit_m is not resultative deverbalization possible realization within a clause (PP), preposition discourse marker takes front position and cannot be modified concise style

6.8 Während, während(P), und währenddessen

6.8.1 Während

Während (while) is one of the temporal connectives signaling simultaneity as in examples (6.63a) to (6.63d):⁹

(6.63)

- a. **Während** *Tom Wasser in den Tank goss, zog Suse an der Zündkerze.*
While Tom water in the tank poured, pulled Suse at the sparkplug.
'While Tom was pouring water into the tank, Suse was pulling the sparkplug.'
- b. **Während** *Tom Wasser in den Tank goss, leuchtete die Tankleuchte auf.*
While Tom water in the tank poured, lit the tank lamp up.
'While Tom was pouring water into the tank, the tank lamp lit up.'
- c. **Während** *die Tankleuchte aufleuchtete, goss Tom Wasser in den Tank.*
While the tank lamp lit up, poured Tom water into the tank.
'While the tank lamp lit up, Tom was pouring water into the tank.'
- d. **?Während** *Tom den Tankdeckel aufsetzte, leuchtete die Tankleuchte auf.*
While Tom the tank cap put on, lit the tank lamp up.
'?While Tom was placing the tank cap, the tank lamp lit up.'

In all examples, the situations denoted by the clause complex overlap. Yet, *während* does not express the exact nature of the overlap (as opposed to the more specific *solange* (as long as), *sobald* (as soon as) and *seitdem* (since), see discussion below and also [Herweg 1991, p76]). Given two durative situations as in example (6.63a), one can imagine nine different ways in which Sit_s and Sit_m can relate:

- beginning and end of Sit_m and Sit_s are the same (*equals*)
- same beginning, but Sit_m either ends before or extends beyond Sit_s (*starts, starts-i*)
- same end, but Sit_m either starts before or after Sit_s starts (*finishes-i, finishes*)
- Sit_m starts before Sit_s and ends before or extends beyond Sit_s (*during-i, overlaps*)
- Sit_m starts after Sit_s and ends before or extends beyond Sit_s (*during, overlaps-i*)

This set is reduced considerably when given a punctiliar situation in the main clause, as in example (6.63b): The momentaneous Sit_m occurs at some point within the temporal interval denoted by the subordinate clause, this leaves the three relations *starts, finishes*

⁹In addition there are the archaic forms *derweil, indes, indessen* [Weinrich 1993, p753], which I will not discuss at this point.

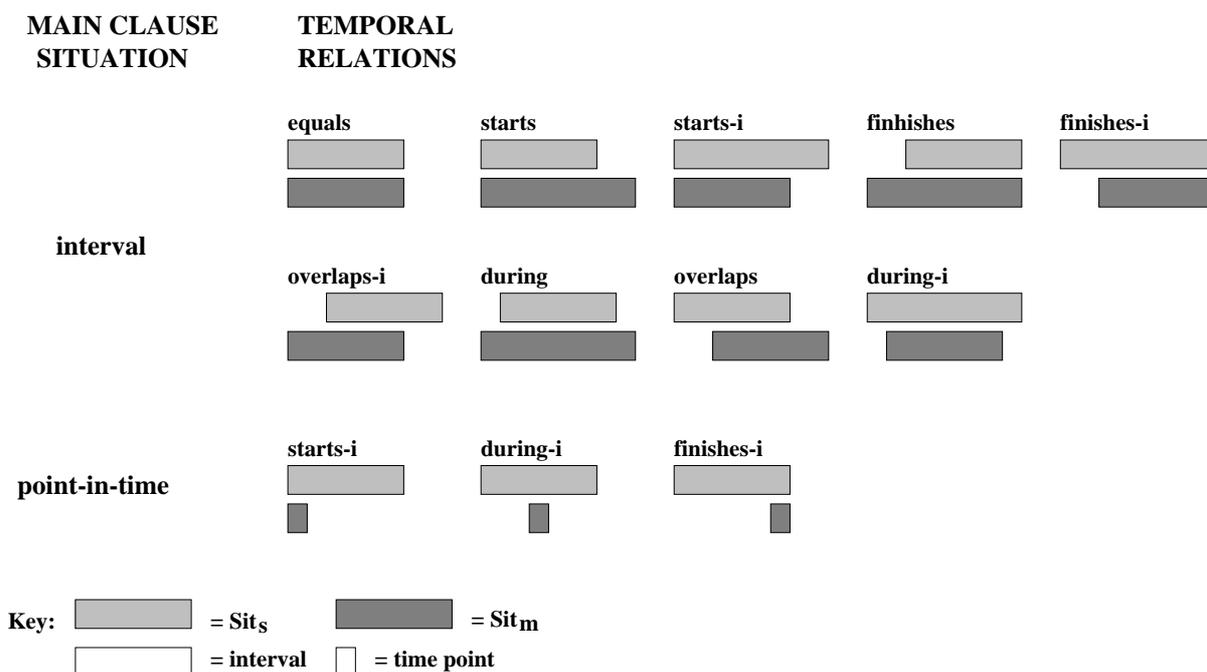


Figure 6.5: Temporal relations signaled by *während* given two intervals, or an interval and a time point

and *during*. Yet, an iterative reading of Sit_m is possible, thereby adding *equals* to the set of possible temporal meanings. In contrast, sentence (6.63c) again allows for all 9 relations, as *während* enforces an iterative re-interpretation of the non-durative Sit_s , now covering a temporal interval; using *als* instead of *während* would give the punctiliar reading of Sit_s . Sentence (6.63d) relates two situations that have no extension in time; here, using *als* is a better alternative (see [Helbig and Buscha 1991, Steube 1980]). Figure 6.5 gives a graphical representation of the set of temporal relations suggested by *während*.

With this variety of possible interpretations, *während* is by far the most ambiguous item from the group of simultaneity markers; other markers such as *solange*, *sobald* and *seitdem* are far more restricted regarding the number of possible interpretations they allow:

(6.64)

- a. **Während** *wir Radfahren, scheint die Sonne.*
While we cycle, shines the sun.
'While we were cycling, the sun was shining.'
- b. **Sobald** *wir Radfahren, scheint die Sonne.*
As soon as we cycle shines the sun.
'As soon as we are cycling, the sun shines.'
- c. **Solange** *wir Radfahren, scheint die Sonne.*
As long as we cycle shines the sun.

‘As long as we are cycling, the sun shines’

d. **Seitdem** *wir Radfahren, scheint die Sonne.*

Since we cycle, shines the sun.

‘Since we are cycling, the sun shines.’

But what is the exact nature of the difference? The examples above suggest that markers differ regarding the assumptions they make about beginning and end points of the related intervals [Sinn 1991, p150ff]: *Während* (6.64a) simply expresses an overlap between two situations; *sobald* (6.64b) suggests a joint beginning, but remains vague regarding the termination of the two situations; *solange* (6.64c) expresses that the two situations end at the same time, but does not relate their starting points; and finally, *seitdem* (6.64d) is the most specific marker as it gives beginning and end alike, the end point being the speaking time S. The following table summarizes the different degree of specificity of simultaneity markers:¹⁰

Marker	$E_s(Sit_s) = E_s(Sit_m)$	$E_f(Sit_s) = E_f(Sit_m)$
<i>während</i>	—	—
<i>solange</i>	—	✓
<i>sobald</i>	✓	—
<i>seitdem</i>	✓	$E_f(Sit_m)$ =speaking time

[Sinn 1991, p147ff] introduces the notion of a *situational focus* imposed by a temporal marker to describe the behaviour of *während*, *solange* and *sobald*. In her view, the three markers realize a different perspective on the same interval: *Sobald* focusses on the beginning of an interval and is therefore retrospective, *solange* highlights the end (prospective), and *während* focusses on the entire interval (introspective). From this perspective, *sobald* and *solange* can, in a way, be interpreted as relating a time point and an interval, hence the restricted set of temporal relations they can signal: Each connective can indicate three relations from the set given in Figure 6.5, namely those where the beginnings (*sobald*) or ends (*solange*) of the two situations co-occur.

To return to the discussion of *während*: Figure 6.5 shows how the type of situation denoted by a clause (durative vs. non-durative situation) interacts with the number of possible temporal relations signaled by *während*. One has to, however, become more specific on the properties of the durative situation to adequately describe the usage condition of *während*. In contrast to *nachdem* (after) and *sobald* (as soon as), which require an inherent beginning of situations in their overlap reading, *während* expects a situation of finite duration in the subordinate clause, which is not given for any of the following situations:

(6.65)

¹⁰ E_s denotes the beginning of a situation, E_f the end (cf. Section 5.3.7 above). Note that the table gives the relations that are made explicit by the discourse marker, not the information that has to be present for the marker to be applicable.

- a. **?Während** *die Erde rund ist, ...*
 While the earth round is, ...
 ‘?While the earth is round, ...’
- b. **?Während** *Magdeburg in der Börde liegt, ...*
 While Magdeburg in the Börde lies, ...
 ‘?While Magdeburg lies in the Börde, ...’
- c. **?Während** *Peter promoviert war, arbeitete er im Fachbereich Informatik.*
 While Peter his PhD had, worked he in the department of computer science.
 ‘?While Peter was holding his PhD, he worked in the computer science department.’

This behaviour of *während* can again be described by turning to [Sinn 1991, p152]. She claims that *während* expects egressive right-temporal states and durative situations. [Klenner 1991, p36] and [Herweg 1991, p77] even maintain that the situations have to be left- and right-bounded alike, although beginning and end do not have to be mentioned explicitly.

Similar constraints apply to the main clause situation. Consider the following examples, where in (6.66a) *Sit_m* is not limited:

(6.66)

- a. **?Während** *Tom in Berlin war, blieb Suse in Bonn.*
 While Tom in Berlin was, stayed Suse in Bonn.
 ‘?While Tom was in Berlin, Suse stayed in Bonn.’
- b. **Während** *Tom in Berlin war, heiratete Suse in Bonn.*
 While Tom in Berlin was, married Suse in Bonn.
 ‘While Tom was in Berlin, Suse married in Bonn.’

Example (6.66a) can only be interpreted adversatively, when construing a contrast relation between the two situations, a temporal reading is not available (see also [Steube 1980, p52]). As with all other temporal markers, the use of *während* requires that *Sit_s* can be presupposed.

With respect to the Aktionsart, *während* expects a stative, durative or a durative-resultative verb in the subordinate clause (see example (6.67a) below). *Während* cannot be used with non-durative verbs in the subordinate clause; here, *als* would be the preferred marker [Herweg 1991, Helbig and Buscha 1991, Steube 1980]. An exception are those semelfactives which can be interpreted iteratively, as the ‘knocking’-event in sentence (6.67b). Such an iterative interpretation cannot be enforced on singular events, as for instance the resultative ‘tear’-event in (6.67c), and the event of ‘getting to know somebody’ in (6.67d). For both sentences holds that the state induced by *Sit_s* cannot be reversed, hence it cannot occur several times in succession:

(6.67)

- a. **Während** *Tom Klavier spielte, las Suse ein Buch.*
 While Tom piano played, read Suse a book.
 ‘While Tom was playing the piano, Suse was reading a book.’
- b. **Während** *Tom klopfte, las Suse ein Buch.*
 While Tom knocked, read Suse a book.
 ‘While Tom was knocking, Suse was reading a book.’
- c. **?Während** *das Seil riss, las Suse ein Buch.*
 While the rope tore, read Suse a book.
 ‘?While the rope tore, Suse was reading a book.’
- d. **?Während** *Tom Suse erkannte, las Suse ein Buch.*
 While Tom Suse recognized, read Sue a book.
 ‘?While Tom recognized Suse, Suse was reading a book.’

Constraints on the main clause situation type are also reflected in the legal Aktionsarten: Duratives and statives (see example (6.68a)) are the rule, semelfactives and transformatives are also possible, now without undergoing an iterative re-interpretation (6.68b). If both, the subordinate clause and main clause verb, are non-duratives as in (6.68c), then *während* is odd; *als* (as) would again be the more appropriate connective (6.68d):

(6.68)

- a. **Während** *Tom Klavier spielte, las Suse ein Buch.*
 While Tom Piano played, read Suse a book.
 ‘While Tom was playing piano, Suse was reading a book.’
- b. **Während** *Tom Klavier spielte, klopfte Suse an die Tür.*
 While Tom piano played, knocked Suse at the door.
 ‘While Tom was playing Piano, Suse knocked at the door.’
- c. **?Während** *das Seil riss, explodierte der Tank.*
 While the rope tore, exploded the tank.
 ‘?While the rope tore, the tank exploded.’
- d. **Als** *das Seil riss, explodierte der Tank.*
 As the rope tore, exploded the tank.
 ‘As the rope tore, the tank exploded.’

As for the aspect, the corpora suggest that the imperfective aspect in both clauses is the ‘standard’ realization (6.69a). Yet, this is not a hard constraint, as sentence (6.69b) illustrates, where two durative verbs are used with perfective aspect, still signaling simultaneity (example (6.69a) is taken from the LIMAS corpus):

(6.69)

- a. **Während** *der Braten gart, bereiten Sie bitte das Gemüse.*
 While the roast meat cooks, prepare you please the vegetables.
 ‘While the roast meat cooks, prepare the vegetables.’
- b. **Während** *Tom Klavier gespielt hat, hat Suse ein Buch gelesen.*
 While Tom Piano played has, has Suse a book read.
 ‘While Tom has been playing the piano, Suse has been reading a book.’

Tense selection, however, is a hard constraint: The verb tense in both clauses has to be the same, as different tenses suggest a precedence relation and are thus to be avoided. Recall the discussion of the overlap and precedence reading of *nachdem*, *sobald* and *seitdem*, where the reading was signaled unambiguously by means of aspectual choice and tense selection, i.e. the use of corresponding tenses vs. sequence of tenses in the related clauses.

Finally, *während* places no constraint on the ordering of clauses, and it can be used with hypothetical situations, as long as both situations conjoined by *während* are still unrealized. *Während* does not allow for modification, since in contrast to anterior and posterior relations there is no temporal distance to quantify. Negation is possible but somewhat odd with *während* and durative Aktionsart (6.70a), but possible with non-duratives, since negating a transformative implies that the pre-state of the situation denoted by the verb holds, and therefore a durative situation (see (6.70b)). Still, *solange* would be the preferred discourse marker here:

(6.70)

- a. **?Während** *Tom nicht Klavier spielte, las Suse ein Buch.*
 While Tom not piano played, read Suse a book.
 ‘?While Tom was not playing the piano, Suse was reading a book.’
- b. **Während** *das Seil nicht riss, segelten wir munter voran.*
 While the rope not tore, sailed we happily on.
 ‘While the rope did not tear, we were sailing happily.’

Here are the properties of *während* at one glance:

während (temporal)	
Temporal relation:	$equals(Sit_m, Sit_s)$ or $starts(Sit_m, Sit_s)$ or $starts-i(Sit_m, Sit_s)$ or $finishes(Sit_m, Sit_s)$ or $finishes-i(Sit_m, Sit_s)$ or $overlaps(Sit_m, Sit_s)$ or $overlaps-i(Sit_m, Sit_s)$ or $during(Sit_m, Sit_s)$ or $during-i(Sit_m, Sit_s)$
Conditions of use:	Sit_s is presupposed Sit_s is lr-bounded verb denoting Sit_s is stative, durative or iterative same tense; $E(Sit_s) = E(Sit_m)$ hypotactic clause complex, subordinate clause discourse marker takes front position and cannot be modified

6.8.2 Während (preposition), bei and mit

The preposition *während* (during) relates to its conjunctive counterpart in the same way as *bevor* and *vor*, *nachdem* and *nach*, *bis* and *bis* (P), etc. Conditions for usage are above all morphosyntactic (does the verb have a deverbal realization?) and stylistic (is a concise text intended?):

(6.71)

- a. **Während** *Tom Wasser in den Tank goss, zog Suse an der Zündkerze.*
 While Tom water into the tank poured, pulled Suse at the sparkplug.
 ‘While Tom was pouring water into the tank, Suse was pulling at the sparkplug.’
- b. **Während** *des Eingießens zog Suse an der Zündkerze.*
 During the pouring pulled Suse at the sparkplug.
 ‘During the pouring Suse was pulling at the sparkplug.’

In contrast to other prepositions, *während* preserves the entire range of temporal relations signaled by the subordinate conjunction:

während (temporal preposition)	
Temporal relation:	<i>equals(Sit_m, Sit_s)</i> or <i>starts(Sit_m, Sit_s)</i> or <i>starts-i(Sit_m, Sit_s)</i> or <i>finishes(Sit_m, Sit_s)</i> or <i>finishes-i(Sit_m, Sit_s)</i> or <i>overlaps(Sit_m, Sit_s)</i> or <i>overlaps-i(Sit_m, Sit_s)</i> or <i>during(Sit_m, Sit_s)</i> or <i>during-i(Sit_m, Sit_s)</i>
Conditions of use:	<i>Sit_s</i> is presupposed <i>Sit_s</i> is lr-bounded verb denoting <i>Sit_s</i> is stative, durative or iterative realization within a clause (PP), preposition discourse marker takes front position and cannot be modified concise style

Bei (at/during) and *mit* (with) are near-synonyms of *während*. Both signal that the situation expressed in the main clause occurs simultaneously with the one depicted in the PP. The difference between *während* and *bei* (as explained by [Schröder 1990, p217ff]) is the following: *Bei* requires that *Sit_s* and *Sit_m* not only occur at the same time, but moreover at the *same place* (example 6.72a). If simultaneity alone is involved, then only *während* is acceptable (6.72b, see also [Durrell and Bree 1993, p314]; examples are theirs):

(6.72)

- a. **Während** *des Vortrags* / **Beim** *Vortrag ist es unhöflich zu sprechen.*
 During the talk is it impolite to talk.
 ‘It is impolite to talk during the talk.’

- b. *Bernd kam noch während / ?bei meiner Abwesenheit an.*
 Bernd arrived still during my absence.
 ‘Bernd arrived during my absence.’

Similar to *während*, *bei* can be used with durative and non-durative situations, whereas *mit* expects a momentaneous situation in the subordinate clause which marks the beginning or the end of the main clause situation [Schröder 1990, p145]:

(6.73)

- a. **Mit** / **Bei** *Sonnenaufgang wanderten wir los.*
 With / At sunrise walked we off.
 ‘With the / At sunrise we began our walk.’
- b. **Bei** *Sonnenaufgang wanderten wir schon.*
 At sunrise walked we already.
 ‘At sunrise we were already walking.’
- c. **?Mit** *Sonnenaufgang wanderten wir schon.*
 With sunrise walked we already.
 ‘?With sunrise we were already walking.’
- d. **Mit** *Sonnenaufgang begannen wir unsere Wanderung.*
 With sunrise began we our walk.
 ‘With the sunrise we began our walk.’

Hence, *bei* as well as *mit* are acceptable in example (6.73a), whereas only *bei* can be used with the durational interpretation (see example 6.73b). A durational reading is ruled out using *mit* (6.73c). Used with a verb that stresses the beginning and not the duration of the walk, as in sentence (6.73d), *mit* yields a well-formed sentence. Given this restriction on punctiliar situations in the PP, *mit* can indicate only a subset of the temporal relations signaled by *während* and *bei*, namely those where Sit_s starts or ends Sit_m . Further consequences of the restriction to non-durative situations are: The Aktionsart of Sit_s is either transformative, semelfactive, or can be interpreted ingressively (6.73d). Here are the restrictions on the use of *bei* and *mit*:

bei (temporal)	
Temporal relation:	$equals(Sit_m, Sit_s)$ or $starts(Sit_m, Sit_s)$ or $starts-i(Sit_m, Sit_s)$ or $finishes(Sit_m, Sit_s)$ or $finishes-i(Sit_m, Sit_s)$ or $overlaps(Sit_m, Sit_s)$ or $overlaps-i(Sit_m, Sit_s)$ or $during(Sit_m, Sit_s)$ or $during-i(Sit_m, Sit_s)$
Conditions of use:	Sit_s and Sit_m occur at the same place Sit_s is presupposed Sit_s is lr-bounded verb denoting Sit_s is stative, durative or iterative realization within a clause (PP), preposition discourse marker takes front position and cannot be modified concise style

mit (temporal)	
Temporal relation:	<i>equals</i> (Sit_m, Sit_s) or <i>starts-i</i> (Sit_m, Sit_s) or <i>finishes-i</i> (Sit_m, Sit_s)
Conditions of use:	Sit_s is presupposed Sit_s is lr-bounded verb denoting Sit_s is semelfactive or transformative realization within a clause (PP), preposition discourse marker takes front position and cannot be modified concise style

6.8.3 Währenddessen

Währenddessen (meanwhile) is the corresponding conjunctive, and *währenddem* (meanwhile, arch.) an archaic variant

- (6.74) *Tom hält einen Vortrag. Währenddessen esse ich eine Tafel Schokolade.*
Tom gives a talk. In the meantime eat I a bar chocolate.
‘Tom gives a talk. In the meantime, I eat a bar of chocolate.’

In contrast to *während*, the ordering of the sentences related by the pronominal adverb is fixed—the anterior situation always comes first, whereas the position of the pronominal adverb is not fixed, as was shown in Section 5.3.

währenddessen (temporal)	
Conditions of use:	two separate sentences, pronominal adverb ordering is preposed discourse marker takes any position and cannot be modified

6.9 Solange

As a durational connective, *solange* (as long as) serves two functions: It signals the kind of temporal relationship holding between two situations, and it specifies the duration of the main clause situation, which—in the case of *solange*—is limited by the end of the subordinate clause situation. Since *solange* defines the end point of two intervals, it is more specific than *während* with respect to the kind of overlap or inclusion relations holding between Sit_s and Sit_m :

- beginning and end of Sit_m and Sit_s are the same (*equals*)
- same end, but Sit_m either starts before or after Sit_s starts (*finishes-i*, *finishes*)

Some researchers like [Helbig and Buscha 1991, p466] and [Buscha 1989, p106] assume that *solange* can indicate only the first relation, where Sit_m and Sit_s have exactly the same

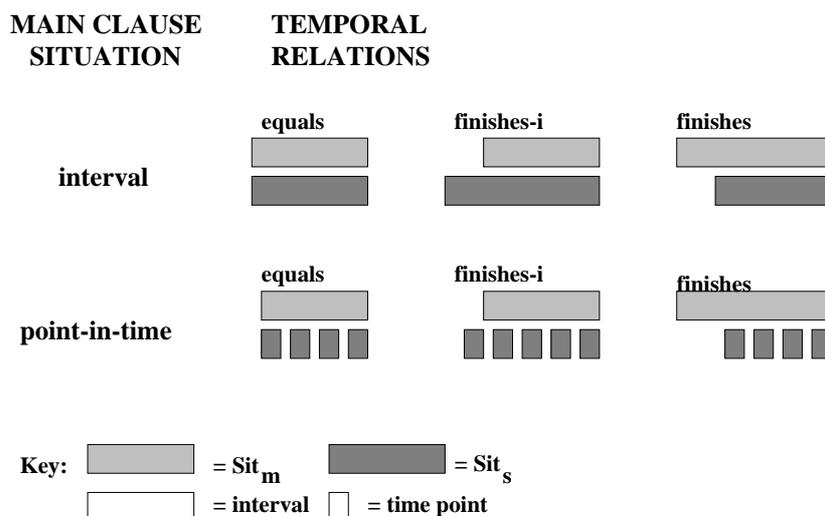


Figure 6.6: Temporal relations signaled by *solange* given two intervals, or an interval and a time point

begin and end points. Yet, consider example (6.75a) (adapted from the *während* examples above): All one can say is that the situations of pouring water into the tank and of pulling the spark plug are co-extensive and end when Sit_s terminates; nothing is implied about the beginnings. In sentence (6.75a), two intervals are related, whereas in (6.75b), the main clause event is punctiliar. Compare this and the corresponding *während* sentence given above: I argued that *während* simply positions the punctiliar event at some point within the interval; *solange*, however, being a durative connective, enforces an iterative reading on the punctiliar situation, so that a duration can be conceptualized. The same applies to sentence (6.75c), where Sit_s is construed as iterative, and in (6.75d), which is interpreted habitually. In both cases, the re-interpretation results in a durative Sit_s (see also [Herweg 1991, 982]):

(6.75)

- a. **Solange** *Tom Wasser in den Tank goss, zog Suse an der Zündkerze.*
 As long as Tom water in the tank poured, pulled Suse at the spark plug.
 ‘As long as Tom was pouring water into the tank, Suse was pulling out the spark plug.’
- b. **Solange** *Tom Wasser in den Tank goss, leuchtete die Tankleuchte auf.*
 As long as Tom water in the tank poured, lit the tank lamp up.
 ‘As long as Tom was pouring water into the tank, the tank lamp lit up.’
- c. **Solange** *die Tankleuchte aufleuchtete, goss Tom Wasser in den Tank.*
 As long as the tank lamp lit up, poured Tom water into the tank.
 ‘As long as the tank lamp lit up, Tom was pouring water into the tank.’
- d. **Solange** *Tom sich mit Suse traf, lebte er bei seinen Eltern.*
 As long as Tom himself with Suse met, lived he at his parents.

‘As long as Tom was meeting Suse, he lived at his parents.’

Figure 6.6 summarizes these observations: *Solange* relates two intervals in three different ways; if time points are involved they are re-interpreted as iterative so that they have a temporal extension. As such, the type of relation signaled is not sensitive to the situation types related, as is the case for *während*. Since *solange* locates Sit_m relative to the ending of Sit_s , Sit_s must be presupposed, and the situational focus is *prospective* (see [Sinn 1991, p147]).

In accordance with *während*, the subordinate clause situation must have an inherent ending, otherwise it cannot provide the end point of Sit_m . Therefore, examples (6.76a) and (6.76b) are ill-formed:

(6.76)

- a. **?Solange** *die Erde rund war, ...*
As long as the earth round was, ...
‘?As long as the earth was round, ...’
- b. **?Solange** *Magdeburg in der Börde lag, ...*
As long as Magdeburg in the Börde lain, ...
‘?As long as Magdeburg was in the Börde, ...’
- c. **Solange** *die Erde rund ist, ...*
As long as the earth round is, ...
‘As long as the earth is round, ...’
- d. **Solange** *Magdeburg in der Börde liegt, ...*
As long as Magdeburg in the Börde lies, ...
‘As long as Magdeburg is in the Börde, ...’
- e. **?Während** *Magdeburg in der Börde liegt, ...*
While Magdeburg in the Börde lies, ...
‘?While Magdeburg is in the Börde, ...’

When changing the tense to ‘present’ as in (6.76c) and (6.76d), they are well-formed when assigned an conditional reading; yet, a temporal interpretation is still not possible. This conditional reading is not available with *während* in example (6.76e).

As opposed to *während*, the type of Sit_m is not restricted at all: The termination of Sit_m is imposed by Sit_s , so there is no need to demand an inherent ending of Sit_m :

(6.77)

- a. **?Während** *Tom in Berlin war, blieb Suse in Bonn.*
While Tom in Berlin was, stayed Suse in Bonn.
‘?While Tom was in Berlin, Suse stayed in Berlin.’

- b. **Solange** *Tom in Berlin war, blieb Suse in Bonn.*
 As long as Tom in Berlin was, stayed Suse in Bonn.
 ‘As long as Tom was in Berlin, Suse stayed in Berlin.’

On the other hand, Aktionsart constraints are more complex than in the case of *während*. The subordinate clause verb has to be stative or duratives as in examples (6.78a) and (6.78b) below. However, in accordance with *während*, *solange* can be used with non-duratives as long as they can be interpreted as iteratives (6.78c), but only if they are not singular events (6.78d) and (6.78e) (see also [Steube 1980, Herweg 1991] for corresponding observations; example (6.78d) is reproduced from [Steube 1980, p50]):

(6.78)

- a. **Solange** *Tom in Berlin war, wohnte er in Kreuzberg.*
 As long as Tom in Berlin was, lived he in Kreuzberg.
 ‘As long as Tom was in Berlin, he was living in Kreuzberg.’
- b. **Solange** *das Eis schmolz, führte der Bach Hochwasser.*
 As long as the ice melted, had the stream high water.
 ‘As long as the ice was melting, the stream was in flood.’
- c. **Solange** *die Lampe aufleuchtete, goss Tom Öl in den Tank.*
 As long as the lamp lit up, poured Tom oil into the tank.
 ‘As long as the lamp lit up, Tom was pouring oil into the tank.’
- d. **?Solange** *das Seil reißt, ...*
 As long as the rope tears, ...
 ‘?As long as the rope tears, ...’
- e. **?Solange** *Tom Suse heiratete, wohnte er in Kreuzberg.*
 As long as Tom Suse married, lived he in Kreuzberg.
 ‘?As long as Tom married Suse, he was living in Kreuzberg.’

Note that sentence (6.78d) and (6.78e) can be paraphrased in two ways: Using *wenn* (when), if *Sit_m* does not have a temporal extension either (6.79a), or using the durative marker *bis* (until) to signal that a resultative situation defines the end point of a durative main clause situation (6.79b)):

(6.79)

- a. **Wenn** *das Seil reißt, ...*
 When the rope tears, ...
 ‘When the rope tears, ...’
- b. **Bis** *das Seil reißt, ...*
 Until the rope tears, ...
 ‘Until the rope tears, ...’

In short, resultatives are not possible in the subordinate clause. However, in case the subordinate clause is negated, momentaneous situations can be conceptualized as states, to be precise as those states that hold until the post-states of the situations denoted by the subordinate clause verb are triggered (6.80a and 6.80c) [Herweg 1991, p82]:

(6.80)

- a. **Solange** *das Seil nicht reißt, ...*
 As long as the rope not tears, ...
 ‘As long as the rope does not tear, ...’
- b. **?Solange** *sich Peter in Berlin niedergelassen hatte, ...*
 As long as himself Peter in Berlin seattled had, ...
 ‘?As long as Peter had settled in Berlin, ...’
- c. **Solange** *sich Peter nicht in Berlin niedergelassen hatte, ...*
 As long as himself Peter not in Berlin seattled had, ...
 ‘As long as Peter had not settled in Berlin, ...’

The same restrictions apply to the main clause verb: *Solange* can combine with statives and duratives, and it may also shift the Aktionsart of the main clause verb; in example (6.81) from a semelfactive to an iterative reading. This reflects one of the major differences between durative and temporal markers: *Solange* always expects a durative or iterative event in the main clause (example 6.81a), whereas *während* (while) does not enforce a re-interpretation of a semelfactive in the main clause (6.81b):

(6.81)

- a. **Solange** *Suse las, klopfte Tom.*
 As long as Suse read, knocked Tom.
 ‘As long as Suse was reading, Tom knocked.’
- b. **Während** *Suse las, klopfte Tom.*
 While Suse read, knocked Tom.
 ‘While Suse was reading, Tom knocked.’

Resultatives are prohibited in the main clause, as the following examples show:

(6.82)

- a. **Solange** *Lucy die Diamanten polierte, goss Jill Wasser in den Tank.*
 As long as Lucy the diamonds polished, poured Jill water into the tank.
 ‘As long as Lucy was polishing the diamonds, Jill was pouring water into the tank.’
- b. **?Solange** *Lucy die Diamanten polierte, füllte Jill den Tank mit Wasser.*
 As long as Lucy the diamonds polished, filled Jill the tank with water.
 ‘?As long as Lucy was polishing the diamonds, Jill was filling the tank with water.’

A durative verb in the main clause can combine with *solange* (6.82a), its resultative correspondent yields an ill-formed sentence (6.82b). Yet, the highly ambiguous *während* is appropriate, at the cost of losing the information on the simultaneous ending of both situations:

- (6.83) **Während** *Lucy die Diamanten polierte, füllte Jill den Tank mit Wasser.*
 While Lucy the diamonds polished, filled Jill the tank with water.
 ‘While Lucy was polishing the diamonds, Jill was filling the tank with water.’

Again in accordance to *während*, the imperfective aspect in the subordinate clause is the rule. Perfective aspect can only be used with *solange* in negated sentences [Steube 1980, p50], as this aspect suggests a resultative reading of the situation, which conflicts with the durative meaning of *solange*, see the discussion on Aktionsart above.

Tense constraints are those from *während*, i.e. the two situations have overlapping event times, and hence the same tense is used in both clauses. Further, past tense is preferred over present tense, since *solange* adopts a conditional reading when combined with present tense. The use of present tense suggests that Sit_s is a condition for maintaining Sit_m [Herweg 1991, p82]. While sentence (6.84a) can have a temporal and a conditional reading, in sentence (6.84b), the temporal reading is lost:

- (6.84)
- a. **Solange** *Suse in Berlin war, war Tom glücklich.*
 As long as Suse in Berlin was, was Tom happy.
 ‘As long as Suse was in Berlin, Tom was happy.’
- b. **Solange** *Suse in Berlin ist, ist Tom glücklich.*
 As long as Suse in Berlin is, is Tom happy.
 ‘As long as Suse is in Berlin, Tom is happy.’

To conclude the discussion of *solange*, here are the temporal relations *solange* can signal and the syntactic environment it can occur in:

solange	
Temporal relation:	$equals(Sit_m, Sit_s)$ or $finishes(Sit_m, Sit_s)$ or $finishes-i(Sit_m, Sit_s)$
Conditions of use:	Sit_s is presupposed Sit_s is r-bounded or lr-bounded verb denoting Sit_s is stative, durative or iterative verb denoting Sit_m is not resultative clause denoting Sit_s has an imperfective aspect same tense; $E(Sit_s) = E(Sit_m)$ where $E(Sit_s) < S$ and $E(Sit_m) < S$ hypotactic clause complex, subordinate conjunction discourse marker takes front position and cannot be modified

6.10 Als and wenn

The subordinating conjunctions *als* (as/when/while) and *wenn* (when) can indicate all three basic temporal relations, as their classification in Table 5.5 shows. [Steube 1980, p46] refers to *als* and *wenn* as ‘Konjunktionen mit offenem Zeitbezug’ (conjunctions with open temporal reference); likewise, [Buscha 1989, Helbig and Buscha 1991, Eisenberg 1994] and [Bäuerle 1995] maintain that the two conjunctions by themselves cannot indicate a particular temporal relation. However, there is no agreement as to what the properties of the linguistic context are that make an unambiguous interpretation possible; positions range from Aktionsart [Steube 1980, Eisenberg 1994], tempus [Steube 1980, Buscha 1989, Helbig and Buscha 1991] to point of reference [Bäuerle 1995].

Two additional characteristics set these two conjunctions apart from all other temporal discourse markers: In contrast to *nachdem*, *bevor*, *während*, *bis* and *seit(dem)*, neither *als* nor *wenn* have a prepositional counterpart or a corresponding conjunctive; they are not lexically related to any other temporal discourse marker [Herweg 1991, Bäuerle 1995].¹¹ Further, according to [Herweg 1991, p79] *als* and *wenn* can be used without restrictions with any kind of verb, whereas all other temporal conjunctions require a particular Aktionsart and aspect in their complement clause. See below for a discussion of this claim.

Als and *wenn* are analysed in one section, because they complement each other: *Als* is used when referring to subordinate clause situations that took place prior to speaking time S, while *wenn* correlates with *Sit_s* that occur at present or in the future [Steube 1980, Buscha 1989, Helbig and Buscha 1991, Herweg 1991]. Therefore, I restrict myself to a discussion of *als*; if not stated differently, the same properties also hold for *wenn*.

6.10.1 Als

[Herweg 1991, p79] claims that semantically, *als* and *wenn* express that the event times of *Sit_s* and *Sit_m* are the same (strict similarity) or as least overlapping. Yet, his claim of identity is in opposition to most other analyses suggested in the literature: [Steube 1980, Buscha 1989, Helbig and Buscha 1991, Eisenberg 1994] all argue that *als* can locate *Sit_m* before, after or parallel to non-durative situations (*Sit_s*); a similar claim is made by [Heinämäki 1978, Martin 1992, Hitzeman 1995] in their analyses of the English *when*. To support this position, consider the following examples, where example (6.85a) expresses simultaneity, example (6.85b) anteriority, and (6.85c) posteriority (examples (6.85a) and (6.85b) are taken from the LIMAS corpus, (6.85c) from [Bäuerle 1995, p162]):

(6.85)

- a. **Als** er redete, klang es, als hätte er Klöße im Mund.
As he talked, sound it as had he lumps in the mouth.

¹¹Based on this observation, [Herweg 1991, p84ff] maintains that *als* and *wenn* are related to the class of interrogatives, while all other temporal and durative conjunctions are conceived as prepositions with a sentential complement.

‘As he was talking, it sounded as if he had lumps in his throat.’

- b. *Erst als seine Munition verbraucht war, erkannte er, dass es keinen
 Only when his munition used was, realized he that there no
 Ausweg mehr gab.
 way out anymore was.*

‘Only when his munition was used up did he realize that there was no way out anymore.’

- c. *Als Fritz ins Bett ging, hatte er sein Glas ausgetrunken.
 When Fritz to bed went, had he his glas finished.*

‘When Fritz went to bed, he had finished his glass.’

In my view, examples such as (6.85b) and (6.85c) do not indicate any overlap between *Sit_s* and *Sit_m* as [Herweg 1991] would claim, but express a strict precedence relation between the two situations, which can be paraphrased with *nachdem* (after) in the case of (6.85b) and *bevor* (before) in the case of (6.85c).

In its simultaneous reading, *als* complements *während* (while): According to [Steube 1980, Buscha 1989, Helbig and Buscha 1991] *während* is restricted to *Sit_s* which have a temporal extension, while *als* is preferred with punctiliar, non-durative situations:¹²

(6.86)

- a. *?Als / Während wir Rad fahren, schien die Sonne.
 As / While we bike cycled, shone the sun.
 ‘?As / While we were cycling, the sun was shining.’*
- b. *Als / Während Tom klopfte, las Suse ein Buch.
 As / While Tom knocked, read Suse a book.
 As / While Tom knocked, Suse was reading a book.’*
- c. *Als / ?Während das Seil riss, las Suse ein Buch.
 As / ?While the rope tore, read Suse a book.
 ‘As / ?While the rope tore, Suse was reading a book.’*

Note that *als* triggers a semelfactive interpretation of the verb *klopfen* in example (6.86b) since it requires a singular event, whereas *während* suggests an iteration of the action. Given a non-durative *Sit_s*, temporal relations between the two situations do not include overlap as *Sit_s* cannot extend beyond *Sit_m*. As with all other temporal markers, *Sit_s* has to be presupposed.

With respect to Aktionsart constraints, the examples given so far suggest that the Aktionsart of the subordinate clause verb must be non-durative, that is, transformative (6.86c) or

¹²[Eisenberg 1994] and [Bäuerle 1995] believe that this use of *als* is over-restrictive, and that examples such as *Als Karl im Harz wanderte, schneite es* (When Karl was walking in the Harz mountains, it snowed) [Eisenberg 1994, p360] are well-formed despite the fact that walking is a durative activity. However, using *als* instead of *während* makes us conceive the situation as a whole, and does not highlight its extension in time, as *während* does.

semelfactive (6.86b); there are no constraints on the main clause verb. The simultaneity reading of *als* correlates with an imperfective aspect in the subordinate clause and the main clause (6.87a). A perfective aspect in the main clause is less frequent (examples are from the ZEIT corpus):

(6.87)

- a. **Als** *Erzbischof Romero noch lebte, war seine Stimme die einzige, die die Wahrheit sprach.*
 As archbishop Romero still lived, was his voice the only one that the truth spoke.
 ‘When archbishop Romero was still alive, his voice was the only one that expressed the truth.’
- b. **Als** *er in England war, hat er jeden Tag angerufen.*
 As he in England was, has he every day called.
 ‘When he was in England, he called every day.’

More importantly, the event times of both situations have to at least partially be the same, which yields the same verbal tense in both clauses (see (6.87a)), or a sequence of tenses (see (6.87b)), depending on the aspect in the main clause. Further, the situations always occur prior to speaking time *S*, i.e. the event time precedes speaking time. Recall that this is the distinguishing feature between *als* and *wenn*. No restrictions apply with respect to ordering and negation [Steube 1980, p48]. Modification is also possible: *gerade als* (just as) and *eben als* (just as).

When used to indicate an anteriority relation between two situations, *als* can sometimes substitute *nachdem* (after) in its precedence reading (example (6.88) is reproduced from [Helbig and Buscha 1991, p454]):

- (6.88) **Als / Nachdem** *die Sonne aufgegangen war, begannen sie mit dem Aufstieg.*
 As / After the sun risen had, began they with the climb.
 ‘When / After the sun had risen, they started the climb.’

It shares the temporal meaning and most of the constraints with *nachdem*. Like *nachdem*, and in contrast to the ‘simultaneous’ *als*, it requires a perfective aspect in the subordinate clause, and a sequence of tenses. In contrast to *nachdem*, the situations have to take place prior to speaking time, and *Sit_s* is a non-durative situation. Thus, the Aktionsart is again restricted to semelfactives and transformatives. In the anteriority reading, a preposed ordering is preferred, as it is the ‘natural’ order.

Finally, there is the posterior reading, which is, however, fairly rare (example (6.89) is reproduced from [Helbig and Buscha 1991, p454]):

- (6.89) *Er hatte sich schlafen gelegt, als das Telefon klingelte.*
 He had himself lain down to sleep, when the phone rang.
 ‘He had lain down to sleep when the phone rang.’

Instead of *als* (as), one could use *bevor* (before) in the example. In contrast to *bevor*, the posterior *als* requires that the subordinate clause denotes a punctiliar situation, or a durative situation that can be interpreted ingressively (as in example (6.89)). The subordinate clause displays an imperfective aspect, whereas the main clause requires a perfective aspect. This yields a resultative reading of Sit_m , which in turn enables a precedence reading of the two situations. As for the event times, Sit_m has to precede Sit_s , and both situations occur prior to speaking time S. In the posterior reading, the preferred order is Sit_m, Sit_s (postponed).

To sum up, *als* relates to *während*, *nachdem* (while, after) and *bevor* (before) in a principled manner: Following grammars and other analyses, I restrict the use of *als* to situations that are punctiliar; and to situations that occur before speaking time. [Bäuerle 1995, p169ff] in his analysis of *als* suggests that the notion of *Bezugpunktsetzung* (placement of reference point) is crucial to the description of *als* and its relation to other temporal discourse markers. In his understanding, *bevor* and *nachdem* are transition-oriented, *während* is extension-oriented, and *als* is neutral with respect to the reference point. This explains why (6.90a) is ill-formed, and (6.90b) is acceptable: *Während* focusses on the extension of a situation, whereas *als* is unspecific as to the orientation:

(6.90)

- a. **?Während** *die Bombe explodierte, war ich in Rom.*
 While the bomb exploded was I in Rome.
 ‘?While the bomb exploded, I was in Rome.’
- b. **Als** *die Bombe explodierte, war ich in Rom.*
 As the bomb exploded was I in Rome.
 ‘As the bomb exploded, I was in Rome.’

This is in conflict with my analysis which states that *als* focusses on the transition from one state to another, and hence on a punctiliar situation, and is by no means unspecific as to the orientation. In my view, example (6.90) can only be interpreted this way.

To conclude, here are the restrictions on the three temporal meanings of *als*:

als (simultaneity)	
Temporal relation:	<i>equals</i> (Sit_m, Sit_s) or <i>during-i</i> (Sit_m, Sit_s) or <i>finishes-i</i> (Sit_m, Sit_s) or <i>starts-i</i> (Sit_m, Sit_s)
Conditions of use:	<p>Sit_s is presupposed</p> <p>Sit_s is non-durative (punctiliar)</p> <p>verb denoting Sit_s is transformative or semelfactive</p> <p>clause denoting Sit_s has an imperfective aspect</p> <p>same tense; $E(Sit_s) = E(Sit_m)$ where</p> <p>$E(Sit_s) < S$ and $E(Sit_m) < S$</p> <p>hypotactic clause complex, subordinate conjunction</p> <p>discourse marker takes front position</p>

als (anteriority)	
Temporal relation:	<i>after</i> (Sit_m, Sit_s) and <i>prox</i> (Sit_s, Sit_m), or <i>meets-i</i> (Sit_m, Sit_s)
Conditions of use:	<p>Sit_s is presupposed</p> <p>Sit_s is non-durative (punctiliar)</p> <p>Sit_s is r-bounded or lr-bounded</p> <p>Sit_m is l-bounded or lr-bounded</p> <p>verb denoting Sit_s is transformative or semelfactive</p> <p>clause denoting Sit_s has a perfective aspect</p> <p>tense sequence; $E(Sit_s) < E(Sit_m)$ where</p> <p>$E(Sit_s) < S$ and $E(Sit_m) < S$</p> <p>hypotactic clause complex, subordinate conjunction</p> <p>preferred ordering is preposed</p> <p>discourse marker takes front position</p>

als (posteriority)	
Temporal relation:	<i>before</i> (Sit_m, Sit_s) and <i>prox</i> (Sit_s, Sit_m), or <i>meets</i> (Sit_m, Sit_s)
Conditions of use:	<p>Sit_s is presupposed</p> <p>Sit_s is non-durative (punctiliar)</p> <p>Sit_s is l-bounded or lr-bounded</p> <p>Sit_m is r-bounded or lr-bounded</p> <p>verb denoting Sit_s is transformative or semelfactive</p> <p>clause denoting Sit_s has an imperfective aspect</p> <p>tense sequence; $E(Sit_m) < E(Sit_s)$ where</p> <p>$E(Sit_s) < S$ and $E(Sit_m) < S$</p> <p>hypotactic clause complex, subordinate conjunction</p> <p>preferred ordering is postponed</p> <p>discourse marker takes front position</p>

6.10.2 Wenn

Wenn (when) is used instead of *als* in case the subordinate clause situation takes place in the present or in the future, i.e. $E(Sit_s) \geq S$ (examples (6.91a/b) are reproduced from

[Helbig and Buscha 1991, p472] and example (6.91c) from [Steube 1980, p46]:

(6.91)

- a. **Wenn** *die Sonne am höchsten steht, ist Mittag.*
 When the sun at its highest stand is noon.
 ‘When the sun is at its highest it is noon.’
- b. **Wenn** *der Besuch gekommen ist, essen wir.*
 When the visitors come is, eat we.
 ‘When the visitors have come, we eat.’
- c. **Wenn** *Peter nach Hause kommt, ist sein Bruder bereits abgereist.*
 When Peter to home comes, is his brother already gone.
 ‘When Peter comes home, his brother has already left.’

Apart from the difference in tense, *wenn* is used in the same way as *als*: It can indicate either simultaneity (example 6.91a), anteriority (6.91b) or posteriority (6.91c), with the same restrictions applying. Therefore, *wenn* inherits all the properties of *als*, except for the legal tense combinations, which look as follows:

wenn (simultaneity)
Constraints: same tense; $E(Sit_s) = E(Sit_m)$ where $E(Sit_s) \geq S$ and $E(Sit_m) \geq S$

wenn (anteriority)
Constraints: tense sequence; $E(Sit_s) < E(Sit_m)$ where $E(Sit_s) \geq S$ and $E(Sit_m) \geq S$

wenn (posteriority)
Constraints: tense sequence; $E(Sit_m) < E(Sit_s)$ where $E(Sit_s) \geq S$ and $E(Sit_m) \geq S$

6.11 Sooft

Finally, there is the iterative conjunction *sooft* (whenever). I found only one instance of *sooft* in the technical corpus, which, however, occurred in an ungrammatical sentence, apparently a bad translation to German. In other words, *sooft* is not a prominent marker in the domain under consideration, but for the sake of completeness, I briefly discuss usage conditions and lexicogrammatical properties of this marker.

Following [Steube 1980, p53] and [Helbig and Buscha 1991, p467], iterative conjunctions such as *sooft* (and its archaic near-synonyms *jedesmal wenn*, *immer wenn* (whenever)) signal that the situation in the main clause Sit_m iterates with every iteration of the subordinate clause situation Sit_s :

[...] zu jeder Wiederholung von S_1 [gehört] eine zeitlich parallele Wiederholung von S_2 .¹³ [Steube 1980, p52]

Like durative conjunctions, *sooft* conjoins relata that have an extension in time. However, in contrast to durative conjunctions, *sooft* and its near-synonyms do not relate continuing situations, but the iteration of situations [Weinrich 1993, p755]. Just as *als* and *wenn*, *sooft* is neutral with respect to the temporal relation holding between Sit_m and Sit_s : Sit_m can be anterior to, posterior to, or simultaneous with Sit_s . Further, *sooft* indicates no relation to speaking time. Consider the following examples reproduced from [Steube 1980, p53], where the situations in example (6.92a) occur simultaneously, in example (6.92b) Sit_m follows Sit_s , and in example (6.92c) Sit_m precedes Sit_s :

(6.92)

- a. **Sooft** *er in B. übernachtet, erzählen die Einheimischen auch*
 Whenever he in B. spends the night, tell the natives also
Spukgeschichten.
 ghost stories
 ‘Whenever he spends the night in B., the natives also tell ghost stories.’
- b. **Sooft** *er die Arbeit vorzeitig abgeliefert hat, ist ihm sofort*
 Whenever he the work ahead of schedule delivered has, is him promptly
eine neue übertragen worden.
 a new assigned.
 ‘Whenever he had delivered a work ahead of schedule, he was promptly assigned a new one.’
- c. **Sooft** *sie Besuch bekam, hat sie vorher die ganze Wohnung*
 Whenever she visitors had, has she beforehand the entire flat
auf den Kopf gestellt.
 turned upside down.
 ‘Whenever she expected visitors, she turned the entire flat upside down beforehand’

The time span which defines the extension of the repetition can either be made explicit or left implicit. In any case, Sit_s must be a bounded situation, either durative or momentaneous, as sentences such as (6.93a) are ill-formed. Likewise, Sit_m cannot be unbounded, as example (6.93b) illustrates where a repetition of the ‘knowing’ event is not possible:

(6.93)

- a. **?Sooft** *sie groß war, staunte er.*
 Whenever she tall was, was astonished he.
 ‘?Whenever she was tall he was astonished.’
- b. **?Sooft** *sie lachte, kannte er sie.*
 Whenever she laughed, knew he her.
 ‘?Whenever she laughed, he knew her.’

¹³English translation: To every repetition of S_1 belongs a temporally parallel repetition of S_2 .

Constraints on properties of the linguistic environment interact with the temporal relation that holds between the two situations. Here, the behaviour of *sooft* corresponds to that of *als* and *wenn* in many respect: Tense and aspect constraints are the same. Given an appropriate situation type, *sooft* does not impose restrictions regarding the Aktionsart of the verbs. Here are the usage conditions of *sooft* in interaction with the temporal relation signaled:

sooft (simultaneity)	
Temporal relation:	$equals(Sit_m, Sit_s)$ or $during-i(Sit_m, Sit_s)$ or $finishes-i(Sit_m, Sit_s)$ or $starts-i(Sit_m, Sit_s)$
Conditions of use:	<p>Sit_s is iterated</p> <p>Sit_s is presupposed</p> <p>Sit_s is lr-bounded</p> <p>Sit_m is lr-bounded</p> <p>clause denoting Sit_s has an imperfective aspect</p> <p>same tense; $E(Sit_s) = E(Sit_m)$ where</p> <p>$E(Sit_s) < S$ and $E(Sit_m) < S$</p> <p>hypotactic clause complex, subordinate conjunction</p> <p>discourse marker takes front position</p>

sooft (anteriority)	
Temporal relation:	$after(Sit_m, Sit_s)$ and $prox(Sit_s, Sit_m)$, or $meets-i(Sit_m, Sit_s)$
Conditions of use:	<p>Sit_s is iterated</p> <p>Sit_s is presupposed</p> <p>Sit_s is lr-bounded</p> <p>Sit_m is lr-bounded</p> <p>clause denoting Sit_s has a perfective aspect</p> <p>tense sequence; $E(Sit_s) < E(Sit_m)$ where</p> <p>$E(Sit_s) < S$ and $E(Sit_m) < S$</p> <p>hypotactic clause complex, subordinate conjunction</p> <p>preferred ordering is preposed</p> <p>discourse marker takes front position</p>

sooft (posteriority)	
Temporal relation:	$before(Sit_m, Sit_s)$ and $prox(Sit_s, Sit_m)$, or $meets(Sit_m, Sit_s)$
Conditions of use:	<p>Sit_s is iterated</p> <p>Sit_s is presupposed</p> <p>Sit_s is lr-bounded</p> <p>Sit_m is lr-bounded</p> <p>clause denoting Sit_s has an imperfective aspect</p> <p>tense sequence; $E(Sit_m) < E(Sit_s)$ where</p> <p>$E(Sit_s) < S$ and $E(Sit_m) < S$</p> <p>hypotactic clause complex, subordinate conjunction</p> <p>preferred ordering is postponed</p> <p>discourse marker takes front position</p>

Chapter 7

Functional description of German temporal markers

This chapter presents a functional classification of the German temporal discourse markers examined in the preceding chapter. Such a functional account captures the differences and commonalities between discourse markers by sets of features organized in a system network, as has been proposed by [Martin 1992] for English. Given the results of the analysis in Chapter 6, I am now able to give a German counterpart for Martin's English temporal conjunctive relation networks [Martin 1992, p185ff].

In Section 7.1, I discuss Martin's conjunctive relation networks and their relation to discourse and lexicogrammar (Section 7.1), and then turn to the methodological question of how to derive classifications of conjunctive relations from the results of the temporal marker analysis (Section 7.2). Section 7.3 proposes the system network for external German temporal conjunctive relations. The chapter concludes with a comparison of the functional modelling for German with results from other languages, in particular with Martin's account of English temporal markers [Martin 1992], and Oversteegen's description of Dutch temporal connectives [Oversteegen 1993] (Section 7.4).

7.1 Martin revisited

Recall that in Martin's understanding conjunctive relations describe the lexico-semantic relations holding between text segments in the ongoing construction of a text from beginning to end, which can be expressed through diverse realizations (see [Martin 1992, p168ff] and Chapter 4). As such, conjunctive relations provide the link between a more abstract discourse representation (which links into the context) and its linguistic realization through lexicogrammatical means. Martin regards such a discourse representation as describing non-local relationships that represent rhetorical effects, and that concern the larger-scale build-up of a text. These are signaled on the linguistic surface by lexicogrammatical resources, among them, as the most straightforward means, connectives. Conjunctive relations relate these two levels, that is, capture the means by which the non-local

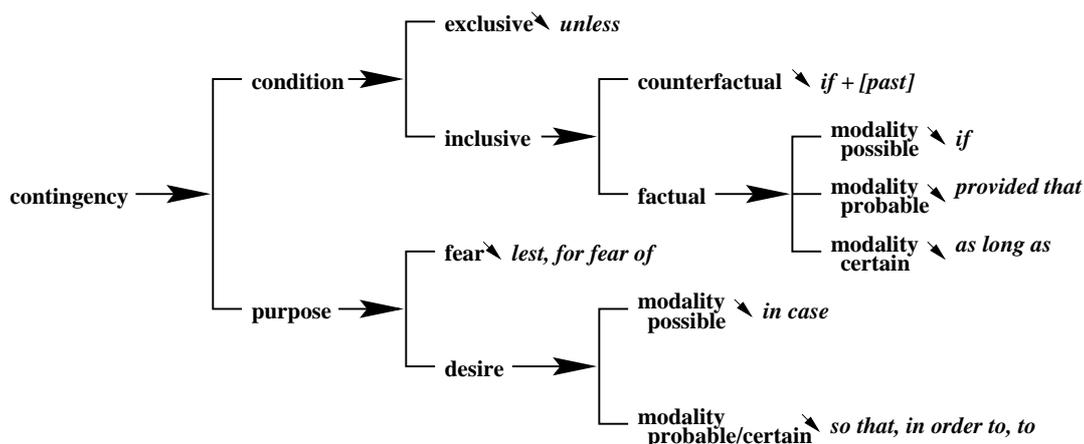


Figure 7.1: Taxonomy of English hypotactic external consequential contingent relations [Martin 1992, p198]

relationships are built up, organized and signaled locally [Bateman and Rondhuis 1997]. In this understanding, conjunctive relations are logical resources.

The major characteristics of Martin’s conjunctive relations, which set them apart from the rhetorical accounts of coherence relations surveyed in Chapter 3, are their close link to lexicogrammar, that is, their constant and systematic reference to the grammatical realizations that particular conjunctive relations allow, and the local character of the relations. As has been argued in Chapter 3, these two aspects and the functional orientation make this approach particularly suitable for the task of selecting discourse markers to signal more ‘abstract’ coherence relations.

[Bateman and Rondhuis 1997], in their work, take Martin’s ideas one step further. They are more explicit on the set up of the discourse level. For them, the logical consequence of Martin’s considerations is to divide the discourse stratum in two regions related by realization:

The “lower”, less abstract region is then responsible for specifying discourse coherence in terms that can be related directly to the lexicogrammar. The “higher”, more abstract region is responsible for relating communicative intentions to configurations of coherence relations. [Bateman and Rondhuis 1997, p33]

To represent conjunctive relations, Martin uses standard systemic networks. An example of such a network is depicted in Figure 7.1. The network classifies a subtype of English consequential relations, relations of contingency. It includes discourse markers as realizations of contingent relations. The system network is to be read as follows: The networks are feature hierarchies, with curly left-facing brackets indicating a conjunction of features, and square right-facing brackets introducing subclasses. Each disjunction holding over a group of features, a grammatical system, is seen as a point of abstract functional

choice. A path through the network from the entry point (here: [contingency]) to a terminal feature yields a set of features, the so-called *selection expression*. This set defines a particular conjunctive relation: “Each conjunctive relation is defined by a path through the conjunctive relation classification networks that describes the relation most closely” [Bateman and Rondhuis 1997, p16]. For instance, one particular conjunctive relation is given by the path from [contingency] to [exclusive]: [contingency:condition:exclusive].

The linguistic forms that may realize particular feature choices are expressed by *realization statements* which are associated with individual features. These statements set lexicogrammatical constraints that must be fulfilled by the linguistic unit classified by a selection expression. In the sample network, this is the lexeme that can signal a particular conjunctive relation. For instance, the selection expression given above is associated with a lexicalization instruction for *unless*. These instructions for the lexicogrammatical realization are introduced by downpointing arrows (\searrow). Each feature in the network specifies an *applicability constraint* defined in terms of semantic/discourse properties and relations, and features may be associated with *realization constraints* that restrict the expression of the related units in the lexicogrammar.

The selection of a particular path through the network, i.e. choosing among alternatives in the hierarchy, depends on conditions that hold in the context. Possible reasons for selecting a particular path are ideational conditions such as causal relationships, or interpersonal aspects such as speaker’s intentions. Depending on what conditions hold, different paths are motivated, and accordingly, different constraints on the linguistic form are established. Consider again the network in Figure 7.1: If—on a more abstract discourse level—a CONDITION relation holds, the feature [condition] would be selected, which makes a group of conditional markers available, such as *unless*, *if*, *as long as*, etc. In the case that a PURPOSE relation holds, one of *lest*, *in case of*, *so that* etc. is verbalized.

Note that the network in Figure 7.1 only gives the simplest realization, i.e. examples of possible connectives. As mentioned above, this is only one means to signal relations on the discourse level in text. [Bateman and Rondhuis 1997, p13] and [Oversteegen 1993] claim that the full network definitions must also include partial constraints on the grammatical structures involved; such constraints are only occasionally given in [Martin 1992]. Section 7.4 below discusses this further.

7.2 Building conjunctive relation networks

7.2.1 Linguistic analysis and conjunctive relation networks

The system networks that classify German temporal conjunctive relations (as proposed in Section 7.3 below) are based on the detailed analysis of German temporal discourse markers in Chapter 6. This is a reasonable approach as discourse markers are one means of realizing conjunctive relations (cf. [Martin 1992] and above). In general, the relation between the results of the descriptive work and the proposed conjunctive relation networks is as follows:

For each temporal discourse marker, the analysis yields a set of properties characterizing the use of the temporal marker which is given at the end of the discussion of individual temporal markers in Chapter 6. The properties can be subdivided into two distinct sets: The first set contains properties that concern the meaning of the marker itself; the second set comprises properties that describe aspects of the linguistic environment that have to be given for a marker to be available.¹ These two groups match the levels that are linked by conjunctive relations in Martin's framework: the former comprises properties that belong to the more abstract discourse representation, and the latter relate to lexicogrammatical resources. Hence, temporal conjunctive relations can be said to provide the link between the two sets, i.e. between properties of temporal marker meaning and the linguistic constraints on a temporal marker's availability.

As described in the preceding section, [Martin 1992] uses systemic networks to classify conjunctive relations. Here, a path from the entrance point of the network to a terminal feature names a particular conjunctive relation. This representation is now applied to German temporal discourse markers, which are one possible realization of temporal conjunctive relations. Restrictions on the availability of a particular interpretation and thus on a temporal connective, the linguistic constraints, directly enter the representation as lexicogrammatical constraints associated with a feature (as *realization statements*). The integration of aspects relating to marker meaning is less straightforward: They do not enter the system network, but provide the *reasons* for choosing a particular path through the network, i.e. a particular feature. For instance, the fact that the temporal relation *before* holds motivates the selection of a subnetwork that describes temporal precedence relations. In the context of temporal connectives, the conditions for choosing among network features are mainly ideational, as has been shown in Section 5.3 when introducing the dimensions of temporal marker description. In a nutshell, the linguistic constraints enter the networks directly, whereas the integration of properties relating aspects of marker meaning is only indirect. The network features on a path leading from the entry point of the system network to a leaf node define a particular temporal conjunctive relation, that has a (set of) temporal marker(s) attached to the leaf node as realizational consequence(s). Similar representations have been proposed by [Oversteegen 1993] for Dutch temporal markers and [Hitzeman 1995] for English temporal markers (these approaches are discussed in detail in Section 7.4 below).

7.2.2 Methodological issues

The discussion so far has dealt with the relation between the results of the temporal marker analysis and a system network classifying German temporal conjunctive relations on an abstract level. Now the task is to build the system network itself given these insights and the characterization of German temporal markers in Chapter 6. In other words, we need to address the methodological question of how to derive a linguistically sound classification

¹Recall that the analysis has shown that different readings of a temporal marker are subject to particular constraints drawn from of the linguistic environment, such as lexical or syntactic features. For instance, the interpretation of *nachdem*, *sobald* and *bevor* (after, as soon as, before) interacts with aspectual choice, the one of *als* and *wenn* (as, when) with tense structure, etc.

of German temporal conjunctive relations from the linguistic data accumulated in the preceding chapter. This involves two subtasks: First, to determine the inventory of features that adequately describes German temporal conjunctive relations, and second, to impose a classification that reflects similarities and differences between the linguistic means under consideration, temporal markers. The resulting network should be able to map properties of the context (as identified in Chapter 6) to linguistic means, i.e. temporal markers.

In Systemic Functional Linguistics the following strategy has been established: Network features are defined so that they group together sets of utterances with similar lower-level linguistic features, and to distinguish between groups of utterances that differ. These minimal oppositions, giving rise to systems, form system networks through their entry conditions, i.e. common conditions of usage. However, deploying system networks as classificatory means has its limitations, as has been pointed out by, among others, [Martin and Matthiessen 1990]. They maintain that a system network makes explicit how phenomena are related, but that it is—similar to taxonomies in general—always just a partial statement of similarity and difference [Martin and Matthiessen 1990, p3]. Depending on the criterion selected as a classificatory principle, a system network explicates a particular set of relations holding between entities and imposes a particular order upon them, while at the same time omitting relations between entities that do not fit the current classificatory principle. In other words, the point of departure, i.e. the primary choice in a system networks, foregrounds some criteria and backgrounds others, and thus determines the shape of the system network. From this point of view, the “system network constitutes a theory of typology of linguistic units” [Martin and Matthiessen 1990, p3].

To illustrate this, consider the following example concerning the classification of process types from [Martin and Matthiessen 1990, p21ff]. According to [Halliday 1994], material and behavioural processes form a system, as do verbal and mental ones, and relational and existential ones. Yet, as [Martin and Matthiessen 1990, p22] point out, behavioural processes do not only resemble material ones regarding some parameters, but also mental and relational ones regarding others. Depending on which parameters are taken as primary choice in a system network classifying process types, behavioural can be grouped with material or with mental processes.

The main point of the argument is that there does not exist a single classification for a particular set of linguistic data, as systemic functional work might sometimes suggest. A complementary view to the “theory of typology”—i.e. to the *typological perspective* imposed by system networks—is what [Martin and Matthiessen 1990, p28ff] introduce as *topological view*, which establishes degrees of nearness or proximity between phenomena based on various criteria without foregrounding a particular parameter: “It turns a ‘collection’ or set of objects into a *space* defined by the relations of these objects.” [Martin and Matthiessen 1990, p28]. Following this approach, the proximity of behavioural processes to material and mental processes could both be captured; one does not have to decide on one relation.

Most research in the area of word field, or lexical field, analysis adopts the topological view. Here, the relations between (groups of) linguistic phenomena do not give rise to a hierarchy, but open up a semantic space that describes the various relations holding between lexemes,

nachdem	$(\text{after} \wedge \text{prox}) \vee \text{meets-i}$
nach	$(\text{after} \wedge \text{prox}) \vee \text{meets-i}$
danach	$(\text{after} \wedge \text{prox}) \vee \text{meets-i}$
nachdem+adverb	meets-i
sobald	$((\text{after} \wedge \text{imm}) \vee \text{meets-i}) \wedge \text{next}$
sowie	$((\text{after} \wedge \text{imm}) \vee \text{meets-i}) \wedge \text{next}$
kaum dass	$((\text{after} \wedge \text{imm}) \vee \text{meets-i}) \wedge \text{next} \wedge \text{negative-judgement}$
seitdem	$((\text{after} \wedge \text{imm}) \vee \text{meets-i}) \wedge \text{next} \wedge \text{dur}$
seit (P)	$((\text{after} \wedge \text{imm}) \vee \text{meets-i}) \wedge \text{next} \wedge \text{dur}$
ab	$((\text{after} \wedge \text{imm}) \vee \text{meets-i}) \wedge \text{next} \wedge \text{dur} \wedge \text{past-duration}$
als	$((\text{after} \wedge \text{prox}) \vee \text{meets-i}) \wedge \text{punctiliar-singular}$
wenn	$((\text{after} \wedge \text{prox}) \vee \text{meets-i}) \wedge \text{punctiliar-singular}$

Table 7.1: Meanings signaled by anterior temporal markers

and that indicates proximity and distance between them. [Fischer 2000, p207ff] gives an apt summary of current work in this area, and also surveys quantitative methods to create lexical fields. Yet, as she notes when applying these methods to the analysis of German discourse particles, although the clusterings given are intuitively plausible, they do not make the contributions of each discourse particle clear (something a systemic classification surely tries to do). Hence, both views—the typological and the topological—should be regarded as complementary, as has been suggested by [Martin and Matthiessen 1990, p3]. The topological view provides us with (groups of) lexical items that are semantically close, and the typological perspective then imposes a particular classification on the relations which might differ depending on the primary criteria (cf. [Martin and Matthiessen 1990, p40]).

Despite the limitations of the system network representation that have been pointed out above, I use this formalism to represent German temporal conjunctive relations for three reasons. First of all, the major criticism that one has to commit oneself to a certain classification principle which might exclude others when using system networks, does not really affect my goals. As I have a particular purpose in mind—the classification of German temporal relations and their lexical realizations—the point of departure for my network is clear: I am concerned with temporal relations holding between the linguistic units, they are thematic for the description, and I on purpose ignore other relations that might also hold. Still, I am well aware that the networks I propose are only one way of classifying the linguistic data under consideration and of representing temporal conjunctive relations. Second, I want to account for the hyponymy relations holding between linguistic units, hence I require a representation that imposes a hierarchy on the relations, just as the system networks do. Third, the application in mind motivates the systemic representation: I need not merely an account of similarities and differences between linguistic units, but also knowledge of the contribution of the linguistic units and the criteria for choice. Thus,

the task of deriving system networks from the linguistic data accumulated in Chapter 6, which gave rise to the present discussion, still has to be addressed.

7.2.3 Building German temporal conjunctive relation networks

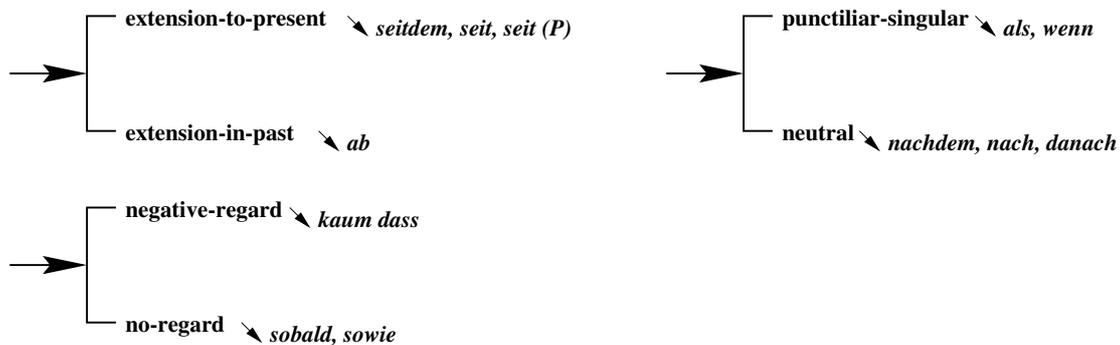
To illustrate the derivation of a systemic classification from the analysis results in Chapter 6, consider the group of anterior markers: This group comprises the following markers: *ab*, *als*, *danach*, *kaum dass*, *nach*, *nachdem*, *nachdem+adverb*, *seit (P)*, *seitdem*, *sobald*, *sowie* and *wenn* (from, as, then, no sooner than, after (P), after, after+adverb, since (P), since, as soon as, as soon as, when). Table 7.1 reproduces the properties relating to context as given in Chapter 6. Now, building a network requires grouping together lexemes that signal similar meanings, and introducing oppositions where linguistic means diverge in meaning. The former requires a top-down strategy, the latter proceeds bottom-up. I use a combined approach.

First, I take a bottom-up perspective and identify minimal oppositions in the marker set given in Table 7.1. Utterances that only diverge with respect to one meaning aspect are grouped together. This yields several pairs: *sobald/sowie* vs. *kaum dass*; *seit/seitdem* vs. *ab* and *nachdem/nach/danach* vs. *als/wenn*.² Next, systems are introduced for these pairs, representing the choice between the alternative means. These are the most delicate systems in the system network. The three resulting systems are depicted in Figure 7.2 (a). The opposition *sobald/sowie* vs. *kaum dass* gives rise to a system selecting between judgemental and neutral temporal markers (features [negative-regard] and [no-regard]); the pair *seitdem/seit* vs. *ab* motivates a system with the features [extension-to-present] and [extension-in-past]. Finally, a system distinguishing between [punctiliar-singular] and [neutral] situations is introduced to capture the difference between *nachdem* on the one hand and *als* and *wenn* on the other hand.

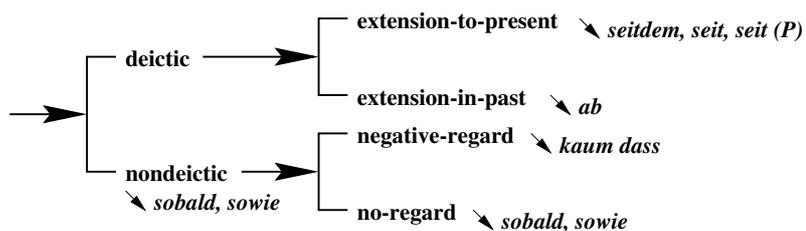
In a next step, minimal oppositions between groups of markers give rise to further features and systems: For instance, the groups *sobald/sowie*, *kaum dass* and *seitdem*, *seit (P)*, *ab* differ only with respect to durativity (cf. Table 7.1). The latter group signals the duration of the situations, whereas the former does not express this meaning aspect. Therefore, I assume a non-terminal system with the features [deictic] and [nondeictic] to account for this opposition. The features act as entry conditions to the systems distinguishing between *seitdem*, *seit* and *ab* on the one hand, and *sobald*, *sowie* and *kaum dass* on the other hand. Note that since *sobald* and *sowie* are neutral with respect to an intention (cf. entries in Table 7.1 which give no such information), they are also treated as possible realizations of the non-terminal [nondeictic] feature itself. This accounts for the fact that *kaum dass* refines *sobald*, and that *sobald* can always be substituted for *kaum dass*, although at the cost of losing the interpersonal information. The resulting network is also depicted in Figure 7.2(b) (System network I).

²When given a larger amount of linguistic units to be related, it would be advisable to not rely on intuition alone to identify minimal pairs but to turn to quantitative methods, for instance, clustering methods, to group together different lexemes that fulfil similar functions (see for instance [Fischer 2000, p207]).

(a) Minimal oppositions



(b) System network - I



(c) System network - II

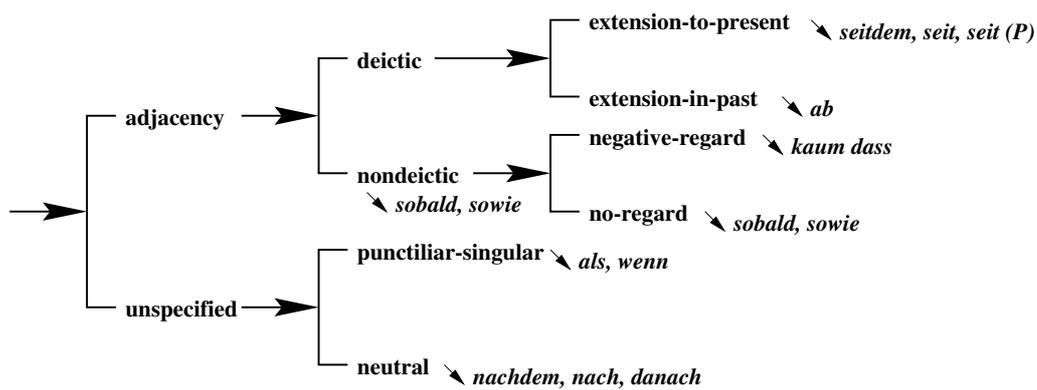


Figure 7.2: Designing the anterior subnetwork: Most delicate systems

The discussion of *sobald* and *kaum dass* exemplifies the general strategy on lexicogrammatical realization adopted in this thesis: In my networks, terminal and non-terminal features can have lexical realizations attached to them. The reason behind this is as follows: It has been pointed out in Chapter 6 that some discourse markers are more widely applicable than others. For instance, it is claimed in the research literature that *nachdem*, *bevor* and *während* (after, before, while) are the prototypical temporal markers, signaling the three general relations of anteriority, posteriority, and simultaneity respectively, and that they can (nearly always) substitute other temporal markers signaling more specific kinds of relations. And indeed, as the analysis in Chapter 6 reveals, the semantic conditions of usage for these three markers are by far the most general ones. They signal a particular temporal relation, but are neutral with respect to additional semantic constraints such as durativity, adjacency, etc. An example is given in Table 7.1, which shows the semantic constraints (or meanings signaled) by the anterior temporal markers. Here, *nachdem* is the least specific marker, all other anterior markers signal further meaning aspects. In short, one observes hyponymy relations between temporal discourse markers such as *nachdem*, *sobald* and *kaum dass*. These hyponymy relations should, of course, also make their way into the system network; they give rise to non-terminal realizations. Further, non-terminal realizations capture the fact that one can deliberately remain vague on certain aspects of the nature of a temporal relation. Also, even in case no information is available to make more delicate choices, i.e. if the temporal conjunctive relation is rather general, a lexicogrammatical realization is ensured. Therefore, non-terminal realizations are included, as in the case of the feature [nondeictic] in Figure 7.2(b), which can be realized by *sobald*.

Consider again Table 7.1 and the construal of the system network. The table further reveals that the markers classified as [deictic/nondeictic] share another property: They all expect adjacency between the situations they conjoin (property *next* in the table); this is in opposition to the temporal markers that are neutral with respect to this property. This motivates the feature pair [adjacency/unspecified], where [adjacency] is the input feature to the [deictic/nondeictic] system, and [unspecified] opens up the [punctiliar-singular/neutral] choice; see System network II in Figure 7.2(c).

So far I have dealt with properties of individual markers that hold simultaneously, i.e. are in a conjunction relation. However, there also exist properties that are exclusive. Take for instance the type of anterior relation: Most temporal markers can be used with *after* or *meets-i* alike. Now adopting a top-down approach, the set of temporal markers can be subdivided into markers signaling one or the other relation; this gives rise to the top-level distinction between [following] and [following-immediately], which is the least delicate system in the anterior subnetwork (cf. Figure 7.4). Still taking a top-down perspective, temporal markers that signal a simple precedence relation can either require punctiliar situations, or are neutral regarding situational characteristics. Hence, [following] is the entry condition to the system distinguishing between [punctiliar-singular] and [neutral]. The temporal markers that are not specified regarding the situation again fall into two broad classes, i.e. those that indicate an additional immediacy and adjacency relation, and those that do not (cf. again Table 7.1). The feature pair [immediacy] vs. [mere-precedence] captures this opposition (see again Figure 7.4). As can be read off Table 7.1, the former feature is shared by the temporal markers *sobald*, *sowie*, *kaum dass*, *seitdem*, *seit* (*P*)

and *ab*, and thus serves as input condition to the [deictic/nondeictic] system. *Nachdem*, *nach* and *danach* do not signal this meaning aspect; they are realizational consequences of the [mere-precedence] feature. Regarding the [following-immediately]-subbranch, less delicate classifications also relate to characteristics of the situation, and to adjacency, and motivate the introduction of two corresponding systems; see Figure 7.4 below for the primary classifications of anterior conjunctive relations.

Various realization statements are added along the paths through the network: For instance, *nachdem* is defined as indicating an *after+prox* relation; hence, *nachdem* is specified as realization of the non-terminal feature [following]. As discussed above, this accounts for the fact that *nachdem*, as the prototypical marker of anteriority, can substitute any of the other markers. The complete classification of German anterior temporal relations is given in Figure 7.4. The design of the posterior and the simultaneity subnetworks follows the strategy outlined in this section.

7.3 German temporal conjunctive relations

7.3.1 The system network

Having addressed the methodological questions concerning the construction of system networks based on the analysis results given in Chapter 6, I am now in a position to propose the system networks for external temporal conjunctive relations in German. These networks merge the results from the descriptions of individual temporal markers into a single functional representation. The system networks are presented in Figures 7.3 to 7.6. From left to right, features are increasingly delicate. Features on a path through the system network from the entry feature to a terminal feature define a German temporal conjunctive relation, and hence characterize the reading of a temporal connective. Some features have associated lists of temporal discourse markers that are potential verbalizations of a specific temporal relation, for instance, the relation [anterior:following:punctiliar-singular] is expressed by *als* or *wenn* (as, when); [anterior:following-immediately:adjacency:nondeictic:no-regard] can be signaled by *sobald* and *sowie* (as soon as) (cf. Figure 7.4).

The choice from within the group of possible realizations is not a matter of (ideational) meaning, but of the linguistic context: For instance, the choice between *als* and *wenn* is made in interaction with the verbal tense, and the one between *nachdem*, *nach* and *danach* (after, after (P), afterwards) is guided by the syntactic structure of the sentences realizing the conjoined situations. Further, stylistic considerations may determine the selection from within a group, as in the case of *bevor* and *ehe*. A list of these additional constraints on the lexicogrammatical realization—as defined in the tables in Chapter 6—is given for each connective. Note, however, that the constraints are not repeated in the system network. Instead, I have included in the network references to the tables in Chapter 6 that list the usage conditions; labels in the boxes next to possible realizations name the corresponding table. For instance, the system network in Figure 7.4 states that the constraints on the linguistic environment of the anterior reading of *nachdem* are given in Table **nachdem**

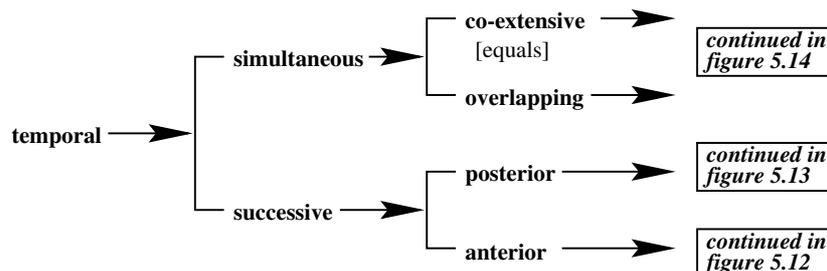


Figure 7.3: External temporal conjunctive relations in German at primary delicacy

(precedence), for *ab* in Table **ab (temporal)** (compare again Figure 7.4). They are reproduced here to give a full picture of the information contained in the system network:

Constraints on *nachdem*:

Sit_s is presupposed

clause denoting *Sit_s* has a perfective aspect

clause denoting *Sit_m* has an imperfective aspect

tense sequence; $E(Sit_s) < E(Sit_m)$ where $E(Sit_s) \leq S$

hypotactic clause complex, subordinate conjunction

preferred ordering is preposed

discourse marker takes front position and can be modified

clause denoting *Sit_s* is positive and not hypothetical

Constraints on *ab*:

Sit_s is presupposed

verb denoting *Sit_m* is stative, durative or iterative

deverbalization possible

$E(Sit_m) < S$

realization within a clause (PP), preposition

discourse marker takes front position and cannot be modified

concise style

Further, the terms given in brackets underneath the nodes in the system network give the reasons for choosing a particular path. The terminology used here is that of the marker description in Chapter 6. For instance, the network shows that the choice of [deictic] (of the feature pair [deictic] and [nondeictic]) depends on the existence of the property *dur*, and the selection of either [adjacency] or [unspecified] depends on the existence of the property *next* (see Figure 7.4).³ I include this information in the system network to elucidate the relation between system network design and marker analysis.

At primary delicacy of the temporal conjunctive relation network, the opposition is between relations expressing simultaneity of situations and those signaling a precedence relation

³From a generation perspective, where *choosers* select between network features by posing *inquiries* to the context, the terms given in square brackets correspond to the answers that the inquiries would provide.

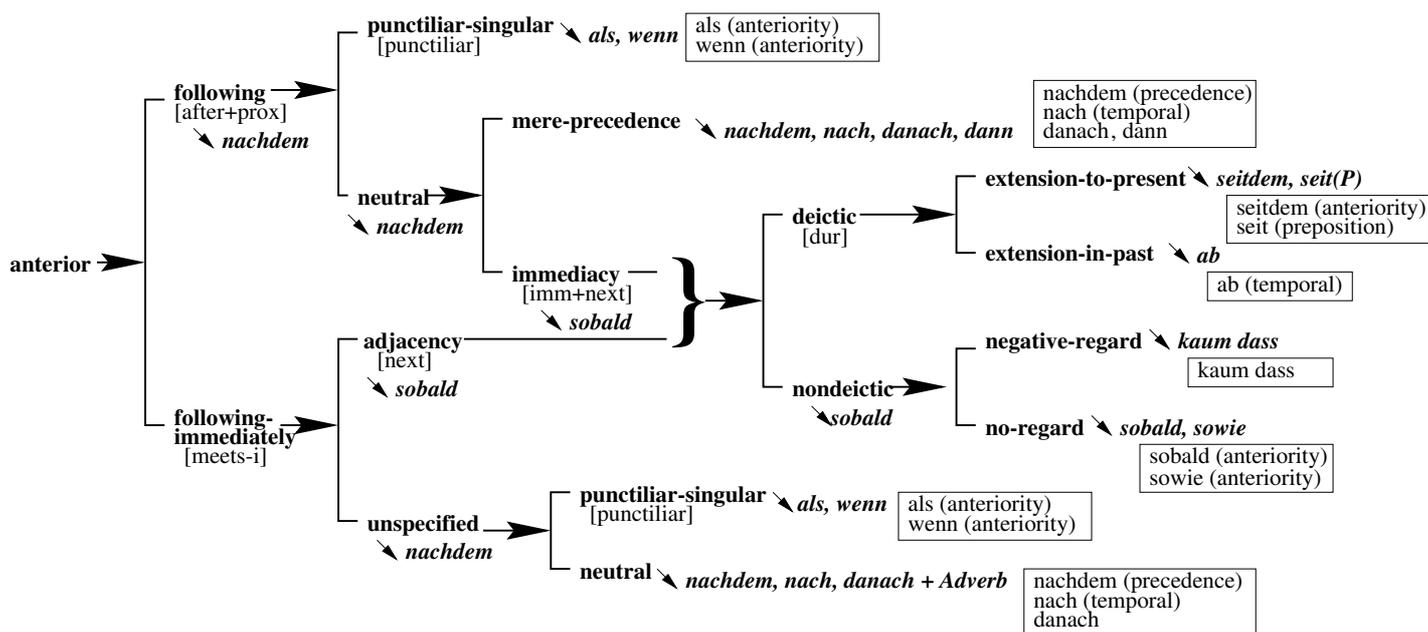


Figure 7.4: External anterior temporal conjunctive relations in German

between two situations. This opposition motivates the top-level features [simultaneous] and [successive] in the network, as depicted in Figure 7.3. Recall that this is only one among several possible perspectives as the choice of this particular distinction at primary delicacy determines the shape of the entire network. Favouring a different classificatory principle would yield a different system network (this has been discussed in detail in Section 7.2 above). Within the [successive] branch, the least delicate choice is that between [anterior] and [posterior], specifying whether the anterior or the posterior situation acts as temporal anchor. This has an effect on the syntactic surface: The dependent part (the one that is the temporal anchor) is moved into the subordinate clause, the PP, or the clause not containing the conjunctive. The [simultaneous] feature and the opposition [posterior/anterior] reflect the top-level classification of temporal connectives according to the three major types of temporal relations acknowledged in standard grammars and dictionaries and Chapter 6. The existence of three prototypical temporal markers *während*, *bevor* and *nachdem* supports this classification.

The anterior subnetwork in Figure 7.4 has already been commented on extensively in the preceding section. The system network comprising the posterior oppositions is depicted in Figure 7.5. Similar to the anterior network, the main opposition is that between two situations simply following each other ([following]) or meeting at one point in time ([following-immediately]). Further distinctions in the network reflect additional temporal constraints such as the relation to speaking time ([deictic/nondeictic]) and the situation type ([punctiliar-singular/neutral]). Note that again lexicalization statements are attached to non-terminal features such as [following] and [following-immediately]. This gives the prototypical realizations *bevor* and *sobald*; further classifications refine these general types and

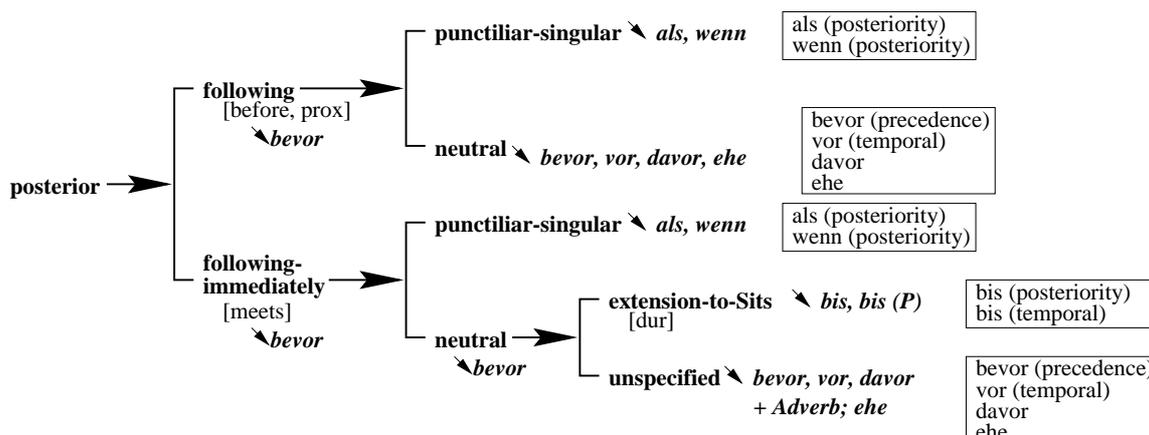


Figure 7.5: External posterior temporal conjunctive relations in German

lead to discourse markers signaling additional meaning aspects (such as *bis* which signals the duration of the anterior situation).

Figure 7.6 presents the more delicate distinctions between temporal markers indicating simultaneity. The major opposition here is between relations indicating that the participating situations have exactly the same extension in time and those that merely share a(n) (arbitrarily long) time span ([co-extensive] vs. [overlapping]). Within these two branches, the primary distinction is that between [punctiliar-singular] and [neutral]: If the situation acting as temporal anchor (the dependent part) encodes a single non-durative situation, then *als* or *wenn* are realized for co-extensive and overlapping relations alike, depending on how the event time relates to speaking time. In all other cases, i.e. for [...:co-extensive:neutral] and [...:overlapping:neutral], more complex distinctions apply, referring to, for instance, properties of the situation, the specific type of overlap relation, etc.

In the co-extensive branch, the boundedness of the conjoined situations triggers the choice between *während* and *solange* (features [bounded-situation] vs. [genuine-ending]). Alongside *während*, the temporal preposition *bei* can be used when both situations take place at the same location. Distinctions in the [...:overlapping:neutral] subnetwork relate to the specific type of overlap: When one situation is contained by another, then [inclusion] is selected, in all other cases [mere-overlap]. In case of [mere-overlap], if the anterior situation serves as temporal anchor ([anterior-dependent]), then *nachdem* and *während* can express the simultaneity relation; if the posterior situation acts as the anchor, then *bevor* and *während* are possible realizations. The choice is more complex in the [inclusion] branch: Here, the main factors to consider are the type of inclusion ([contained, prospective, retrospective]), boundedness of the situation ([bounded-situation, genuine-beginning, genuine-ending]), and whether the extension of a situation is indicated ([deictic, nondeictic]); see Figure 7.6 for the corresponding systems and possible realizations.

Note that in the simultaneity system network there is a lot of overlap in the realizations, that is, a number of temporal connectives realize several terminal features. This is due to

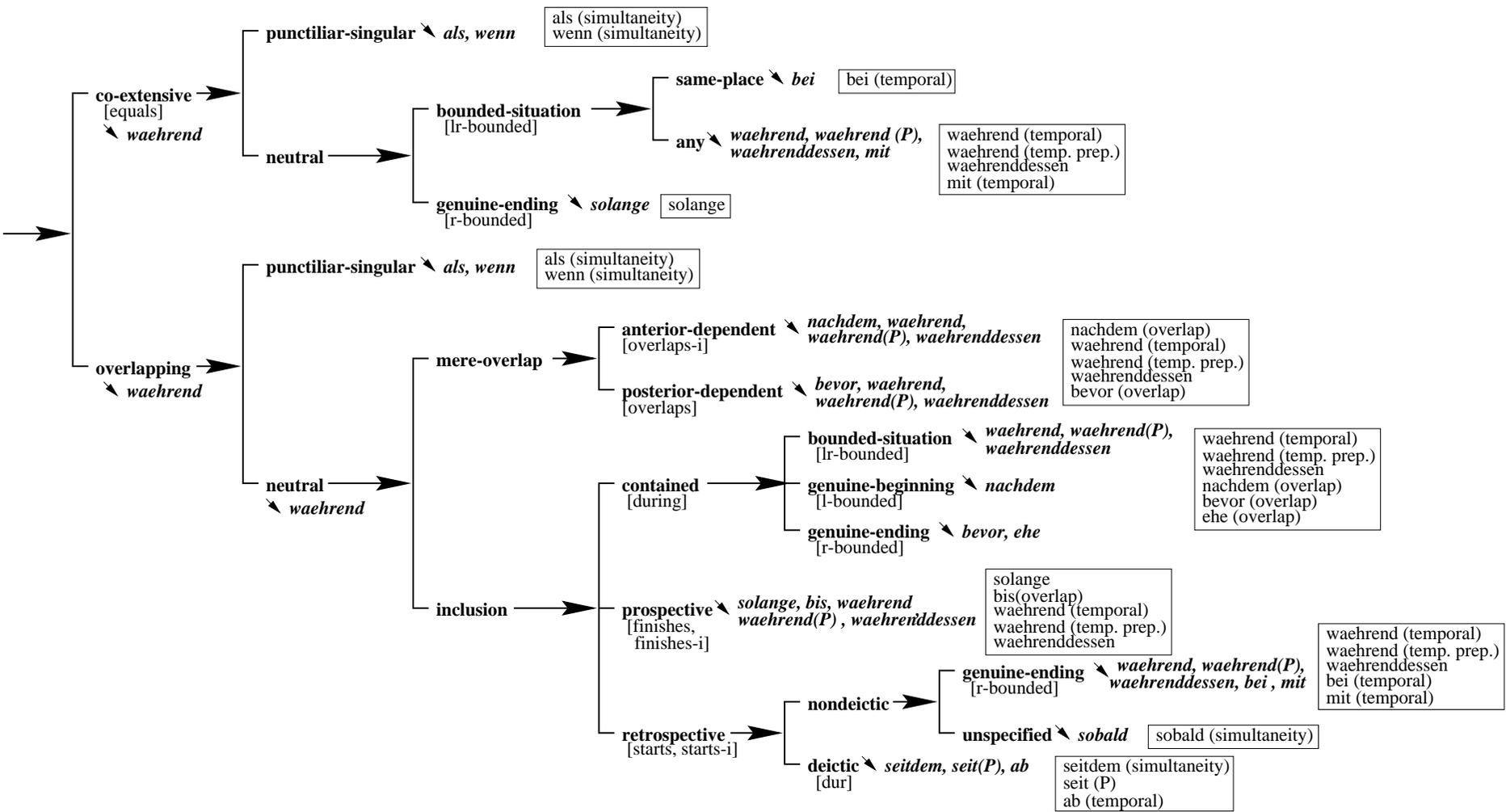


Figure 7.6: External simultaneous temporal conjunctive relations in German

the fact that none of the German simultaneity markers specifies a unique relation between two situations. In particular, *während* is highly ambiguous, as the linguistic analysis of *während* in Chapter 6, Section 6.8.1, has revealed. It is given as realization of six terminal features, i.e. it can signal six different types of conjunctive relations.

7.3.2 Realizations of temporal conjunctive relations

The following examples illustrate the realization of the temporal conjunctive relations specified in Figures 7.3 to 7.6. I restrict myself to conjunctive relations that are defined by a path from the root feature to a terminal feature. Where examples can be found, hypotactical, phrasal and cohesive realizations are given. Let us first consider anterior relations, which are defined by the less delicate features [temporal:successive:anterior]:

- (7.1) [...:following:punctiliar-singular]
 a. **Als** *die Sonne aufgegangen war, begannen sie mit dem Aufstieg.*
 b. **Wenn** *die Sonne aufgegangen ist, beginnen sie mit dem Aufstieg.*
- (7.2) [...:following:neutral:mere-precedence]
 a. **Nachdem** *die Sonne aufgegangen war, ging er baden.*
 b. **Nach** *Sonnenaufgang ging er baden.*
 c. *Die Sonne ging auf. Danach* *ging er baden.*
 d. *Die Sonne ging auf. Dann* *ging er baden.*
- (7.3) [...:following:neutral:immediacy:deictic:extension-to-present]
 a. **Seitdem** *ich ihn getroffen habe ist er Nichtraucher.*
 b. **Seit** *unserem Treffen ist er Nichtraucher.*
- (7.4) [...:following:neutral:immediacy:deictic:extension-in-past]
Ab *dem Treffen mit Suse war er Nichtraucher.*
- (7.5) [...:following:neutral:immediacy:nondeictic:negative-regard]
Kaum dass *er sich hingelegt hatte, klingelte das Telefon.*
- (7.6) [...:following:neutral:immediacy:nondeictic:no-regard]
 a. **Sobald** *ich mich vor den Fernseher gesetzt habe, bin ich eingeschlafen.*
 b. **Sowie** *ich mich vor den Fernseher gesetzt habe, bin ich eingeschlafen.*
- (7.7) [...:following-immediately:adjacency:deictic:extension-to-present]
 a. **Seitdem** *ich ihn getroffen habe, ist er Nichtraucher.*
 b. **Seit** *dem Treffen mit Suse ist er Nichtraucher.*
- (7.8) [...:following-immediately:adjacency:deictic:extension-in-past]
Ab *dem Treffen mit Suse war er Nichtraucher.*

- (7.9) [...following-immediately:adjacency:nondeictic:negative-regard]
Kaum dass er sich hingelegt hatte, klingelte das Telefon.
- (7.10) [...following-immediately:adjacency:nondeictic:no-regard]
 a. **Sobald** die Toastzeit abgelaufen ist, schaltet sich das Gerät ab.
 b. **Sowie** die Toastzeit abgelaufen ist, schaltet sich das Gerät ab.
- (7.11) [...following-immediately:unspecified:punctiliar-singular]
 a. **Als** der Gong ertönte, begann die Vorstellung.
 b. **Wenn** der Gong ertönt, beginnt die Vorstellung.
- (7.12) [...following-immediately:unspecified:neutral]
 a. **Direkt nachdem** die Toastzeit abgelaufen ist, schaltet sich das Gerät ab.
 b. **Direkt nach** Ablauf der Toastzeit schaltet sich das Gerät ab.
 c. Die Toastzeit ist abgelaufen. **Direkt danach** schaltet sich das Gerät ab.

Examples for realizations of posterior temporal conjunctive relations classified as [temporal:successive:posterior] are:

- (7.13) [...following:punctiliar-singular]
 a. **Als** Fritz ins Bett ging, hatte er sein Glas ausgetrunken.
 b. **Wenn** Fritz ins Bett geht, hat er sein Glas ausgetrunken.
- (7.14) [...following:neutral]
 a. **Bevor** Suse studierte machte sie eine Lehre.
 b. **Vor** dem Studium machte Suse eine Lehre.
 c. Suse studierte. **Davor** machte sie eine Lehre.
 d. **Ehe** Suse studierte machte sie eine Lehre.
- (7.15) [...following-immediately:punctiliar-singular]
 a. **Als** Suse weinte, hatte gerade das Gewitter begonnen.
 b. **Wenn** Suse weint, hat gerade das Gewitter begonnen.
- (7.16) [...following-immediately:neutral:extension-to-Sits]
 a. Tom schlief **bis** Suse kam.
 b. Tom schlief **bis** zu Suses Ankunft.
- (7.17) [...following-immediately:neutral:unspecified]
 a. **Direkt bevor** Suse einschlieft, sah sie ein Ufo.
 b. **Direkt vor** dem Einschlafen sah Suse ein Ufo.
 c. Suse schlief ein. **Direkt davor** sah sie ein Ufo.
 d. **Ehe** Suse einschlieft sah sie ein Ufo.

Finally, simultaneous relations [temporal:simultaneous] are illustrated by the following examples:

- (7.18) [...co-extensive:punctiliar-singular]
 a. **Als** das Seil riss, gab es einen lauten Knall.
 b. **Wenn** das Seil reisst, gibt es einen lauten Knall.

- (7.19) [...:co-extensive:neutral:bounded-situation:same-place]
Beim *Elfmeterschuss hielt Manfred den Atem an.*
- (7.20) [...:co-extensive:neutral:bounded-situation:any]
 a. **Während** *der Elfmeter geschossen wurde, hielt Manfred den Atem an.*
 b. **Während** *des Elfmeters hielt Manfred den Atem an.*
 c. *Der Elfmeter wurde geschossen. Währenddessen* *hielt Manfred den Atem an.*
 d. **Mit** *dem Elfmeterschuss hielt Manfred den Atem an.*
- (7.21) [...:co-extensive:neutral:genuine-ending]
Solange *die Musik spielt, tanzt Anne.*
- (7.22) [...:overlapping:punctiliar-singular]
 a. **Als** *die Bombe explodierte, war ich in Rom.*
 b. **Wenn** *die Bombe explodiert, bin ich in Rom.*
- (7.23) [...:overlapping:neutral:mere-overlap:anterior-dependent]
 a. **Nachdem** *Tom die Blumen goss, schnitt Suse den Baum.*
 b. **Während** *Tom die Blumen goss, schnitt Suse den Baum.*
 c. **Während** *des Blumengießens schnitt Suse den Baum.*
 d. *Tom goss die Blumen. Währenddessen* *schnitt Suse den Baum.*
- (7.24) [...:overlapping:neutral:mere-overlap:posterior-dependent]
 a. **Bevor** *Peter den Mantel abgelegt hatte, klingelte das Telefon.*
 b. **Während** *Peter den Mantel ablegte, klingelte das Telefon.*
 c. **Während** *des Ablegens klingelte das Telefon.*
 d. *Peter legte den Mantel ab. Währenddessen* *klingelte das Telefon.*
- (7.25) [...:overlapping:neutral:inclusion:contained:bounded-situation]
 a. **Während** *der Braten gart, bereiten Sie bitte das Gemüse.*
 b. **Während** *des Garens des Bratens bereiten Sie bitte das Gemüse.*
 c. *Der Braten gart. Währenddessen* *bereiten Sie bitte das Gemüse.*
- (7.26) [...:overlapping:neutral:inclusion:contained:genuine-beginning]
Nachdem *Peter in seinem Sessel saß, griff er nach der Zeitung.*
- (7.27) [...:overlapping:neutral:inclusion:contained:genuine-ending]
 a. **Bevor** *das Jahr zu Ende war starb die Kuh.*
 b. **Ehe** *das Jahr zu Ende war starb die Kuh.*
- (7.28) [...:overlapping:neutral:inclusion:prospective]
 a. **Solange** *der Schnee schmolz, führte der Bach Hochwasser.*
 b. **Während** *der Schnee schmolz, führte der Bach Hochwasser.*
 c. **Während** *der Schneeschmelze führte der Bach Hochwasser.*
 d. *Der Schnee schmolz. Währenddessen* *führte der Bach Hochwasser.*
 e. *Der Bach führte Hochwasser bis* *der Schnee geschmolzen war.*

- (7.29) [...:overlapping:neutral:inclusion:retrospective:nondeictic:genuine-ending]
- Während** *die Sonne aufging, wanderten wir los.*
 - Während** *des Sonnenaufgangs wanderten wir los.*
 - Die Sonne ging auf. Währenddessen* *wanderten wir los.*
 - Bei** *Sonnenaufgang wanderten wir los.*
 - Mit** *Sonnenaufgang wanderten wir los.*
- (7.30) [...:overlapping:neutral:inclusion:retrospective:nondeictic:unspecified]
- Sobald** *ich vor dem Fernseher sitze, schlafe ich ein.*
- (7.31) [...:overlapping:neutral:inclusion:retrospective:deictic]
- Er ist Nichtraucher* **seitdem** *ich ihn kenne.*
 - Seit** *unserem Kennenlernen ist er Nichtraucher.*
 - Ab** *unserem Kennenlernen war er Nichtraucher.*

7.3.3 Ambiguity of temporal discourse markers

To conclude the discussion of the temporal conjunctive relation networks, a few general remarks on the ambiguity of temporal markers, and on the role of linguistic constraints in resolving it. As pointed out above, most German temporal connectives realize a number of terminal—and sometimes also non-terminal—features in the network; in other words, they signal different conjunctive relations. Especially simultaneity markers are highly ambiguous, as Figure 7.6 shows: *Während* (while) signals no less than six conjunctive relations (examples (7.20), (7.23-25) and (7.28-29)). To give another example, *bevor* (before) is given as realization of two simultaneity relations, in addition to the two posterior relations it expresses (examples (7.24), (7.27), (7.14), and (7.17)). Further, *als* and *wenn* (as, when) occur at six places in the network (illustrated by examples (7.1), (7.11), (7.13), (7.15), (7.18) and (7.22)), which is to be expected given that they are considered as temporal connectives with an unspecified temporal reference (see Chapter 6).

It is not always possible to derive the exact meaning, i.e. temporal conjunctive relation signaled, from the linguistic realization. For several conjunctive relations, the choice of the connective and the associated linguistic constraints are the same. For instance, there are no linguistic means indicating the difference between [...:posterior:following:punctiliar] and [...:posterior:following-immediately:punctiliar]; both relations are realized by either *als* or *wenn*, with the additional linguistic constraints given in Tables **als (posteriority)** and **wenn (posteriority)** respectively. In other words, the different underlying temporal relations are not signaled on the surface. As a result, the meaning aspects distinguishing the relations remain implicit, and the discourse marker meaning is ambiguous. This is due to the fact that there is a difference between what kind of relation(s) a temporal marker can be used with, and the temporal relation(s) it makes explicit. Some markers—those that are attached to non-terminal features in the networks—remain vague on more delicate aspects of a conjunctive relation and are hence widely applicable. For instance, the markers *nachdem* (after) and *sobald* (as soon as) can both be used if two situations follow each other immediately, but only *sobald* makes this relation explicit; when using the

non-terminal lexical realization *nachdem*, this information remains implicit.

As a consequence, only temporal conjunctive relations that differ in the constraints on the linguistic environment from other relations signaled by the same temporal connective can be made explicit on the linguistic surface. Here, the potential ambiguity of a temporal marker is resolved by unique linguistic constraints, which separate the different readings of a marker. In the case of *nachdem* (after), these are the anterior and the overlap readings. To illustrate this, consider the constraints on the availability of *nachdem* in its purely anterior reading (selection expression: [successive:anterior:following:neutral:mere-precedence]):

clause denoting Sit_s has a perfective aspect
 clause denoting Sit_m has an imperfective aspect
 tense sequence; $E(Sit_s) < E(Sit_m)$ where $E(Sit_s) < S$
 hypotactic clause complex, subordinate conjunction
 preferred ordering is preposed
 discourse marker takes front position and can be modified
 clause denoting Sit_s is positive and not hypothetical

The constraints associated with the two overlap readings of *nachdem* (selection expression: [simultaneous:overlapping:neutral:inclusion:contained:genuine-beginning] or [simultaneous:overlapping:neutral:mere-overlap:anterior-dependent]) differ regarding constraints on Aktionsart, aspect and tense:

verb denoting Sit_s is stative or resultative
 clause denoting Sit_s has an imperfective aspect
 same tense; $E(Sit_s) = E(Sit_m)$ where $E(Sit_s) \leq S$ and $E(Sit_m) \leq S$
 hypotactic clause complex, subordinate conjunction
 preferred ordering is preposed
 discourse marker takes front position and can be modified
 clause denoting Sit_s is positive and not hypothetical

Note that the two overlap relations are not signaled on the linguistic surface, only the distinction between anterior and simultaneous reading is linguistically marked. This raises the question of why these fine-grained distinctions between different readings of a temporal marker are made in the system network even though they do not have an immediate reflex in form? The motivation is twofold: From a theoretical perspective these distinctions are required to account for the use of *nachdem* (after) in opposition to *bevor* (before) (features [anterior-dependent] vs. [posterior-dependent] in Figure 7.6), and to *bevor* and *während* (while) (features [genuine-beginning] vs. [genuine-ending] vs. [bounded-situation]). In short, network features and the corresponding temporal relations are motivated from distinctions in the surface form, here the availability of different markers to express a (more general) feature. From a more practical point of view, the answer simply is that I am interested in the entire range of potential meanings of discourse markers, because the ultimate goal is to use the knowledge on temporal marker usage and meaning

accumulated in the system network to automatically generate temporal discourse markers. In this context, it is vital to know about all different meanings a temporal marker can be used with.

Not only do most temporal markers realize several terminal features, but most terminal features—and hence conjunctive relations—also possess more than one possible realization. To give an example from the posterior network in Figure 7.4, the following discourse markers are listed as possible realizations of the relation [posterior:following:neutral]: *bevor*, *ehe*, *vor*, *davor* (before, before (archaic), before (P), before it). The temporal relation is expressed by that marker from the set of possible markers whose linguistic properties are satisfied. In the present example, deciding factors are the syntactic structure, distinguishing between *vor* (requiring a phrasal realization), *davor* (expecting two separate sentences) and *bevor* / *ehe* (requiring a hypotactic construction), and style, accounting for the stylistic difference between *bevor*, *davor*, *vor* on the one hand, and *ehe* on the other hand.

From the generation perspective, the system networks represent the logical sequence of choices that must be performed in order to select a temporal marker. The selection expression characterizes the type of temporal conjunctive relation and hence gives the temporal meaning of the discourse marker; the constraints specify the properties of its linguistic environment that have to be given for a temporal marker to be applicable. Yet, the system network itself does not say anything on *when* a particular meaning is signaled. Deciding on the path through the system network, i.e. making a motivated choice between competing features in the network, requires knowledge of the context, for instance, the discourse structure, user model, discourse history, and knowledge on the properties of the situations to be conjoined. The process of selecting temporal discourse markers automatically, exploiting the knowledge contained in the system networks, will be addressed in detail in Chapters 9 and 10 of this thesis.

7.4 Comparison with English and Dutch

There already exist functional classifications of temporal conjunctive relations for English ([Martin 1992] and [Hitzeman 1995]) and for Dutch [Oversteegen 1993]. For two reasons, it seems worthwhile to compare the proposed German networks with these accounts. First, there is a growing interest in Systemic Functional Linguistics to provide multilingual accounts of linguistic resources for different languages; proposals for inherently multilingual grammars and semantics have been put forward by, for instance, [Bateman *et al.* 1991, Bateman *et al.* 2000]. This requires—next to clarifying the design principles for multilingual resources—contrastive knowledge of the languages. In particular, one needs to identify commonalities and divergences between the functional potential of different languages [Teich 1995, Bateman *et al.* 1999].

The second reason follows from the goals of this thesis: One of the aims is to propose a framework for the automatic selection of temporal discourse markers. In text generation, there is a growing need to develop systems that produce text in more than one language from the same knowledge source. This requires multilingual linguistic resources, such as

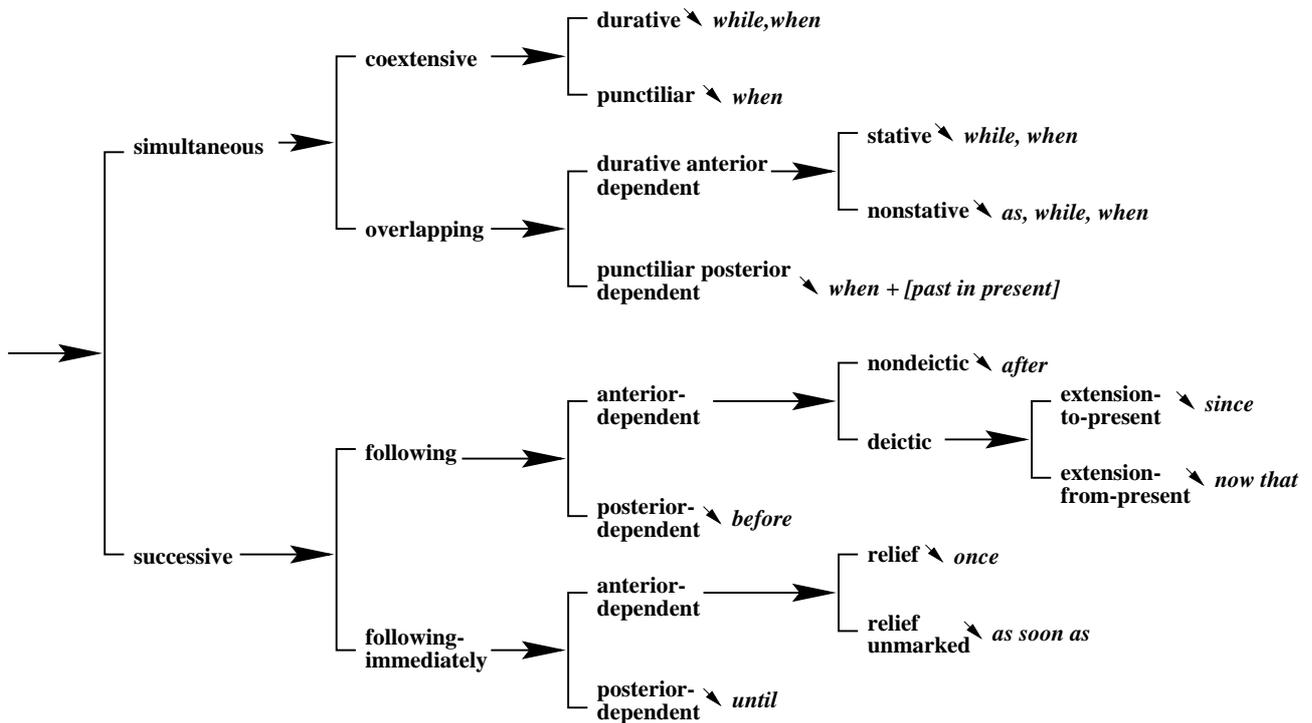


Figure 7.7: Hypotactic external temporal relations in English. Reproduced from [Martin 1992, p191]

realized in the KPML sentence generator for, among others, English, German, and Dutch, and developed within the AGILE project for Slavic languages [Kruijff et al. 2000].

Although the specification of multilingual resources is beyond the scope of this thesis, it nevertheless seems reasonable to at least address the following issues: First, to examine the similarities and differences between existing descriptions of temporal conjunctive relations in other languages, and second, to discuss in how far these accounts provide the information required to be employed in a text generation scenario. The goal is to provide the basis for future work on building multilingual temporal conjunctive relation networks.

Section 7.4.1 briefly presents existing functional accounts of temporal conjunctive relations for English and Dutch. The strategy of comparison is introduced in Section 7.4.2, before discussing cross-linguistic similarities and differences in Section 7.4.3.

7.4.1 English and Dutch temporal conjunctive relations

Functional accounts of temporal conjunctive relations already exist for two other languages:

- [Martin 1992, 168ff] discusses hypotactic temporal relations in English; his networks are enhanced by [Hitzeman 1995].

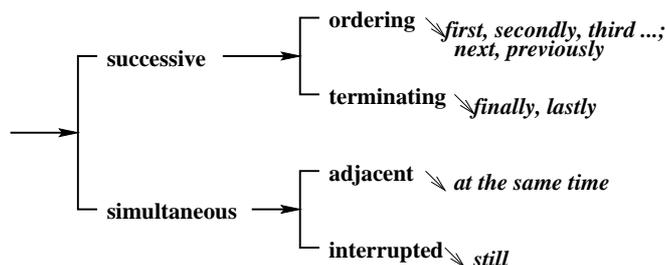


Figure 7.8: Internal temporal relations in English. Reproduced from [Martin 1992, p226]

- [Oversteegen 1993] proposes system networks for hypotactic external temporal relations in Dutch.

Martin's account constitutes the initial work on temporal conjunctive relations and temporal connectives in a systemic framework: He examines external and internal temporal relations in English, and proposes a system network for hypotactic external temporal relations, which is reproduced in Figure 7.7, and a classification of internal temporal relations, presented in Figure 7.8. The networks classify temporal conjunctive relations, with English temporal connectives as lexical realizations, namely the external subordinate conjunctions *as, when, while, after, since, once, now that, before, as soon as, until*, and the internal temporal connectives *first, secondly, third, next, previously, finally, lastly, at the same time, still*. The external system network contains information on the temporal relation and intention that is signaled by a temporal connective (compare e.g. the feature pairs [coextensive/overlapping] and [relief/relief unmarked] in Figure 7.7), the relation of the conjoined events to speaking time ([extension-to-present/extension-from-present]), the event type ([durative/punctiliar]), and the temporal anchor ([anterior-dependent/posterior-dependent]). For internal connectives, major factors are again temporal relation and additionally the type of structure they impose on a text (e.g. [ordering/terminating] in Figure 7.8).

In her work, [Oversteegen 1993] investigated a set of Dutch temporal connectives (*toen, terwijl, sinds, voordat, nadat, totdat*, i.e. when, while, since, before, after, until respectively), and in particular the relation between temporal and non-temporal senses of these connectives. The general idea behind her work is that temporal and non-temporal readings are strongly related, and that they mainly differ regarding the constraints on their linguistic environment. Her analysis of Dutch temporal markers uses the *Two Track theory of Time* (TTT) [Oversteegen 1993] in the description of marker meaning and usage. TTT is a representation model for temporal meaning, which can account for two ways of conceptualizing time: the dynamic, deictic temporal meaning which gives a subjective temporal perspective on events, and the static, non-deictic temporal ordering of events in the world, independent of the point of view. The basic idea of TTT is that linguistic resources expressing temporal meaning provide a link between these two aspects. Oversteegen presents TTT representations along these two dimensions for the Dutch temporal markers listed

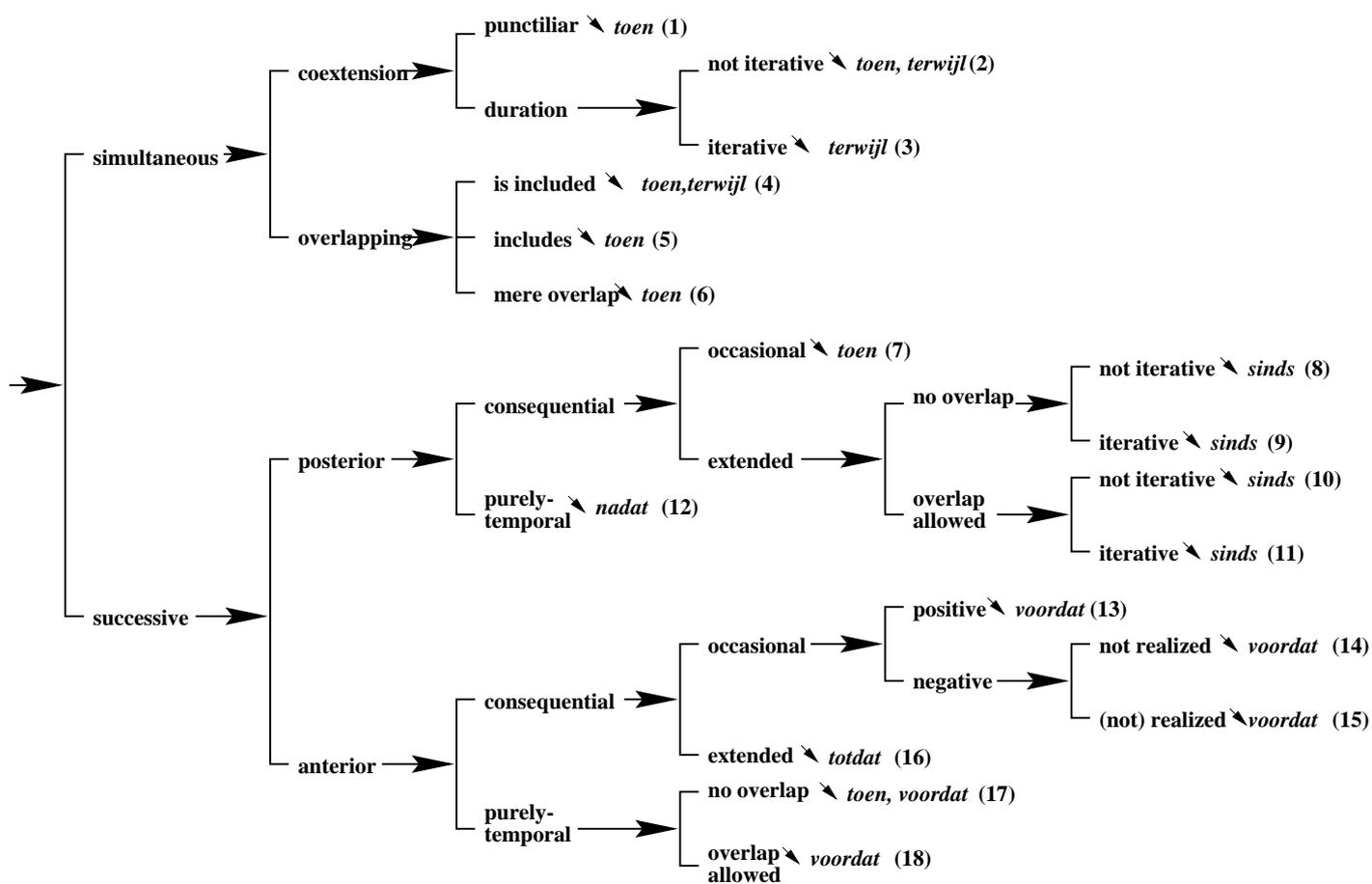


Figure 7.9: Hypotactic external temporal relations in Dutch. Reproduced from [Oversteegen 1993, p70]

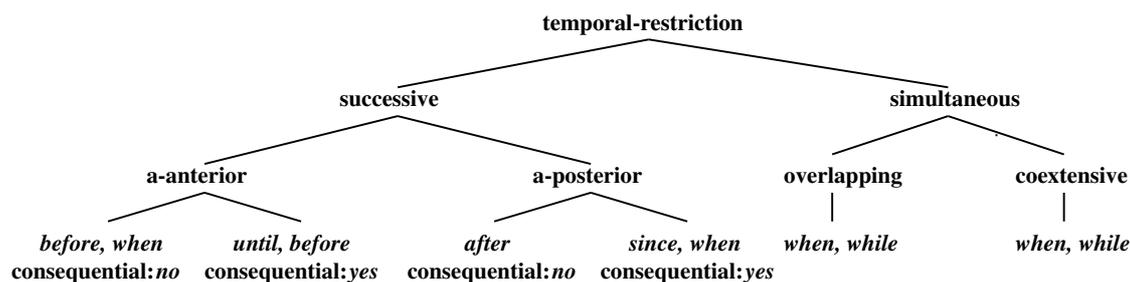


Figure 7.10: Hierarchy of English temporal connectives. Reproduced from [Hitzeman 1995, p11]

above.

Starting from these representations, she extends and modifies Martin's system network to deal with temporal Dutch connectives in their temporal and non-temporal usage. Oversteegen's system network is reproduced in Figure 7.9. She relates this modified systemic network to the TTT approach by including the TTT representations as constraints on the availability of particular temporal meanings. The conditions concern the semantics of the sentences in which a connective occurs, properties of the discourse level such as the informational status or the relation between speaker and hearer, and syntactic aspects such as the ordering of clauses and verbal tense. To give a simple example, the conditions on *toen* (when) as realization of the [simultaneous:coextension:punctiliar]-path are [Oversteegen 1993, p71]:

E_s is presupposed
 E_s and E_m are terminative events
 deictic constraint

In brief, her account strictly distinguishes between meaning aspects of the temporal connective itself, and conditions on the context that have to hold in order to make a relevant interpretation available [Oversteegen 1993, p68].

[Hitzeman 1995] builds on the work by Martin and Oversteegen. Her goal is to use Martin's hierarchical account in a unification-based system, here *Head-Driven Phrase Structure Grammar* (HPSG) [Pollard and Sag 1994], to select English temporal connectives. In a first step, she restructures Martin's hypotactic external network by moving some constraints into a separate lexicon (such as aspectual and durativity constraints), and modifies his hierarchical system to make it applicable in a unification-based system such as computational HPSG. She then incorporates Oversteegen's changes into the system network so that it also covers non-temporal readings of English temporal markers. Her proposal for a classification of the English temporal connectives *when*, *while*, *after*, *before*, *since* and *until* is presented in Figure 7.10.

In addition to the feature representations of English temporal connectives derived from the network, she specifies constraints on marker usage, given in Oversteegen's TTT representation, and on the linguistic context, for instance, on syntactic structure, verbal tense, and aspect. These different kinds of information are conflated into a lexicon entry, given as a HPSG feature structure.

7.4.2 Dimensions of comparison

Although they are all situation in certain respects in the systemic functional framework, the approaches to temporal marker classification surveyed above differ. In order to make a systematic comparison possible, the following points need clarification:

1. What are the **dimensions** of comparison?
2. What is the **method** of comparison?

Dimensions of comparison taken into account in this study are:

- **Scope of study.** This concerns the set of temporal markers examined, and the coverage of this set (in relation to all temporal markers given in a language).
- **Types of temporal markers.** Points of discussion include: Does the study consider internal and/or external markers; temporal and/or non-temporal readings? Is the set of markers under investigation restricted by syntactic criteria?
- **Properties of temporal markers.** This refers to the types of marker properties examined and described. In other words, which aspects of marker meaning (ideational, interpersonal ...) and of the linguistic environment are considered, and how are they represented?
- **Functional classification of temporal markers.** This is the major point of comparison raising questions of functional differences and commonalities between temporal marker classifications in different languages.

In addition, from a generation perspective, the following points have to be discussed: Do the studies examine a comprehensive set of temporal markers for a given language? Does the description of temporal connectors provide sufficient information and is the representation explicit enough to be used for MLG purposes?

The second point that needs to be addressed concerns the method of comparison. How can approaches such as the ones discussed in Section 7.4.1, which diverge regarding the weight they place on a systemic-functional description, and regarding the formalisms applied for representing constraints on marker usage, be compared? Comparing scope, type of temporal markers, and the set of properties used to describe them, seems to be a straightforward

task. In contrast, detecting commonalities and divergences in the functional classification of temporal conjunctive relations, and hence temporal markers, is more complex.

SFL maintains that a crucial criterion for grasping commonalities between languages is functionality [Halliday *et al.* 1964, Bateman *et al.* 1991, Teich 1995]. This rests on the assumption that commonalities across languages are functional in the first place: Function is mostly preserved, where structural variation may very well differ [Bateman *et al.* 1991, p966]. Describing similarities and differences between languages involves the construction of contrastive knowledge. To achieve this, one needs a model of language comparison that accommodates both cross-linguistic commonality and divergence. Following, among others, [Bateman *et al.* 1991, Teich 1995, Teich *et al.* 1996, Bateman *et al.* 1999], parameters of cross-linguistic variation are the global dimensions of *stratification*, *instantiation* and *metafunction*, and the inter-stratal dimensions *axis*, *rank* and *delicacy*. In other words, commonalities across languages exist on different levels, and a contrastive linguistic description in SFL has to account for these aspects.

The parameters of contrastive linguistic description that are relevant for classifying temporal conjunctive relations are a subset of the ones listed above:

- **Axis.** Accounts differ in whether they give a paradigmatic description only, or additionally describe the syntagmatic, surface-syntactic organization of a language. Further, languages tend to be similar in terms of paradigms (systems) and different in terms of the syntagmatic realization.
- **Delicacy.** Systems of low delicacy, i.e. less specific oppositions, tend to be similar across languages, and systems of higher delicacy, i.e. more specific oppositions, tend to be different between languages.
- **Rank.** Languages show different preferences concerning the grammatical rank at which a certain phenomenon is grammatically expressed.
- **(Meta)functions.** Corresponding linguistic means can serve different functions in different languages, i.e. have a different functional potential.

In the remainder of this section, classifications of temporal conjunctive relations in German, English, and Dutch are compared with respect to the four dimensions of comparison given at the beginning of this section.

7.4.3 Similarities and differences between functional classifications

As mentioned above, comparing coverage, types of temporal markers examined, and the properties taken into account is a rather straightforward task:

	Martin 1992	Oversteegen 1993	Hitzeman 1995	this study
Language	English	Dutch	English	German
Connectives	when, while, as, after, since, now that, before, once, as soon as, until, first, secondly, third, next, previous, finally, lastly, still, at the same time	toen, terwijl, vordaat, nadat, sinds, totdat	when, while, before, after, since, until	see Table 5.5
No. of markers	19	6	6	27
No. of readings	25	21	12	72
No. of relations	16	18	4	31
Types	external, internal	external	external	external
Readings	temporal	temporal non-temporal	temporal non-temporal	temporal
Word classes	subc, conj	subc	subc	subc, prep, conj, pronadv

Table 7.2: Coverage of different studies on temporal conjunctive relations

7.4.3.1 Scope of study.

With respect to coverage of the studies one can note the following: [Oversteegen 1993] and [Hitzeman 1995] examine a small subset of Dutch and English temporal markers only. They each discuss six temporal connectives, namely *when/toen*, *while/terwijl*, *before/voordat*, *after/nadat*, *since/sinds* and *until/todt*. The number of interpretations examined is, however, much higher: Oversteegen describes 21 readings of the six markers, and Hitzeman identifies 12 readings. [Martin 1992] examines 19 different temporal markers. In his account, only the simultaneous markers are ambiguous, apart from that there is a one-to-one mapping from conjunctive relation to temporal connective. Hence one finds only 25 readings for 19 different connectives in English. Temporal markers signal 18 different conjunctive relations in Oversteegen's study, 16 relations in Martin's account, and only 4 relations in Hitzeman's classification. Considering the relation between number of markers and relations signaled, Oversteegen's Dutch temporal markers are the most ambiguous. With respect to the number of temporal connectives and the temporal relations distinguished, my approach is the most comprehensive: It covers the entire set of German temporal markers given in grammars such as [Helbig and Buscha 1991, p450ff], i.e. 27 different temporal connectives in 72 readings. They verbalize 31 German temporal conjunctive relations, with various markers realizing several relations. For instance, *während* occurs at six places in the system network. The top five rows in Table 7.2 summarize the discussion so far.

7.4.3.2 Types.

The four studies consider different types of temporal connectives and temporal conjunctive relations (compare also Table 7.2, bottom three rows): The restricted number of temporal connectives in [Oversteegen 1993] and [Hitzeman 1995] is due to the fact that they examine temporal and non-temporal readings for each temporal connective, whereas the present study, like [Martin 1992], focusses on the temporal interpretation only. However, my work differs from [Martin 1992] as he also presents a classification of internal temporal relations, which neither [Oversteegen 1993] and [Hitzeman 1995] nor my study does. Finally, the system network for external temporal relations in German proposed in the preceding section goes beyond the other accounts in that it is not restricted to one word class (subordinate conjunctions) in realization, but additionally considers prepositions, conjunctives, and pronominal adverbs. Note that [Martin 1992] also analyses conjunctives, but only as realizational consequences of internal temporal conjunctive relations.

7.4.3.3 Properties.

The third point of comparison concerns the aspects of marker description that are taken into account in the different studies. In Chapter 6, I distinguished between properties that relate to marker meaning and properties that concern the linguistic environment of a temporal marker. All four classification take properties of marker meaning into account. Like [Oversteegen 1993] and [Martin 1992], my functional classifications specifies aspects such as the temporal relation and intention signaled, the relation to speaking time, the types of situations conjoined, and the type of dependency (compare Figures 7.3 to 7.6 and Figures 7.7 and 7.9). In contrast, [Hitzeman 1995] considers only two temporal relations and the type of dependency. As regards properties of the lexicogrammatical environment, Oversteegen's study and my account consider constraints regarding presuppositions, tense, syntactic structure, ordering of relata, and Aktionsart (see again the functional classification given in Sections 7.3 and 7.4.1 above, and the usage conditions enumerated in the tables in Chapter 6). While such constraints are also formulated in [Hitzeman 1995] for English, Martin's study does not take these properties into account. Differences in the range of properties studied are above all due to differences in focus of the studies, as the discussion below will reveal.

7.4.3.4 Functional classification.

Finally, how do the functional classifications of temporal conjunctive relations in Dutch, English and German relate to each other? I introduced four dimensions of cross-linguistic analysis of functional classifications that are worth considering: rank, metafunctions, axis, and delicacy.

Rank. Concerning the rank, all studies name temporal subordinating conjunctions as realizations of temporal conjunctive relations; these realize constituents of the clause rank.

In addition, I assume a verbalization at phrase rank when using a preposition to indicate a relation. I have included this construction because in German the realizations of temporal conjunctive relations by means of preposition are frequent, and especially prominent in the text type under consideration, technical instructions. This option is also available in other languages, although less frequently used than in German. Martin explicitly includes circumstantials in his list of possible grammaticalizations of conjunctive relations (cf. Chapter 4, Figure 4.4, and [Martin 1992, p170]). Hence, this difference in the functional classifications is simply a matter of coverage, and not due to any substantial difference between languages.

Metafunction. Likewise, there is not much to discuss regarding metafunctions: [Martin 1992] and [Oversteegen 1993] argue that external temporal conjunctive relations are ideational in the first place; this is confirmed by the kinds of distinctions made in their system networks for English and Dutch. As shown in Section 5.3 above, German temporal connectives also primarily relate primarily to ideational aspects, and have only a limited interpersonal and textual potential. [Martin 1992] goes beyond the other studies in that he also considers internal temporal relations, which have, above all, a textual meaning. Again, divergencies with respect to metafunctions are not a matter of principle but are due to the particular interests that motivated the functional classifications for German, English, and Dutch.

Axis. More substantial differences exist with respect to axiality. In my account of German temporal conjunctive relations I describe the paradigmatic, strategic organization of the resources as well as the syntagmatic structure resulting from choices in the functional classification. Likewise, [Oversteegen 1993] and [Hitzeman 1995] distinguish between paradigmatic description and syntagmatic structure. The former is specified in the system network, the latter results from constraints on the lexicogrammatical context that are associated with individual temporal markers. In contrast, Martin's networks do not generally contain constraints on the structural realization of functional choices apart from the selection of a temporal connective (see Figure 7.7 above). He presents a purely functional classification; the reference to the syntagmatic axis is underdeveloped. Yet again, the variation in the four functional classifications is not due to differences in the functional potential of the languages involved, but is a difference in focus. In fact, the accounts merely differ in how much weight they place on the syntagmatic realization. Martin's orientation is mainly descriptive, whereas the other functional classifications are developed with a particular application in mind—a computational application of some kind—where the syntagmatic axis is essential. A full network definition for English temporal connectives must also include partial constraints on the grammatical structures involved. Syntagmatic information is provided, at least for six English temporal connectives, by [Hitzeman 1995]. Hitzeman's constraints may act as a starting point for extending Martin's networks to contain syntagmatic specifications.

Delicacy. Finally, there is the dimension of delicacy, that is, the delicacy of the paradigmatic organization. It has been observed that systems of low delicacy, which define less specific oppositions, tend to be similar across languages, and that systems of higher delicacy, which reflect more fine-grained distinctions, tend to be dissimilar (see, for instance, [Bateman *et al.* 1991, Teich 1995, Bateman *et al.* 1999, Grote 2000]). The temporal conjunctive relation networks proposed in [Martin 1992, Oversteegen 1993] and [Hitzeman 1995] (depicted in Figures 7.7, 7.9 and 7.10) and my networks presented in Figures 7.3 to 7.6 confirm this impression. Choices at primary and secondary delicacy describe equivalent oppositions. The least delicate opposition is that between [simultaneous] and [successive], shared by the four accounts under consideration. Secondary choices are those between [co-extensive] (also: [coextension]) and [overlapping]), and between [anterior] and [posterior]. In the simultaneity region of the network ([co-extensive/overlapping] opposition), the type of situation is considered as meaning-differentiating in the [co-extensive] branch for all three languages. In the successive branch ([anterior/posterior] opposition), tertiary choices include the opposition [following] vs. [following-immediately] in Oversteegen's and my networks. In contrast, [Martin 1992] reverses the sequence of choices, presenting the [posterior / anterior] opposition as a tertiary choice, occurring after the distinction between [following] and [following-immediately]. However, as has been pointed out in Section 7.2.2 above, this difference is not a substantial one but is due to the typological perspective imposed by a system network, which enforces a particular hierarchical view on the relations between linguistic units. In the present instance, the fact that the sequence of choices is reserved in Martin's network does not, however, indicate a difference in function; both sequences can be realized without loss in meaning.

When it comes to the more specific or delicate areas of the paradigmatic description, the classifications of temporal relations in the system networks diverge to some extent. Divergencies are of various kinds: they relate to the terminology employed, the range of linguistic phenomena considered and the granularity of the distinctions made between them, the kinds of oppositions (as has been outlined in the paragraph on "Properties" above) accounted for in the network, and the functional potential of the languages under investigation.

With respect to the terminology, the four accounts sometimes use different feature name to denote the same property; an example is offered by the features [co-extensive] and [coextension]. These differences can be neglected. More interesting are those differences, where the same term (name of a feature) is used to denote different temporal relations. For instance, the use of posteriority and anteriority in Oversteegen's network is exactly opposite to its use in Martin's and my networks: She assumes that a temporal subordinate clause creates the temporal domain for the main clause. Consequently, she classifies *voordat* (before) as anterior instead of posterior, as done in Martin's and my networks, because it locates the main clause situation before the subordinate clause situation [Oversteegen 1993, p70]. In her view, this does not "indicate a fundamental difference of opinion but rather a difference in point of view from which the relations are described." (see [Oversteegen 1993, p70]).

The four functional classifications of temporal conjunctive relations further differ with

respect to the granularity of the description. For instance, [Hitzeman 1995] does not subclassify temporal relations beyond the [simultaneous/successive opposition], giving several possible realizations for each terminal feature. Yet, she provides no means to further distinguish between the realizational alternatives. Another example is the distinction between types of precedence relations as captured by the [following/following-immediately] feature pair. This distinction is absent in Oversteegen's network; here, [anterior] and [posterior] constitute the most delicate choice. Temporal discourse markers are not further characterized. Only one system actually describes the purely temporal readings of temporal connectives, and the entire [successive] subnetwork only characterizes three purely temporal uses of the markers *nadat*, *toen*, *voordat*. The description remains, in comparison to my treatment of German temporal markers, at a rather general level. Likewise, [Martin 1992] sometimes gives several lexical realizations for one feature, even though the markers involved can be further classified. Consequently, there is no way to choose between these temporal markers, such as, to give an example, *as*, *while* and *when* for the relation [simultaneous:overlapping:durative-anterior-dependent:nonstative]. These differences in the system networks, however, are again not a matter of different functional potentials of the languages under consideration. Instead, the difference in granularity is due to the specific interests of the researchers, which in turn determines which aspects of the functional classification are highlighted. For instance, Oversteegen's major interest is the non-temporal readings of temporal markers, therefore she considers the temporal ones only insofar as they are in opposition to the non-temporal readings.

Often, the German networks make the most fine-grained distinctions, i.e. account for oppositions that are not considered in the other networks. For instance, my successive network depicts additional, more specific, classifications relating to the boundedness of situations and additional semantic restrictions. Also, I classify relations according to the features [adjacency, immediacy] and [mere-precedence], while [Martin 1992] recognizes two types of precedence relations only ([following/following-immediately]). Like [Oversteegen 1993], I acknowledge several subtypes of overlap relations; yet, again my distinctions are more fine-grained in that I introduce further oppositions, as shown in the [overlapping] subnetwork in Figure 7.6 above. This higher delicacy in the systemic description results from the fact that I consider a wider range of markers than, for instance, [Oversteegen 1993] and [Hitzeman 1995] do. They are primarily interested in non-temporal readings of temporal connectives, hence they only examine a subset of temporal markers of their languages. This restriction has, of course, an effect on the delicacy of the paradigmatic description. To give an example, in my simultaneity network, eight temporal connectives are classified by the feature [co-extensive], as opposed to two markers in the Dutch and English accounts. Here, more fine-grained distinctions are required to give a comprehensive account of the usage conditions of the larger set of markers.

Functional classifications also differ regarding the distinctions made, i.e. the properties considered as discriminating between temporal markers. For instance, [Oversteegen 1993] and [Hitzeman 1995] include oppositions relating to non-temporal readings of temporal markers, which are not present in Martin's and my account. My representation shares a number of oppositions with Martin's networks, in particular the [deictic/nondeictic] opposition, which captures the relation of the dependent clause situation to speaking time, the spec-

ification of the extension of the situation denoted by the dependent clause ([extension-to-present/extension-from-present/extension-in-past]), and the reference to the speaker's attitude towards the information she presents ([relief/relief-unmarked] and [negative-regard/no-regard]). However, similar to Martin, and in contrast to Oversteegen, I also take the type of dependency into account [anterior-dependent/posterior-dependent], an opposition which is only selectively accounted for in Oversteegen's network (see the opposition [is included/includes]). Yet, I believe that these divergencies are mainly due to the different motivations that lead to the design of the system network, to the size of the marker set examined, and to the granularity of the description. In other words, differences in the functional classification pertain to the description, and not of the functional potential of the languages under consideration.

To sum up the discussion so far, the functional classifications of temporal conjunctive relations for German and for English (in particular, Martin's account) share a large number of features and oppositions, and only diverge regarding the more delicate choices, the weight they place on the syntagmatic descriptions, and the terminology. The comparison has revealed that these differences are mainly due to the larger set of temporal markers examined in the German study, which requires more delicate choices, and the different interests and goals of the researchers that motivated the design of the system networks. In my view, the contrastive study does not suggest that differences result from substantial divergencies between the functional potentials of these two languages. Due to the lack of data for Dutch—[Oversteegen 1993] considers only a small number of temporal relations, as she focusses on the non-temporal uses of temporal markers—no claims can be made regarding the commonalities and differences in the more delicate regions of the temporal conjunctive relation networks for Dutch and German, and hence on the potential sharing of portions of the system network.

The ultimate goal of my contrastive analysis should be the specification of a joint, multilingual resource. The actual "unification" of the functional classifications is beyond the scope of this thesis, nevertheless I briefly address the issues that have to be taken care of. Given the results from above it seems likely that German and English could share large portions of the temporal conjunctive networks, and mainly require language-specific systems for a few systems at high delicacy. In order to arrive at a common description for German and English temporal conjunctive relations, a number of steps have to be taken:

- **Rank:** The English account requires a phrase rank.
- **Metafunction:** The German account has to cover internal temporal conjunctive relations.
- **Axis:** Detailed specifications on the linguistic environment of a marker in the shape of constraints on the lexicogrammatical realizations have to be given for the English temporal connectives.
- **Delicacy:**
 - Corresponding sets of temporal markers should be considered for both languages

- The analysis has to be at the same level of granularity. Ideally, a terminal node should have one marker as realization (exceptions are, of course, synonyms).
- One needs to examine how far functional classifications for both languages can foreground the same classificatory principles, i.e. whether the sequence of systems can be the same.
- Oppositions specific to a particular language have to be identified.
- **Terminology:** The terminology has to be unified.

7.4.4 Temporal conjunctive relation networks in multilingual generation

To conclude this chapter, let me briefly address two issues: First, there is the subject of multilingual resources. In this section, I identified similarities and differences in the classification of temporal conjunctive relations in English, Dutch, and German. This comparative discussion of the temporal conjunctive relation networks is a first step towards a multilingual account of linguistic resources from different languages, as suggested in [Bateman *et al.* 1991] and partially realized within the functional grammars of the KPML sentence generator [Bateman 1997].

Second, there is the question of the applicability of the functional classifications of temporal markers in multilingual generation, which is one of the goals of this thesis. In automatic text production, it is important to know about the structural consequences of paradigmatic choices. The temporal conjunctive relation networks for Dutch and German are explicit about this issue by incorporating constraints on the realization of functional choices. Yet, the English network cannot be employed in text generation as it stands: As maintained above, a complete definition of temporal conjunctive relations and thus classification of temporal connectives has to account for both the paradigmatic organization and its structural realization. Consequently, Martin's network has to be supplemented by constraints on the syntagmatic structure prior to its employment in text generation. As already indicated, the constraints given in [Hitzeman 1995] may provide an initial specification. A further requirement on linguistic resources in text generation relates to coverage: To be applicable in text generation systems, the functional classifications of temporal markers have to cover at least the most frequent temporal markers of a language. While the temporal conjunction network for Dutch [Oversteegen 1993] and the network given in [Hitzeman 1995] fall short of this goal—they only examine six connectives from one word class—[Martin 1992] presents a complete picture of English hypotactical temporal markers, yet does not explore other words classes such as prepositions and conjunctives (an exception is internal temporal conjunctives). However, this is not a principled objection as his representations can be enhanced by further lexical realizations, as I have done for my German temporal conjunctive relation networks. As regards coverage, my account is by far the most elaborate one, covering the German temporal markers given in standard grammars such as [Helbig and Buscha 1991], comprising prepositions, subordinating conjunctions, coordi-

nating conjunctions, and conjunctives, and even accounting for intentional and stylistic differences.

Part III

Lexical modelling and application

Chapter 8

Modelling the discourse level

The goal of this chapter is to develop a discourse representation that adequately describes the coherence relations holding between discourse segments in (multilingual) technical instructions, and that meets the demands of discourse marker representation and choice (as discussed in Chapter 2). The basic underlying assumptions are, as argued for in previous chapters, that discourse markers are a prominent means to signal coherence relations in text, and that the information provided on the discourse level is the major factor in deciding on the applicability of a discourse marker. I suggest that this information cannot be provided by an RST-like discourse representation, which is usually taken as a starting point for discourse marker choice processes in MLG, and that many problems in discourse marker choice stem from problems inherent to the RST framework.

The chapter starts by briefly surveying the problems encountered in discourse marker choice when starting from an RST-like discourse representation, and by motivating my decisions regarding the representation to be assumed at discourse level (Section 8.1). Next, I describe how the different dimensions of discourse representation are defined for the text type under consideration, technical instructional texts (Section 8.2), and then introduce the paradigmatic representation of coherence relations (Section 8.3). After briefly addressing the issue of discourse structure (Section 8.4), the chapter concludes with sample analyses of two texts using the proposed set of coherence relations, and a few remarks on the relation between the proposed discourse representation and discourse marker choice (Section 8.5).

8.1 Basic assumptions about the discourse level

This section motivates my assumptions about the discourse level by first discussing the problems encountered with RST in the context of discourse marker choice, and then examining different approaches to discourse representation with respect to their suitability for the present task, discourse marker selection in multilingual text generation.

8.1.1 Problems with RST in the context of discourse marker choice

Following the prevalent approaches to discourse representation in MLG (see Chapter 3), I take the discourse level as a level of textual representation that captures the coherence relations in a text, i.e. the relations between adjacent discourse segments. In the context of text generation, *Rhetorical Structure Theory* [Mann and Thompson 1988] is the most prominent approach; the majority of strategies for automatic discourse marker selection also adopt RST at the discourse level and hence as starting point for discourse marker choice mechanisms, for instance, [Scott and de Souza 1990, Rösner and Stede 1992, Vander Linden 1994]. However, as already suggested in Chapter 2 and Chapter 3, using RST in its present shape for discourse representation and discourse marker selection in the context of multilingual text generation is not in all cases an adequate solution. This is due to two factors:

- **Problems inherent to RST.** As discussed in Chapter 3, there are a number of unresolved issues regarding RST; these problems of the RST framework carry over to discourse marker choice.
- **Requirements of discourse markers.** From the discourse marker study in Chapter 6 it became clear that deciding on the applicability of a discourse marker in a discourse representation requires more information than is provided by an RST relation alone.

As for the first point, open issues regarding RST that affect discourse marker choice include the following: RST as used in text generation is not clear on whether it is language-specific or language-neutral (cf. Chapter 3). The debate on language-specificity of RST interacts with the question of how closely RST relations and discourse markers are related. If one follows, for instance, [Delin *et al.* 1994] and postulates that RST relations are close to the linguistic surface, then discourse markers and RST relations are closely coupled, and RST is regarded as the most important, and sometimes sole source for discourse marker choice (cf. discussion in Chapter 2). Other researchers introduce new relations based on linguistic evidence, such as PRECONDITION and RST-UNTIL [Rösner and Stede 1992], again suggesting a close linkage between RST-relation and discourse markers.

Yet, RST was originally defined as being detached from the linguistic surface, and as such it has never been intended as guiding discourse marker choice, even though it is frequently used that way. If, however, a discourse structure based on RST is regarded as language-neutral, then the gap between discourse representation and the linguistic surface is stretched very far (as argued by, for instance, [Bateman and Rondhuis 1997]), and additional knowledge sources have to be integrated in order to support motivated discourse marker choice (see discussion in Section 8.1.2.1 below).

Another problem arises from the fact that the set of relations is an open issue, and that no generally accepted criteria exist for introducing relations to the set. In an approach that regards discourse markers as realizations of coherence relations, the semantics of discourse markers is usually described in terms of coherence relations. However, if no common

basis exists for the introduction of coherence relations, then the semantic specification of discourse markers is not on very solid ground. Finally, another criticism of RST relates to leaving information implicit and being underspecified, which gives various discourse markers for one coherence relation, and raises the issue in how far discourse marker choice can actually be motivated from an RST-like discourse representation. Studies of discourse markers in Chapter 6 show that various dimensions influence the applicability of discourse marker choice such as semantic relations, intentions, focus, presuppositions and beliefs, etc, which is more than can be read off an RST-tree. This has already been pointed out in Chapter 3.

If RST as it is used in current approaches to multilingual text generation is not an adequate representation of the discourse level for discourse marker choice in the automatic production of multilingual instructional texts, then, what does the discourse representation have to look like?

8.1.2 Discourse representation

To answer this question, one needs to be more specific about the demands on a discourse representation. Consider a short fragment from the operating instructions for the Bosch toaster (example (8.1a) from TC.21; see example (8.57) below for the full text), and examples from other toaster operating instructions, which describe similar situations:

(8.1)

- a. *Mit dem Herunterdrücken und Einrasten der Aufzugstaste schaltet sich das Gerät ein und der Toastvorgang beginnt.*
 With the pressing down and clicking into place of the lever switches itself the device on and the toasting process starts.
 ‘By pressing down the lever and clicking into place the toaster is switched on and the toasting process begins.’
- b. *Das Gerät schaltet automatisch ab. Dieses bewirkt, dass die Brotscheiben hochgeschoben werden.*
 The toaster switches automatically off. This causes that the bread slices popped up are.
 ‘The toaster switches off automatically. This causes the bread slices to pop up.’
- c. *Zum Einschalten des Toasters die Taste nach unten drücken.*
 To switch on the toaster the button down press.
 ‘To switch on the toaster, press down the button.’
- d. *Mit dem Drücken der Taste schaltet sich das Gerät ein.*
 With the pressing of the button switches itself the device on.
 ‘With pressing down the button the device switches on.’

In the examples, different linguistic means are employed to link the two clauses: the additive *und* (and) in example (8.1a), the consequential *dieses bewirkt* (this causes) in

(8.1b), the purposive *zu* (to) in (8.1c), and finally, the instrumental *mit* (with) in (8.1d). Despite these differences in surface form, the examples all have something in common: The same relationship holds between the two situations denoted by the clauses; in all cases, one situation brings about the other situation. Hence, we need to provide a discourse representation that can capture the commonalities between examples such as these, and at the same time support differences in verbalization.

8.1.2.1 Degree of abstraction

Approaches that regard discourse representation as being closely related to the linguistic surface (such as [Martin 1992, Knott and Mellish 1996]) assign different coherence relations to examples (8.1a) to (8.1d). For instance, Martin would assume an additive relation in example (8.1a) and a consequential relation in example (8.1b). Likewise, using RST the way frequently done in MLG (for instance, [Delin *et al.* 1994, Oberlander *et al.* in press]), different RST relations would be assigned to the examples due to different surface cues. Adopting this view, commonalities between the two examples are lost. In contrast, approaches to discourse representation that abstract from linguistic phenomena define coherence relations in terms of ‘real-world’ relations, ‘deep’ intentions, etc. holding between text segments (for instance, [Hobbs 1990, Moser *et al.* 1996]) which can be realized differently when linearizing, or unfolding, a text. Following this approach, the examples above are analysed as differing in terms of the relation signaled by surface cues, but not in terms of the relationship holding between the two situations denoted by the clauses, here that of one situation bringing about another situation. I opt for representing coherence relations at a level that is independent of particular linguistic surface cues, because first, I believe that various factors apart from the coherence relation come into play when deciding on a particular verbalization (e.g. text type, assumptions about reader goals, discourse history, language); hence one cannot infer a coherence relation from linguistic means alone. Second, the production of mono- and multilingual paraphrases requires that coherence relations and their linguistic realizations are decoupled, such that the discourse representation preserves the commonalities underlying different verbalizations. Finally, the MLG perspective provides another argument in favour of a language-independent discourse level: In the context of generation, coherence relations do not link *text* segments, but preverbal *discourse* segments, i.e. propositions that have to be verbalized in later steps of the generation process.

To sum up, in my view, the discourse level describes the rhetorical relationships independently of how these are communicated in a single temporal unfolding of the text. This position is in line with [Bateman and Rondhuis 1997] who argue that the gap between a conceptual representation and the linguistic surface is too large anyway, and that it cannot be bridged by an RST-like discourse representation alone. Instead, they advocate an approach comprising two strata in discourse representation (see Chapter 3): A language-independent level, where the relationships between what I term discourse segments are described, and a language-specific level which links text segments, i.e. the discourse segments in their realization in text. The discourse level I assume corresponds to the lower strata of Bateman’s and Rondhuis’ approach; discourse markers then verbalize the link

between text segments.

8.1.2.2 Dimensions of representation

I argued above that a language-independent discourse representation can capture the common semantic relation underlying examples (8.1a) to (8.1d). Now, consider examples (8.1c) and (8.1d); in what respect do they differ? With sentence (8.1c), the speaker clearly attempts to activate the reader to perform a specific action by presenting the switching action as the goal, thus realizing a different intention from all other examples. This distinction between semantic relations and intentional links has been widely accepted, see the informational and intentional levels in [Moore and Pollack 1992] and [Moser *et al.* 1996], and the semantic-pragmatic distinction advocated by [Sanders *et al.* 1992] and [Knott and Mellish 1996], but is somewhat blurred in the RST framework as relations conflate different aspects of coherence (cf. Chapter 3). Further, the examples contrast in what they express in the matrix clause and thus present as ‘major’ information: *drücken* (press) in (8.1c) vs. *einschalten* (switch on) in (8.1d); in RST terms, they differ in nuclearity. I therefore assume three dimensions in the discourse representation for my texts, and follow [Maier and Hovy 1993], [Bateman and Rondhuis 1997] and [Degand 1998] in classifying coherence relations according to the three metafunctions of language as maintained in Systemic Functional Linguistics (SFL). Adopting SFL’s metafunctional diversification, the three functions of discourse can be described as follows:

- **Ideational function.** Relations that fall into this category are “those that hold between adjacent segments of material that expresses some experience of the world about us and within our imagination” [Hovy 1993, p376]. They are “deep” relations between chunks of knowledge/content, and thus kind of encode general world knowledge like cause-effect, temporality, etc.
- **Interpersonal function.** Relations of this type “establish a link between the illocutionary meaning of one of the discourse units with the locutionary meaning of the other” [Degand 1998, p29]. In Hovy’s terms: “those relations holding between adjacent segments of material in which the author attempts to affect the addressee’s beliefs, attitudes, desires, etc.” [Hovy 1993, p378].
- **Textual function.** Relations signaling this function “establish a sequential, text-organizing relationship between ideationally/interpersonally only loosely or indirectly related adjacent discourse segments.” [Degand 1998, p30]. In short, they organize the text itself, but do not introduce new information.

8.1.2.3 Relation definition

[Maier and Hovy 1993] assume *atomic* relations at each metafunction, which can hold simultaneously between discourse segments. The problem is, however, that their relations conflate various aspects of coherence. To illustrate this point, consider examples

(8.1a) to (8.1d) again, which can be analysed as (8.1a) SEQUENCE, (8.1b) VOLITIONAL-RESULT, (8.1c) PURPOSE, (8.1d) VOLITIONAL-CAUSE (see the ideational taxonomy in [Maier and Hovy 1993] and the RST definitions in [Mann and Thompson 1988]). These subject-matter relations are claimed to ‘re-state’ semantic relationships holding in an abstract content representation; so why do I end up with different ideational relations? The reason is that subject-matter relations are not purely ideational but always add information whose nature remains unclear, here intentions and nuclearity. Since motivated discourse marker choice requires access to all aspects of coherence, definitions such as these are not suitable for my purposes.

I turn to [Bateman and Rondhuis 1997] for a solution: They suggest decomposing atomic coherence relations into their contributions to the different metafunctions (They have been introduced in Chapter 3). Coherence relations are now defined as configurations of ‘pure relations’ which describe the different types of links between text segments. To illustrate this point, the VOLITIONAL-RESULT in example (8.1b) could be described as serving the ‘purpose’ of signaling a causal relationship, of which the reader is informed, and where the focus is on the causing action. Following the systemic tradition, Bateman and Rondhuis represent the different kinds of purposes (or ‘functions’ a relation can serve) in system networks (paradigmatic description). Their initial system network of rhetorical relations was shown in Chapter 3, Figure 3.7. Individual coherence relations are now described by selecting alternatives from the ideational, interpersonal and textual networks. The resulting ‘feature bundles’ define the coherence relation between discourse segments (syntagmatic description).¹ Further evidence for such a composite definition of coherence relations has been put forward by [Grote *et al.* 1997], who identify three dimensions in the description of the *Concession* relation—the ‘semantics’ of the relation, the speaker’s intention, and the distribution of information to main and minor act—and who demonstrate that a selection from the different dimensions results in a special type of concession relation.

In brief, advantages of this approach are: Composite coherence relations make all kinds of links between two discourse segments explicit; an independent description and a flexible combination of features is possible by decoupling decisions concerning the three different metafunctions; and text segments can simultaneously realize several functions from different dimensions.

8.1.2.4 Set of relations

When taking coherence relations as cross-classifications of features in the networks, the set of possible relations is the set of all possible combinations. However, not all combinations actually occur; the set of permissible combinations as well as the more specific relations can only be defined for a given text type (see also [Hovy 1993, Bateman and Rondhuis 1997]).

¹In Bateman’s and Rondhuis’ understanding [Bateman and Rondhuis 1997, p38], the three-way classification in system networks is not a classification of coherence relations, but of the ‘functions’ or discourse purposes of a rhetorical relation. Hence, the features in the networks do not name relations, but the ‘function’ or a purpose that a relation fulfils. I will stick to the term (pure) *relation* for these ‘purposes’ and *coherence relation* to refer to the composite relation (a feature bundle) resulting from network choices.

For example, Hovy notes that

in available attempts at listing relations, the intended purpose determines the nature and the number identified. [Hovy 1993, p359]

In this thesis, I also adopt this strategy, and define the coherence relations that hold between discourse segments in technical instructional texts. Section 8.2 deals with this topic.

8.2 Coherence relations in technical instructional texts

So far, I have motivated the general framework for representing information at the discourse level, but I have not yet specified the distinctions for the three dimensions of discourse representation, i.e. what composite coherence relations are made of. In this section I describe my approach to identifying and defining the relations that hold in the text type under consideration by analysing the extra-linguistic context, and then turn to linguistic variation for classifying these relations in Section 8.3.

8.2.1 Approach to identifying relations

I carried out an analysis of 25 texts from a corpus of technical instructions in order to determine the genre-specific relationships at the three dimensions of representation: ideational, interpersonal and textual. (Appendix A lists the texts that make up the corpus.) In other words, the task is that of analysing the *register* of a text type, here, of technical instructions.² Ideational relations characterize the *field* variable, while interpersonal and textual reflect *tenor* and *mode* of a particular text type respectively. The difficulty lies in identifying ‘pure’ relations, in other words, those that only express a single kind of information. I adopted the following strategy: As ideational relations relate to the abstract content representation, I tried to extract typical patterns of how propositions relate to one another. More specifically, given the text type technical instructional texts, this means above all examining how actions that are part of the procedure described in technical instructions are linked. These relations serve as candidates for the ideational part of the rhetorical relation network.

²Register and text type or genre are used as defined in [Martin 1992]:

[...] genre (context of culture) and register (context of situation), with register functioning as the expression form of genre, at the same time as language functions as the expression form of register. [Martin 1992, p495]

Register itself is organized with respect to field (capturing experiential meaning), tenor (interpersonal meaning) and mode (textual meaning).

Interpersonal relations were identified by performing a Grosz-Sidner style analysis of the intentional structure [Grosz and Sidner 1986], and by extracting the interpersonal contributions of the RST-relations assigned to the same text, drawing on the re-analysis of RST-relations in [Bateman and Rondhuis 1997]. This gives us the intentions realized in the current text type. Finally, textual relations, in particular the nuclearity distribution, were determined by mapping a purely ideational representation of a text onto an RST analysis of the same text; this gives us first the nuclearity assignments, and second, those text segments that are introduced for textual reasons alone.

8.2.2 Ideational relations

The exact set of ideational relations to be included in the paradigmatic representation depends on the text type. In a domain such as technical instructions, ideational relations holding between two discourse segments describe how the actions in a procedure that are denoted by the discourse segments are related to each other, i.e. they capture the underlying semantics of actions and their relationships. These relationships are often called *procedural relations* when talking about relations applying between actions in a task [Goldman 1970, Pollack 1986, DiEugenio 1993, Delin *et al.* 1994]. [Kosseim and Lapalme 1994] describe the relations by means of *semantic carriers*, others again call them *informational relations* [Moser *et al.* 1996] or *semantic relations* [Barker 1994].

Starting from the *Generation* and *Enablement* relation (see [Goldman 1970, Pollack 1986, Balkanski 1992, Delin *et al.* 1994]) and the temporal relations by [Allen 1984], I successively added further relations to meet the demands of my domain, since these relations alone cannot account for a wide range of relationships typically expressed in task-related discourse (see among others [Young 1995, DiEugenio 1994, Kosseim and Lapalme 1994]). My initial set of ideational relations consists of 24 relations; the set is by no means exhaustive but confined to the requirements of the present application domain.

Sets of relations for task-related discourse have also been put forward by [DiEugenio 1993, Barker 1994, Kosseim and Lapalme 1994, Delin *et al.* 1996, Moser *et al.* 1996]. The work in the context of DRAFTER [Delin *et al.* 1994, Delin *et al.* 1996] starts from a task representation, here a formal plan structure, very much like STRIPS plans [Sacerdoti 1977]. Yet, their account mainly focusses on pairs of actions in a *Generation* and *Enablement* relation; they ignore temporal information and other relationships holding in task-related discourse. Barker's semantic relationships between acts, events or states are defined as holding between clauses, i.e. between surface-syntactic constituents of the sentence [Barker 1994]; I aim at a set independent of the surface realization. [Moser *et al.* 1996] give the most complex collection of informational relations, however, their set turns out to be different from mine because they define relations holding in explanatory texts in a dialogue situation. Further proposals include the semantic relations by [Sanders *et al.* 1992], Hobbs' coherence relations [Hobbs 1990], [Asher and Lascarides 1994] work, and, to some extent, Mann and Thompson's subject-matter relations [Mann and Thompson 1988].

In the remainder of this section, I provide definitions and examples of ideational links

between two discourse segments that can be observed in technical instructional texts. I will adopt the following notational conventions, I will use S_0 and S_1 to refer to the discourse segments that are in a coherence relation, and α and β to refer to the actions, or situations, that are denoted by the discourse segments. In the discussion below I will mainly discuss how actions relate to each other, and define the procedural relations holding between them. This approach is feasible as in my understanding ideational relations are defined in terms of the procedural relation holding between the two situations, or actions, α and β denoted by the discourse segments S_0 and S_1 . Hence, identifying the different instances of *procedural-relation*(α, β) implies the different instances of IDEATIONAL-RELATION(S_0, S_1). For instance, identifying an instance of *Generation*(α, β) leads me to assume the ideational link *generation*(S_0, S_1).

I will relate to available accounts by other researchers (see above) at various stages in the discussion of my set of relations. Relation definitions are given in the following uniform way:

- Name of relation
- Natural language definition of relation
- Examples from the technical text corpus (see Appendix A)
- Discussion (optional)

On a very general level, I distinguish between three types of ideational links: causal, temporal and additive. These three categories are often regarded as patterns of conceptual interpretation by means of which humans structure reality (*konzeptuelle Deutungsmuster*, [Linke *et al.* 1994, p228]). This division is adopted by many of the accounts mentioned above, for instance, [Barker 1994, Moser *et al.* 1996, Hobbs 1990]. [Sanders *et al.* 1992], in contrast, distinguish between causality (implication) and addition (conjunction) only, and regard temporal relations as additive ones, whereas [Soria and Ferrari 1998] take consequentials and additives as the basic division, too, but classify temporals as consequentials.

Regardless of the classification details, there is a general agreement that discourse segments (and hence the situations they denote) are strongly connected if a causal link is given, and weakly connected if only an additive relation holds. In this view, a causal relation implies a temporal relation, which in turn implies an additive relation. In other words, there is a decrease in specificity from causal to additive relationships.

8.2.2.1 Causal relations

Causal relationships can be of three kinds: One action is sufficient to cause another action, one action causes another action if some additional circumstances are given, and some constraints/conditions hold for the execution of another action.

- **Cause.** A cause relationship represents the situation where an action α makes a second action β occur or exist, often referred to as cause-effect or reason-consequence.

The main characteristic of these relations is that the first action is sufficient to cause the second action, and the occurrence of first action is required for the second action to happen. I distinguish different kinds of causal relations in the present domain:

- actions cause other actions/states (*cause-effect, generation*)
- actions have side-effects (*side-effect*)
- performing an action prevents another action (*prevention*)
- conditions cause actions (*occurrence*)
- conditions may cause another action (*eventuality*)
- actions occur contrary to the expectation induced by another action (*concession*)

[Barker 1994, Hobbs 1990] and [Moser *et al.* 1996] all distinguish between several types of cause relations, ranging from three [Barker 1994] to thirteen [Moser *et al.* 1996] subtypes.

- **Enablement.** A number of relationships hold between actions, where one action α is not sufficient on its own to make a second action β happen, but provides the grounds for the subsequent performance of β . Following other work on representing relationships between actions (see [Pollack 1986, Hobbs 1990, DiEugenio 1993, Delin *et al.* 1994]) I refer to these relations as Enablement. Enablement relations have in common that the execution of one member of the pair results in the execution of the other member only by means of some intermediary action. That is, the enabling action provides only one of the conditions for the performance of the second action: “When α enables β , then the agent needs to do something more than α to guarantee that β will be done” [Delin *et al.* 1994, p63]. Note that in contrast to Generation, and in correspondence with Cause-Effect, the actions in an Enablement relation can be performed by two different agents.

I distinguish three subtypes:

- an action is one step amongst others in achieving a goal, but by itself not sufficient (*plan-step*)
- one action leads to a state/effect, that enables the execution of another action (*preparatory action*)
- a state enables the successful execution of an action (*precondition*)
- **Others.** Causal relations that do not fall into one of the two categories include
 - condition on the execution of an action that cannot be planned for (*constraint*)

The various causal relations are defined as follows:

Generation. The Generation relation has been mentioned above as one of the two most prominent relations in technical instructions (see e.g. [Balkanski 1992, DiEugenio 1993, Delin *et al.* 1994, Kosseim and Lapalme 1994, Young 1995, Delin *et al.* 1996]). Following [Delin *et al.* 1994], the Generation relationship holds between two actions³ α and β if “by performance of one of the actions, the other will *automatically occur*” (cf. [Delin *et al.* 1994, p61]). A canonical example for this relation is *Jane turns on the light by flipping the switch*, where the first action generates the turning on of the light automatically. Examples from the present domain are:⁴

(8.2)

- a. *Aufzugstaste bis zum Anschlag nach unten drücken. Damit schaltet sich
Lever to the rest position down press. Thereby switches itself
das Gerät ein. (TC.20)*
the device on.
'Press down the lever to the rest position. This switches on the device.'
- b. *Die Betätigung der Taste setzt die Uhr auf volle Minute.*
The operation of the button sets the clock to full minute.
'Operating the button sets the clock to a full minute.'

The examples illustrate the additional criteria that must apply for a Generation relationship to hold between two actions: The actions should be performed by the same agent (see also [Pollack 1986, DiEugenio 1993]); the relation should be asymmetric; neither action should be subsequent to the other; the actions should not be co-temporal. A discussion of these conditions is provided by [Delin *et al.* 1994]. In example (8.2a), pushing down the lever generates a state transition of the toaster: Its state changes from *off* to *on*. This always and automatically occurs when pushing down the lever.

In the following example, the generating action is *not* doing anything for 30 seconds:

- (8.3) *Drücken Sie [...] 30 sec. lang keine Taste, so wird die Programmierung
Press you [...] 30 sec. long no button, then will be the programming
unterbrochen.*
interrupted.
'If you do not press any button for 30 sec., then the programming will be interrupted.'

Cause-Effect. Cause-Effect is very similar to Generation in that this relation holds between two discourse segments S_0 and S_1 if the action denoted by S_0 (α) makes the action denoted by S_1 (β) occur or exist. It differs in that it loosens some of the constraints

³To be precise, between two act-types. [Goldman 1970] regards the relations as applying between *act-tokens* in certain well-defined situations, whereas [Delin *et al.* 1994] consider the relations to apply between *act-types*. This is due to the fact that in the context of generating technical instructions, one deals with potential actions (= types) and not with actions that have already been performed (= tokens).

⁴Numbers in brackets following the example give the text from the technical corpus that the example originates from (cf. Appendix A).

imposed by Generation: In contrast to Generation, the actors of the two actions can be different, the actions may be in a temporal sequence, i.e. they may be subsequent and there may be some intervening time. Finally, β can be any type of action.

(8.4)

- a. *Nach Beendigung des Toastvorgangs schaltet der Toaster ab. (TC.20)*
 After completion of the toasting process switches the toaster off.
 ‘When the toasting process is completed, the toaster switches off.’
- b. *Betätigen Sie den Zündschlüssel zum Starten des Wagen. Der Motor läuft.*
 Use you the ignition key for starting the car. The engine runs.
 ‘Turn the ignition key to start the car. The engine runs.’

Side-Effect. Side-Effects are additional consequences of executing an action α which are not the goal of that action. As opposed to generation, the effect β is unintended:

- (8.5) *Drücken Sie die START/STOP-Taste. Zur Funktionskontrolle leuchten*
 Press you the START/STOP-button. For function control light
sämtliche Zahlensegmente und Funktionssymbole kurz auf. (TC.4)
 all number segments and function symbols briefly up.
 ‘Press the START/STOP-button. In order to ensure correct functioning, all number segments and symbols light up briefly.’

Prevention. [Barker 1994] introduces Prevention as a complement to Generation in that a Prevention relation holds if α prevents β from occurring or existing. His example is *The files were not copied since the hard disk crashed*. Here, the hard disk crash (α) prevents the copying of the files from happening ($NOT\beta$). An example from my domain is:

- (8.6) *Die Zündkerzen eine nach der anderen auswechseln, damit die*
 The spark plugs one after the other change, so that the
Zündkabel nicht durcheinandergebracht werden. (TC.22)
 spark plug wires not mix up will be.
 ‘Change the spark plugs one at a time so that you do not mix up the spark plug wires.’

Changing all spark plugs at the same time results in mixing up the spark plug wires; changing the spark plugs one at a time (α) prevents mixing up the cables ($NOT\beta$).

Occurrence. Another distinction is that between causing actions that are realized (as in the examples given so far) and causing actions that are potential. Consider the following examples from the technical domain where the realization of the effect β depends on the realization of the causing action α :

(8.7)

- a. *Wenn die Lautstärke-Regelung zu niedrig eingestellt ist, wird die Lautstärkekontur-Schaltung aktiviert. (TC.18)*
 If the volume-control to low set is, will the volume-contour-control activated.
 ‘In case the volume control is set too low, the volume contour control will be activated.’
- b. *Wenn während der Rückspulung oder des Schnellvorlaufs das Bandende erreicht wird, sofort die STOP/EJECT-Taste drücken. (TC.18)*
 If during the rewinding or the fast forward-winding the tape end reached is, immediately the STOP/EJECT-button press.
 ‘If the end of the tape is reached while rewinding or fast forward-winding of the tape, then immediately press the STOP/EJECT-button.’

The actions in example (8.7a) are in a Generation relation: The occurrence of α always triggers β , without any reader intervention. In example (8.7b) the potential, i.e. currently unrealized, occurrence of α causes the reader to press the STOP/EJECT button.

Similar relations have been introduced by, for instance, [Barker 1994] who postulates the Entailment relation in order to capture the potential occurrence of an action, here of α . This is in opposition to Cause and Generation, where the occurrence of the action is known. The following example is given by [Barker 1994]:

(8.8)

- a. *The file printed because the program issued a print command. (cause)*
- b. *The printer will print if a print command is issued. (entailment)*

In (8.8a), α is known to occur or exist, while in (8.8b) α is not known to occur or exist. [Kosseim and Lapalme 1994] introduce *eventual* to capture this relation; RST has the subject-matter relation CONDITION, whose informational contribution is as follows: The causing action is an unrealized action, and the resulting action depends on the occurrence of the unrealized causing action. RST’s OTHERWISE is the negated variant, in other words, a Prevention with an unrealized α .

Eventuality. While Occurrence describes the potential or future occurrence of α , eventuality describes the potential occurrence of the effect. An eventuality holds if an action α is sufficient to cause an action β , but α does not always cause β , the occurrence of β is only likely, but not certain. Consider the following example taken from the Honda car manual, where the relation between two actions α and β is a potential one:

- (8.9) *Eine lose Zündkerze kann sehr heiß werden, und möglicherweise den Motor beschädigen. Eine zu fest angezogene Zündkerze kann das damage. A loose spark plug can very hot get, and possibly the engine damage. A too tight fastened spark plug can the*

Zylinderkopfgewinde beschädigen. (TC.22)
 cylinder head threads damage.

‘A plug that’s too loose can get very hot and possibly damage the engine; one that’s too tight could damage the threads in the cylinder.’

There exist a potential causal link between over-tightening a spark plug and damaging the cylinder head. In other words, the effect does not always occur, it is only likely to occur. Yet, in those cases where the effect β holds, the cause α is sufficient to trigger β . [Martin 1992] describes this as modalization: An unrealized effect is subject to “probability”.

Concession. Concessions can be traced back to causal relations: They state that a causal relationship, which is expected to hold, does not hold in a given context (violated expectation). In other words, on the one hand α holds, implying the expectation of β . On the other hand, γ holds, which implies $\neg\beta$, contrary to the expectation induced by α (cf. [Grote *et al.* 1997]). Examples from the technical corpus are:

(8.10)

- a. *Fernsehgeräte mit kleinem Bildschirm besitzen eine*
 TV sets with small screen have a
Hochleistungszimmerantenne; trotzdem kann der Empfang [...] nicht ideal
 high performance indoor aerial; still can the reception [...] not ideal
sein. (TC.6)
 be.
- ‘TV sets with small screen possess a high performance indoor aerial; still the reception might not be ideal’
- b. *Wenn Sie nicht möchten, daß Ihr Gesprächspartner Sie hören kann [...],*
 If you not want that your dialogue partner you can hear [...]
drücken Sie die Stummtaste. Gleichzeitig hören Sie Ihren
 press you the silence button. At the same time hear you your
Gesprächspartner auch nicht mehr. Die Verbindung bleibt jedoch bestehen.
 dialogue partner also not more. The connection remains however
(TC.4)

‘If you do not want your dialogue partner to hear you, press the silence button. At the same time, you cannot hear you dialogue partner anymore. The connections holds, however.’

In example (8.10a) the expected causal relationship is that the reception is very good given a high-performance aerial ($\alpha \rightarrow \beta$). Against expectation, the producer concedes that the reception still might not be ideal ($\neg\beta$), without giving the reason (γ) for this fact. Likewise, an expected effect of an action α (β = the connection is cut) is negated in example (8.10b).

In this interpretation, concessive relations are conceived as negated causal relationships (see also [Martin 1992, 199]). The negation can apply to all types of causal relations introduced so far. In contrast to Prevention, which states that α prevents β from existing (i.e. assumes a rule $\alpha \rightarrow \neg\beta$), a Concession relation does not introduce such a rule but states that an existing causal relationship ($\alpha \rightarrow \beta$) is overruled in a particular context by a second causal rule ($\gamma \rightarrow \neg\beta$).⁵

Plan-Step. Often, several actions are required to achieve a particular effect β . Each of these actions is in a Plan-Step relation with the effect (or goal), but none of the actions is by itself sufficient to bring about the intended action. In other words, $\text{Plan-Step}(\alpha, \beta)$ holds if α is an element of the set of actions that causes the goal β : $\alpha \wedge \gamma \wedge \delta \wedge \dots$ cause β . Here, the goal β does not automatically occur given α . For example, there is more to removing the cables than pressing the notch (8.12a), and pressing the function button is only one step in a larger plan to record from the radio (8.12b):

(8.12)

- a. *Zum Lösen der Schnüre drücken Sie den Rasthaken in Richtung
To remove the cables press you the notch in direction
Steckerkörper.
of the plug.
'In order to remove the cables press the notch in direction of the plug.'*
- b. *Um von Radio aufzunehmen, den FUNCTION-Schalter auf "ON/RADIO"
To from radio record, the FUNCTION-button to "ON/RADIO"
stellen. (TC.18)
set.
'In order to record from the radio, set the FUNCTION-button to "ON/RADIO".'*

[DiEugenio 1993, p72] introduced a similar relation: *indirect-generation*.

Preparatory-Action. In contrast to the Plan-Step relation, which captures the relation between one of the actions required to achieve a goal and the goal itself, Preparatory-Action describes the relation between two actions that are both steps towards such a goal. In particular, one of the actions (action α) provides the precondition for the other action β to take place, i.e. it ensures that the conditions required for carrying out that action hold.

(8.13)

⁵Compare the following examples from [Barker 1994], which exemplify a Prevention (8.11a) and a Concession (8.11b):

(8.11)

- a. *Since the hard disk crashed, the files were not copied.*
- b. *Although the hard disk crashed, the file were copied.*

- a. *Zuleitung in benötigter Länge abwickeln und einklemmen. (TC.10)*
 Cable in required length pull out and secure.
 ‘Pull out the cable in the required length and secure it.’
- b. *Nach Abnahme des Bohrfutters kann der Bit direkt in der Bohrspindel aufgenommen werden.*
 After removing the jig can the bit directly into the drilling spindle inserted be.
 ‘After removing the jig, the bit can be directly inserted into the drilling spindle.’

In example (8.13a), pulling out the cable and securing it are both steps towards plugging in the toaster; the first action has an effect which is the precondition for the second action to be executable. The enabling action thus establishes the conditions that are needed for carrying out the enabled part of the relation, but the agent needs to do something more than the enabling action to guarantee that the enabled action will be carried out. This definition is similar to the *Preparation:Act* relation in [Moser *et al.* 1996], and the *gen-enable* relation proposed by [Balkanski 1992] and discussed in [DiEugenio 1993, p73].

Precondition. In contrast to Plan-Step, a Precondition is not a step in a procedure (here, the procedure “Checking engine oil”), and as opposed to Preparatory-Action it is not required for the execution of another action. Instead, Preconditions specify conditions that have to be met in order to guarantee the *successful* execution of an action β :

(8.14) *Check the engine oil with the ignition key off and the car parked on level ground. (TC.24)*

Checking the engine oil can be performed regardless of whether the car is parked on level ground; however, the intended result can only be achieved if the preconditions are met. [Balkanski 1992] and [DiEugenio 1993] make a similar distinction: They differentiate between conditions that are required for the occurrence of another action (*generation-enabling conditions* which apply to the *gen-enable* relation), and conditions, that are required for the successful execution of an action (*necessary-executable conditions*, [DiEugenio 1993, p83]). In the latter case, the *exec-enable* relation holds, which corresponds to my Precondition. Preconditions differ from Constraints (see below) in that they can be planned for.

Constraint. Constraint names a condition α on the execution of an action β that cannot be planned for, it can only be verified before executing an action (in contrast to Preconditions). Relieving the pressure in the example below cannot be influenced by the reader; she simply has to wait until the pressure has been relieved:

(8.15) *Nachdem der Druck abgelassen ist, den Deckel abnehmen. (TC.24)*
 After the pressure released is, the cap remove.
 ‘After the pressure has been released, remove the cap.’

Constraints are states that must hold before an action can be executed successfully; [Delin *et al.* 1994] describe a *constraint* relation, too, [Moser *et al.* 1996] name this relation *Constraint:Act*.

8.2.2.2 Temporal relations

Temporal relations are of two kinds. Either two actions or states are in a temporal sequence, or their occurrence somewhat overlaps:

- **Temporal sequence.** Two actions α and β are in a sequence relation if α occurs prior to β . The two actions simply follow each other on a temporal axis, and a causal relation is not required. Thus, in contrast to Enablement, the successful execution of the first action is not a prerequisite for the execution of the second action. Following [Allen 1984] I distinguish the subtypes *Before* and *Meets*.⁶
- **Temporal co-occurrence.** Two actions occur or two states exist at the same time. There can be a partial or total overlap, but there must be some co-extension. Subtypes according to [Allen 1984] are: *Overlaps*, *During*, *Finishes*, *Starts* and *Equals*.

[Allen 1984] gives another six relations, which are the inverses of the ones listed above. However, these do not describe a different informational relation between two situations, but only differ regarding the situation that serves as temporal anchor. For instance, *Before* (*A before B*) and *After* (*B after A*) both describe the temporal relation of α (denoted by A) preceding β (denoted by B).

Before. One action α ends before the second action β begins. The execution of α is no prerequisite of β , as in example (8.16a), where the water tank can be filled regardless of whether the device is unplugged or not. Likewise, there is no causal link between ending the work and switching off the mixer in example (8.16b):

(8.16)

- a. *Bevor Sie den Wassertank füllen, ziehen Sie bitte immer den Stecker aus*
 Before you the water tank fill, pull you please always the plug from
der Steckdose.
 the socket.
 ‘Before you fill the tank, please always unplug the device.’

⁶In Allen’s definitions of temporal interval relations, the relations hold between time intervals. For instance, *Before*(t_1, t_2) says that the time interval t_1 is temporally located before the time interval t_2 , and they do neither overlap nor meet at some point in time. In analogy to causal relations, I will use the notation *Before*(α, β), assuming that the two situations/actions are coerced to their corresponding time intervals.

- b. *Nach der Arbeit das Gerät ausschalten. (TC.15)*
 After the work the device switch off.
 ‘Switch off the device after work’

This relation matches the *sequence* relation by [Kosseim and Lapalme 1994], *Before:After* by [Moser *et al.* 1996], and the *narration* relation by [Lascarides and Asher 1991]. The latter argue that in *Max stood up. John greeted*, the first event might be a consequence of the second (but not necessarily), but most importantly, they are in a temporal sequence.

Meets. This relation holds if one action α precedes another action β , and if they additionally meet at some point in time, i.e. the end point of α and the begin point of β are identical:

- (8.17) *Sobald das Wasser einläuft, die Waschmittelschublade zu 3/4 herausziehen. (TC.7)*
 As soon as the water runs in, the washing powder tray three-quarters pull out.
 ‘As soon as the water runs in, pull the washing powder tray three-quarters out.’

Overlaps. Two actions α and β are in a partial overlap, and none of the actions starts or ends at the same time as the other:

- (8.18) *Sie geben die Töne ein, während die Ansage [...] wiedergegeben wird. (TC.4)*
 You enter the sounds in, while the recording [...] reproduced is.

‘You enter the sounds while the recording is reproduced.’

During. An action α happens during the occurrence of another action β , i.e. it starts after and ends before the second action, as in:

(8.19)

- a. *Während des schnellen Rücklaufs die Taste 3 drücken. (TC.18)*
 During the fast rewind the button 3 press.
 ‘Press button 3 during fast rewind.’
- b. *Die Taste 3 drücken und währenddessen den Netzstecker erneut einstecken. (TC.5)*
 The button 3 press and meanwhile the plug again insert.

‘Press button 3. Meanwhile, plug in again.’

Finishes. Two actions α and β are in a partial overlap, and they end at the same time:

(8.20)

- a. *Das Fernsehgerät sucht automatisch solange, bis ein Fernsehsender gefunden worden ist. (TC.6)*
 The television searches automatically as long, until a channel found been has.
 ‘The TV searches automatically until a channel has been found.’
- b. *Den Schieber mit leichtem Druck auf der Hobelplatte hin und her schieben, bis der Teig durchpassiert ist. (TC.13)*
 The dough pan with gentle pressure on the grater plate backward and forward push, until the dough passed through is.
 ‘Applying gentle pressure, push the dough pan backward and forward across the grater plate until all the dough has passed through the grater.’

Starts. Two actions α and β are in a partial overlap, and they begin at the same time:

- (8.21) *[...] und dann die BIS-Taste betätigen, sobald der zweite Wählton zu hören ist. (TC.4)*
 [...] and then the BIS-button operate, as soon as the second dial tone to hear is.
 ‘[...] and then operate the BIS-button as soon as you can hear the second dial tone.’

Equals. Two actions begin and end at the same time. In example (8.22a), pressing down the button and turning the knob have to be carried out simultaneously to enable the preset-action, i.e. total overlap is required:

(8.22)

- a. *Voreingestellt werden die verschiedenen Sender—bei gedrückter Taste—durch Drehen des jeweiligen Rändelkopfes. (TC.6)*
 Preset are the different channels—with pressed button—by turning the respective knob.
 ‘The different channels can be preset by turning the respective knob with the button pressed down.’
- b. *Während des automatischen Abtauvorgangs hört man eventuell das Tropfen von Wasser. (TC.16)*
 During the automatic defrosting hears one possibly the dripping of water.
 ‘During automatic defrosting one might hear the dripping of water.’
- c. *Den Deckel beim Drehen nicht niederdrücken. (TC.25)*
 The cap while turning not press down.
 ‘Do not press down the cap while turning.’

In all examples, α and β co-occur, but in (8.22a) the co-occurrence is obligatory, while in (8.22b), β might occur at the same time as α . This relates nicely to the Eventuality relation introduced above: Temporal relations may also be described as always holding (being certain) or potentially holding (being likely). Further, in example (8.22c) we find a temporal relation between the occurrence of α and the non-occurrence of β , hence the relation is similar to Prevention: α co-occurs with *NOT* β .

Again, [Kosseim and Lapalme 1994] and [Moser *et al.* 1996] discuss relations similar to co-occurrence: *concurrent* and *Co-Temp1:Co-Temp2*. Yet, they do not differentiate between different types of co-occurrence. [Lascarides and Asher 1991] define the *Background* relation, which involves temporal overlap of two events but no cause, as in *Max opened the door. The room was pitch dark.*

8.2.2.3 Additive relations

I encountered three types of additive relations in my corpus: *Conjunction*, *Disjunction* and *Contrast*.

Conjunction. This is the ‘minimal’ relation: No more can be said about two actions or states than that they both occur or exist; no causal or temporal relationship holds between the two relata:

- (8.23) *Gewünschte Bräunung mit dem Röstgradwähler einstellen. Brot
Desired roasting with the roast intensity selector set. Bread
einlegen. (TC.21)
insert.
‘Set the desired toasting level with the roast intensity selector. Insert the bread.’*

The order in which the actions are executed is, in contrast to the enabling or temporal relations, of no importance. Similar relations are *list* by [Sanders *et al.* 1992] (which is an additive with a positive polarity), and *Step1:Step2* by [Moser *et al.* 1996].

Disjunction. The exclusive counterpart is disjunction: One of the actions or states which are in a disjunction relation occurs or exists (see also [Barker 1994]): *The program may terminate OR it may hang indefinitely*. In other words, the actions or states exclude each other, as in:

- (8.24)
- a. *Das Gerät ist entweder mit anderen Funktionen beschäftigt oder erwartet
The device is either with other functions busy or awaits
andere Aufgaben. (TC.5)
other tasks.
‘The device is either busy with other functions or awaits other tasks.’*

- b. *Die Antenne drehen oder den Winkel verändern. (TC.6)*
 The aerial turn or the angle change.
 ‘Turn the aerial or change the angle.’

Contrast. A Contrast relation holds between two situations α and β when one can induce $NOT\alpha$ from β , and when α and β are similar in that they belong to a set of alternatives (see also [Hobbs 1990, Umbach and Stede 1999]). In other words, contradictory predications are made about similar entities [Hobbs 1990]. Similarity between two propositions can be of different kinds, as the following examples illustrate:

(8.25)

- a. *...dessen Zustimmung bei manchen Gesetzen erforderlich ist, während bei ...whose approval with some laws required it, while with anderen Gesetzen vom Bundesrat nur Einspruch eingelegt werden kann, ... other laws the Bundesrat merely objection raised be can, ...*
 ‘... whose approval is required for some laws, while for other laws the Bundestag can merely raise objection ...’
- b. *Metallband-Cassetten können wiedergegeben, aber nicht wieder aufgenommen werden. (TC.18)*
 Metal tapes can reproduced, but not again recorded
 be.
 ‘Metal tapes can be used for reproduction, but not for new recording.’

In example (8.25a) the Bundestag’s consent is required for some bills (α), but for others the Bundestag can only object to the bills (β). Both situations are about similar entities (types of bills), but involve actions that belong to a set of alternatives that exclude each other: Either a bill can be approved of, or objection can be raised. Thus, given a bill that can only be objected to (β), one can induce that no approval is required ($NOT\alpha$), which is in contrast to the proposition α . Example (8.25b) works slightly different: Both situations are about the same entity (metal tape), and similar predications are made about them (reproducing, recording). Here, the contrasting proposition $NOT\beta$ is explicitly stated in the text. Again, a Contrast relation can only be inferred because the reproducing and recording actions are similar in that they belong to a set of alternatives.

This definition of Contrast differs from, for instance, [Sanders *et al.* 1992] who define Contrast as ‘additive negative’ (compare their *Opposition* relation), whereas I, following [Umbach and Stede 1999], regard the notion of similarity as central to the definition of Contrast.

8.2.2.4 Expansion

For the present text type, I identified a number of discourse segments that are not required for carrying out a task, but provide extra information for specific actions (sometimes

referred to as *instruction-information*). These discourse segments do not “move discourse forward” [Hobbs 1990, p90], but rather expand it in place, elaborate on a subject matter or add circumstantial information. [Sanders *et al.* 1992, p26] refer to these relations as *linkage relations*. In the present domain, expanding discourse segments are not part of the procedure described in the text itself, but provide additional information on some action, and are related to these actions by means of an Elaboration or Circumstance relation.

Elaboration. Following [Mann and Thompson 1988] I distinguish several types of elaborating relationships: Example (8.26a) illustrates the object-attribute relation, (8.26b) the general-specific relation (the changing action is further specified):

(8.26)

- a. ... *den Ölstand ablesen. Der Ölstand sollte sich zwischen der oberen und*
 ... the oil level read. The oil level should itself between the upper and
unteren Pegelmarke befinden. (TC.24)
 lower mark be.
 ‘... and read the level. The level should be between the upper and lower marks.’
- b. *Zündkerzen wechseln. [...] Die Zündkerzen eine nach der anderen auswechseln,*
 Spark plugs change. [...] The spark plugs one after the other change,
damit die Zündkabel nicht durcheinander gebracht werden. (TC.22)
 so that the spark plug wires not mixed up are.
 ‘Changing the spark plugs. [...] Change the spark plugs one at a time so that you do not mix up the wires.’

Circumstance. A Circumstance provides additional information about a situation; in the following example, the circumstance of controlling the operating temperature is described in the prepositional phrase:

- (8.27) *Den Kühlmittelstand im Reservetank bei normaler Betriebstemperatur*
 The coolant level in the reserve tank at normal operating temperature
des Motors kontrollieren. (TC.25)
 of the engine control.
 ‘Check the coolant level in the reserve tank when the engine is at normal operating temperature.’

These relations are very similar to the ideational contributions of RST’s ELABORATION and CIRCUMSTANCE relations (see [Mann and Thompson 1988]. Likewise, [Moser *et al.* 1996] discuss a set of elaborating relations, among them *Generic:Specific* and *Circumstance:Situation*.

To sum up the discussion of ideational relations, Table 8.1 lists the ideational relations that may hold between discourse segments in technical instructional texts.

Causal	Generation(S_0, S_1)	Plan-Step(S_0, S_1)
	Cause-Effect(S_0, S_1)	Preparatory-Act(S_0, S_1)
	Side-Effect(S_0, S_1)	Precondition(S_0, S_1)
	Prevention(S_0, S_1)	Constraint(S_0, S_1)
	Occurrence(S_0, S_1)	Concession(S_0, S_1)
	Eventuality(S_0, S_1)	
Temporal	Before(S_0, S_1)	Starts(S_0, S_1)
	Meets(S_0, S_1)	Finishes(S_0, S_1)
	Overlaps(S_0, S_1)	Equals(S_0, S_1)
	During(S_0, S_1)	
Additive	Conjunction(S_0, S_1)	Contrast(S_0, S_1)
	Disjunction(S_0, S_1)	
Expansion	Elaboration(S_0, S_1)	Circumstance (S_0, S_1)

Table 8.1: Set of ideational relations holding in technical instructional texts

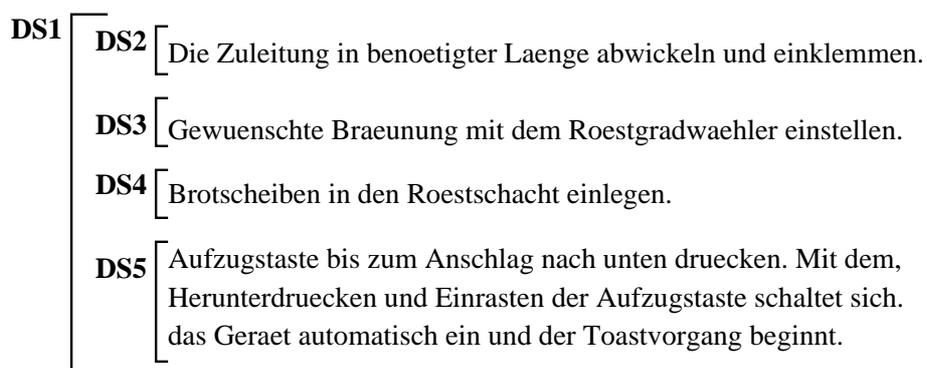
8.2.3 Intentions or interpersonal relations

Interpersonal aspects of discourse concern the speaker's intention, i.e. what she wants to do to the goals or opinions of the hearer, and the speaker's attitude towards the utterance. In my text type, one discourse segment (S_0) expresses an action that the speaker intends the hearer to adopt, or an understanding that she wants the hearer to achieve (see also [Moser *et al.* 1996]), for instance, to make the hearer perform an action, or to increase the hearer's understanding of a situation. The action denoted by the discourse segment S_1 then helps to achieve the speaker's goal.

In the present domain, technical task-related discourse, one can observe long stretches of text without any change in communicative goals. In other words, intentions stay constant over long parts of texts, as Figure 8.1 illustrates: I applied Grosz and Sidner's intentional relations [Grosz and Sidner 1986] to the toaster text (TC.21). The resulting structure of discourse purposes and primary intentions underlines the claim that texts in the present domain only have a simple intentional structure: For the discourse segments I2, I3 and I4, there is no change in communicative goals. Nonetheless, I need to represent the intentions in order to be able to provide a complete picture of discourse functions, and consequently of coherence relations.

I distinguish three types of speaker goals in my domain, drawing on Hovy [Hovy 1988] (definitions are reproduced from [Hovy 1988, p23]):

- **Affect the hearer's knowledge**, with the subtypes *increase understanding* and *increase ability*
- **Affect the hearer's goals**, with the subtypes *increase willingness* and *decrease willingness*



Primary intentions

- I1** (Intend W (Do R (Toast R Bread)))
- I2** (Intend W (Do R (Fix R Cord)))
- I3** (Intend W (Do R (Set R Roast-level)))
- I4** (Intend W (Do R (Insert R Bread)))
- I5** (Intend W (Know-How-To R (Switch-on R Toaster)))

Dominance Relations

- I1 DOM I2
- I1 DOM I3
- I1 DOM I4
- I1 DOM I5

Satisfaction-Precedence Relationship

- I2 SP I5
- I3 SP I5
- I4 SP I5

Figure 8.1: Grosz and Sidner [Grosz and Sidner 1986] style analysis of the intentional structure of part of the toaster text

- **Affect the hearer's opinion of a topic** (*increase regard*)

These interpersonal links are defined as follows:

Increase understanding. This relation holds if one discourse segments provides information intended to increase the hearer's understanding of the subject-matter by, for instance, describing the consequences of an action:

- (8.28) *Nach Unterbrechen von Netz- und Batteriespannung sind alle eingegebenen Zeiteinstellungen gelöscht.*
 After interrupting the mains and battery voltage are all programmed time setting deleted.
 'After interrupting the mains and battery voltage all programmed time settings are deleted.'

Increase ability. This relation holds if one discourse segments specifies the way to perform an action, but does not activate the reader to immediately carry out the action, as is the case for the increase-willingness goal below. This intention corresponds to Grosz and Sidner's *Know-How-To* discourse purpose.

- (8.29) *Durch Betätigen der Signaltaste können Sie in den IWV-Wahlmodus zurückschalten. (TC.4)*
 By operation of the signal button can you in the IWV mode switch back.
 'By operating the signal button you can switch back into the IWV mode.'

Increase willingness. This relation holds if the speaker intends to influence the hearer's future actions, and tries to activate some goal in the hearer. For instance, in example (8.30) the relation linking the two discourse segments is that of activating the reader to execute the 'press' action by mentioning the 'remove' action:

- (8.30) *Zum Lösen der Schnüre drücken Sie den Rasthaken in Richtung Steckerkörper. (TC.13)*
 To remove the cables press you the notch in direction plug.
 'In order to remove the cables press the notch in the direction of the plug.'

Again, [Grosz and Sidner 1986] give a corresponding intention: *Do*, and [Hovy 1988] proposes the intention *activate a specific goal in hearer*, taken from the group 'action'.

Hearer knowledge	increase-understanding(S_0, S_1) increase-ability(S_0, S_1)
Hearer goals	increase-willingness(S_0, S_1) decrease-willingness(S_0, S_1)
Hearer opinion	increase-regard(S_0, S_1)

Table 8.2: Set of interpersonal relations observed in technical instructional texts

Decrease willingness. The speaker tries to prevent the reader from performing some kind of action, i.e. to de-activate some goal of the hearer, as in (8.31), where the speaker's goal is to prevent the hearer from performing the action described in the main clause:

- (8.31) *Den Kühlerdeckel nicht bei heißem Motor entfernen; das Kühlmittel steht unter Druck und könnte Sie ernsthaft verbrennen. (TC.25)*
 The radiator cap not with hot engine remove; the coolant is under pressure and could you severely scald.

'Do not remove the radiator cap when the engine is hot; the coolant is under pressure and could severely scald you.'

[Hovy 1988] proposes a similar intention: *de-activate a specific goal in hearer*, also taken from the group 'action'.

Increase regard. Finally, a speaker can try to increase the positive regard for either an action (by providing information that increases the hearer's desire to perform this action), or a fact (by providing information that increases the hearer's positive regard for that fact). In example (8.32), the specific way of performing the 'changing spark plugs'-action is motivated, thereby increasing the reader's positive regard for the propagated way:

- (8.32) *Die Zündkerzen eine nach der anderen auswechseln, damit die Zündkabel nicht durcheinandergebracht werden. (TC.22)*
 The spark plugs one after the other change, so that the spark plugs wires not mixed up are.

'Change the spark plugs one at a time so that you do not mix up the wires.'

Speaker's goals are usually discussed in combination with the hearer's beliefs. However, I do not consider beliefs as discourse functions, since they are factors guiding the choice of a particular relation, but are not themselves relations. Discourse can be realized without taking the hearer's beliefs into account—only that it might turn out to be not mutually coherent discourse and hence not communicatively successful. Table 8.2 summarizes the interpersonal relations.

8.2.4 Textual relations

Textual relations relate to how information is presented in the text. They are defined with respect to the role the elements play in the construction of the text. These involve nuclearity and what [Bateman and Rondhuis 1997, p35] term *textual predicates*.

8.2.4.1 Nuclearity

The notion of nuclearity was introduced in [Mann and Thompson 1987]; they describe the nucleus as the segment that is more essential to the speaker's purposes, that is comprehensible without the other segment, and that cannot be omitted. Nuclearity is a textual means to relate discontinuous elements in a text, and to direct the hearer "to respond to the text in a particular and locally structured way" [Mann and Thompson 1987, p38]. Consider the following example of a Cause-Effect relation. In (8.33a) the causing action is presented as the most important action, in (8.33b) the effect is in the center of attention:

(8.33)

- a. *Zum Einschalten des Toasters die Aufzugstaste bis zum Anschlag nach unten drücken.*
 To switch on the toaster the lever until to the rest position to down press.
 'In order to switch on the toaster, press down the lever to its rest position.'
- b. *Den Toaster einschalten. Dazu die Aufzugstaste bis zum Anschlag nach unten drücken.*
 The toaster switch on. Thereto the lever until to the rest position to down press.
 'Switch on the toaster. To achieve this, press down the lever to its rest position.'

Nuclearity assignment can be of three kinds: the first discourse segment (S_0) is the nucleus, i.e. the causing action in a causal link, the preceding action in a preceding link, etc. (S_0 -nuclear), the second segment (S_1) is the nucleus (S_1 -nuclear), several nuclei exist (*multinuclear*) (cf. [Bateman and Rondhuis 1997]). This is reflected in the CAUSE vs. RESULT opposition in RST, where both express a causal relationship, but differ with respect to the nucleus assignment: in case of the CAUSE relation, the effect is the nucleus (S_1), in case of RESULT the cause (S_0). Likewise, [Lascarides and Asher 1991] distinguish two types of causal relations, which are complementary, and differ regarding what they term 'main eventuality': Result(α, β) and Explanation(β, α).

8.2.4.2 Textual predicates

In the technical domain, one encounters two types of restating content: by rephrasing and by summarising the content.

Nuclearity	S_0 -nuclear(S_0, S_1) S_1 -nuclear(S_0, S_1) multinuclear(S_0, \dots, S_n)
Textual predicates	rephrasing(S_0, S_1) summary(S_0, S_1)

Table 8.3: Set of textual relations observed in technical instructional texts

Rephrasing. A discourse segment S_0 is re-expressed in similar words by S_1 , i.e. is paraphrased. In example (8.34), two discourse segments relate to the same action:

- (8.34) *Aufzugstaste bis zum Anschlag nach unten drücken. Mit dem*
Lever until the rest position to down press. With the
Herunterdrücken und Einrasten der Aufzugstaste schaltet sich das
pressing down and clicking into place of the lever switches itself the
Gerät ein. (TC.21)
device on.

‘Press down the lever to its rest position. By pressing down the lever and clicking into place the device is switched on.’

Summary. More complex task descriptions are sometimes summarized as in the following example. Here, the final sentence is in a Summary relationship with the remainder of the text:

- (8.35) *Um Leerstellen zu erzeugen, den folgenden Schritte folgen: 1. Am Ende*
To gaps to create, the following steps follow: 1. At the end
jeder Aufnahme eines Titels die PAUSE-Taste drücken. 2. ... Die Schritte
of each recording of a title the PAUSE-button press. 2. ... The steps
1-8 durchführen, um zwischen den einzelnen Stücken Leerstellen zu erzeugen.
1-8 perform, to between the individual pieces gaps to create.
(TC.18)

‘In order to create gaps, follow the following steps: 1. Press the PAUSE-button at the end of each recording. 2. ... Perform the steps 1-8 to create gaps between individual pieces.’

Table 8.3 summarizes the results of the discussion.

8.3 The system network: Classifying relations

The previous section gives an initial set of hypotheses about relevant distinctions at the different dimensions of discourse representation, which form the starting point for the

discourse representation I aim at. As argued above, I follow [Bateman and Rondhuis 1997] and model coherence relations as feature bundles resulting from choices in system networks at the discourse level. Hence, the task is now—given the set of ‘pure’ relations—to arrive at an inventory of features that describe the rhetorical relations in instructional text, and to develop a classification of features that captures commonalities and makes generalizations across categories wherever possible. They will be captured in a system network of rhetorical relations.

In SFL, network features are defined so as to group together sets of utterances with similar lower-level linguistic features, and to distinguish between groups of utterances that differ. To detect features and oppositions to be included in my system network, I analyse utterances from the text corpus with respect to the relations (as identified in the preceding section) they signal, and then compare these sets of relations (one or more from each meta-function) with the set of relations indicated by paraphrases of the utterances. Note that the restrictions inherent to the typological perspective imposed by system networks, which have been addressed in Chapter 7, also apply to the classification of coherence relations.

8.3.1 Motivating the inventory of features

8.3.1.1 Causal relations

Let us start with an instance of the Generation relation occurring in the corpus of technical texts. I argued that this is a purely ideational link; so the question is what are the intentional and textual features of an abridged version of example (8.34):

- (8.36) **Mit** *dem Herunterdrücken der Aufzugstaste* *schaltet sich das Gerät ein.*
 With the pressing down of the lever switches itself the device on.
 ‘By pressing down the lever the device is switched on.’

This text fragment tells the reader *how* to perform the ‘switching on’ action (interpersonal: increase ability), with the second discourse segment being the nucleus (textual: S_1 -nucleus). Now, consider alternative verbalizations of this Generation relation:⁷

- (8.37)
- a. **Durch** *das Herunterdrücken der Aufzugstaste* *schaltet sich das Gerät ein.* (by means of)
 - b. **Indem** *die Aufzugstaste heruntergedrückt wird,* *schaltet sich das Gerät ein.* (by means of)
 - c. **Beim** *Herunterdrücken der Aufzugstaste* *schaltet sich das Gerät ein.* (with)
 - d. **Zum** *Einschalten des Geräts* *die Aufzugstaste herunterdrücken.* (to)
 - e. **Um** *das Gerät einzuschalten,* *die Aufzugstaste herunterdrücken.* (in order to)

⁷I do not give glosses and translations for the paraphrases, as the important variation concerns the discourse marker only. Therefore, only the English translations of the discourse markers are provided.

f. *Die Taste herunterdrücken. Das Gerät schaltet sich ein.* (no marker)

What makes the difference? Examples (8.37a) and (8.37b) realize the same purposes as (8.36) (interpersonal: increase ability, textual: S_1 -nuclear), merely the surface forms differ. In contrast, (8.37c) and (8.37d) illustrate variation regarding the interpersonal dimension: While (8.37c) simply informs the reader about the relation holding between the actions (interpersonal: increase understanding), (8.37d) and (8.37e) clearly attempt to increase the reader's willingness to perform the 'pressing' action by presenting the 'switching' on action as the goal (interpersonal: increase willingness). Examples (8.37d) and (8.37e) also differ from their predecessors with respect to nucleus assignment: They realize an S_0 -nucleus, whereas examples (8.37a) to (8.37c) express an S_1 -nucleus. Finally, (8.37f) is an example of multi-nuclearity.

The variations observed in these instances of Generation motivate a set of oppositions that are candidates for choices in the network of coherence relations: increase-understanding vs. increase-willingness vs. increase-ability for the interpersonal dimension, and S_0 -nuclear vs. S_1 -nuclear vs. multinuclear in the textual realm; these conform to the features predicted by analysing the context (Section 8.2).

In Section 8.2 I proposed two additional cause relations, which are closely related to Generation: Cause-Effect and Side-Effect. While the opposition in nuclearity applies to both relations, too,⁸ differences in verbalization indicate different semantic relations, thus motivating their introduction into the network. Instances of Cause-Effect, such as given in Section 8.2, example (8.4), can undergo the same variation as the Generation relation. Additionally, paraphrases containing the discourse markers *nach* (after) and *und* (and) can also be used to indicate this relation; they are misleading when used to signal a Generation relation. Consider example (8.36) from above, and a paraphrase with *nach*:

(8.38) **Nach** *Herunterdrücken der Aufzugstaste schaltet sich das Gerät ein.* (after)

This suggests a temporal sequence of the events, which contradicts the definition of Generation. Side-Effects, on the other hand, cannot be expressed using linguistic surface forms that indicate a goal or a purpose such as *um...zu* (in order to) or *zu* (to), or an ability using *mit*, *indem*, *durch* (with, by means of, by means of), as side-effects are by nature unintended. To illustrate this, here is an abridged version of example (8.5) and some paraphrases:

(8.39)

- a. *Drücken Sie die START/STOP-Taste.[...] sämtliche Zahlensegmente und Funktionssymbole [leuchten] kurz auf.*
- b. *?Zum kurzen Aufleuchten sämtlicher Zahlensegmente und Funktionssymbole drücken Sie die START/STOP-Taste.* (In order to ...)

⁸Examples can easily be constructed from the examples given in Section 8.2; spelling out all paraphrases is beyond the scope of this chapter.

- c. ?**Durch** *Drücken der START/STOP-Taste leuchten sämtliche Zahlensegmente und Funktionssymbole kurz auf.* (By means of ...)

Examples (8.39b) and (8.39c) are somewhat misleading; the ideational relation Side-Effect can apparently only combine with the interpersonal relation Increase-Understanding. Given these differences in the range of verbalizations and usage I assume three relations in opposition, all subtypes of Cause: Generation, Cause-Effect and Side-Effect.

In order to determine whether the oppositions observed in the context of Cause relations are productive across a broader range of ideational relations, I now examine relations from the Enablement group (cf. Section 8.2). Consider the following two instances of an Enablement relation encountered in instructional texts ((8.40a) and (8.41a)) and some paraphrases:

(8.40)

- a. *Zuleitung in benötigter Länge abwickeln und einklemmen.*
Cable in required length pull out and secure.
'Pull out the cable in the required length and secure it.'
- b. **Bevor** *die Zuleitung eingeklemmt wird, Zuleitung in benötigter Länge abwickeln.* (before)
- c. **Nachdem** *die Zuleitung in benötigter Länge abgewickelt wurde, die Zuleitung einklemmen.* (after)
- d. ?**Zum** *Einklemmen die Zuleitung in benötigter Länge abwickeln.* (to)

(8.41)

- a. **Zur** *Kontrolle heben Sie das Bügeleisen bitte an.*
For control lift you the iron please up.
'In order to check the iron, lift it.'
- b. **Durch** *Anheben können Sie das Bügeleisen kontrollieren.* (By means of ...)

Examples (8.40a) to (8.40c) illustrate the variation in nucleus assignment, with constant ideational relation and intention: multinuclear in (8.40a), S_0 -nuclear in (8.40b), and S_1 -nuclear in (8.40c). (8.41a) and (8.41b), on the other hand, deviate regarding the underlying intention: (8.41a) increases the willingness of the reader (interpersonal: increase willingness), (8.41b) increases the ability (interpersonal: increase ability). Note that in (8.40), as opposed to (8.41), the Enablement relation cannot be expressed using surface forms that indicate a goal (such as *zu* (to), *um ...zu* (in order to)). This difference in possible verbalizations leads me to assume two subtypes of Enablement, as proposed in Section 8.2: Preparatory-Actions, where one action provides the grounds for another to be performed (as in 8.40), and Plan-Step, where one action is one of the steps in achieving another action, the goal (as in 8.41).

The relations subsumed by Cause and Enablement are more fine-grained choices in the class of causal relations, which is in opposition to temporal and additive ones: Temporal

and additive markers can be used to express causal relations, as is the case in several of the examples given above, but not vice versa.

Next, consider another causal relation introduced in Section 8.2: Prevention has been defined as a Generation relation where the effect is prevented. Hence, this relation can be further decomposed into the ideational features Generation and negative. The positive/negative opposition as exemplified by Generation and Prevention cuts across several categories, for instance, the Enablement relations can be negated, too; hence, this opposition cross-classifies with choices in the causal network. Next, here is an instance of an Occurrence relation:

- (8.42) **Wenn** *die Aufzugstaste einrastet,* *schaltet sich das Gerät ein.*
 When the lever clicks into place, switches itself the device on.
 ‘When the lever clicks into place, the device switches on.’

The difference with respect to other causal relations is that this Generation relation is hypothetical. This observation gives rise to a realis/irrealis feature pair, which again cross-classifies with other choices for causal relations. For instance, a Preparatory-Action can also be unrealized, as the paraphrase of example (8.43) exemplifies:

- (8.43) **Wenn** *Sie die Zuleitung in benötigter Länge abwickeln,* *können Sie es*
 When you the cable in required length pull out, can you it
einklemmen.
 secure.
 ‘If you pull out the cable in the required length, you can secure it.’

The Eventuality relation, which has been defined as cause relation which does not necessarily hold, motivates another pair of features that again applies to all causal relations: the certain/possible opposition. The examples given in Section 8.2 can easily be transformed by introducing a modal verb into the clause denoting the caused action β .

The Concession relation holds if an expected causal relationship does not hold in a given context: The effect does not hold, for whatever reason. This can be true for all types of causal relationships, as the following conceded variants of example (8.4b), a Cause-Effect, and of example (8.13), a Preparatory-Action, illustrate:

- (8.44)
- a. **Obwohl** *der Toastvorgang beendet ist,* *schaltet sich der Toaster nicht*
 Although the toasting process completed is, switches itself the toaster not
ab.
 off.
 ‘Although the toasting process is completed, the toaster does not switch off.’
- b. *Die Zuleitung ist in benötigter Länge abgewickelt.* **Trotzdem** *läßt sie sich*
 The cable is in required length pulled out. Still, let it itself
nicht einklemmen.
 not secure.

‘The cable has been pulled out in the required length. Still, it cannot be secured.’

Hence, I assume the feature pair conceded/not-conceded that cuts across all causal relations.

Oppositions in the interpersonal and textual realm that have been observed for other causal relations also apply to Concessions. One encounters Concessions whose communicative intention is to simply inform, to convince or to activate the hearer. Examples (8.10) and (8.11) are both instances of ‘inform’. Likewise, choosing different connectors, nuclearity distribution differs. Using *obwohl* (although) as in example (8.44a) assigns nuclearity to the conceding clause, whereas using a conjunctive such as *trotzdem* (see example (8.45) below) assigns nuclearity to the conceded part.

- (8.45) *Der Toastvorgang ist beendet. Trotzdem schaltet der Toaster sich nicht ab.*
 The toasting process is completed. Still switches the toaster itself
 not off.

‘The toasting process is completed. Still, the toaster does not switch off.’

To sum up the discussion so far, here are the network features and oppositions that have been identified in the context of causal relations:

ideational causal	causal vs. temporal vs. additive cause vs. enablement positive vs. negative realis vs. irrealis certain vs. possible conceded vs. not-conceded
cause enablement	generation vs. cause-effect vs. side-effect preparatory-act vs. plan-step
interpersonal	increase understanding vs. increase ability vs. increase willingness
textual	S_0 -nuclear vs. S_1 -nuclear vs. multinuclear

8.3.1.2 Temporal relations

For the temporal relations, I apply the same strategy as in the context of causal relations: Examples from the corpus plus paraphrases help to identify minimal oppositions and thus the inventory of network features. Let us first consider an instance of a Precedence relation from the technical corpus:

- (8.46) *Kühlmittel nachfüllen, dann den Deckel wieder aufschrauben. (TC.25)*
 Coolant add, then the cap again install.

‘Add coolant, then re-install the cap.’

By means of this text fragment, the reader is instructed to perform the ‘filling’ and the ‘re-installing’ actions in temporal sequence (ideational: preceding; interpersonal: increase willingness) with both actions given equal importance (textual: multinuclear). Now, here are alternative realizations of the sequence relation (again, no glosses are given for the paraphrases; merely the discourse markers are translated):

(8.47)

- a. *Kühlmittel nachfüllen, und den Deckel wieder aufschrauben.* (and)
- b. **Bevor** *der Deckel aufgeschraubt wird, Kühlmittel nachfüllen.* (before)
- c. **Vor** *Aufschrauben des Deckels Kühlmittel nachfüllen.* (before (P))
- d. **Nachdem** *Kühlmittel nachgefüllt wurde, den Deckel wieder aufschrauben.* (after)
- e. **Sobald** *Kühlmittel nachgefüllt wurde, den Deckel wieder aufschrauben.* (as soon as)

All text fragments express the same ideational relation, that of temporal precedence, but differ concerning the nuclearity: While example (8.47a) also indicates a multinuclear relation, examples (8.47b) and (8.47c) realize a S_0 -nuclear relation, and examples (8.47d) and (8.47e) present S_1 as the nucleus (textual: S_1 -nuclear). Note that in contrast to causal relations, the interpersonal oppositions—that is the choice between increase understanding, increase ability and increase willingness—are not reflected in the use of specific temporal discourse markers, but are realized by other syntactic means such as mood and modality. For instance, simply informing the reader about a sequence of situations such as in

(8.48) **Nachdem** *Kühlmittel nachgefüllt wurde, wurde der Deckel wieder
After coolant added was, was the cap again
aufgeschraubt.
installed.*

‘After coolant has been added, the cap has been re-installed.’

does not affect the availability of the temporal marker. An exception is the discourse marker *kaum dass* (no sooner than). Take the following paraphrases of example (8.48):

(8.49)

- a. **Sobald** *Kühlmittel nachgefüllt wurde, wurde der Deckel wieder aufgeschraubt.* (as soon as)
- b. **Kaum dass** *Kühlmittel nachgefüllt wurde, wurde der Deckel wieder aufgeschraubt.* (no sooner than)

Again, the ideational link signaled in examples (8.48, 8.49a) and (8.49b) is that of a temporal sequence, where the ‘filling’ action precedes the ‘re-install’ action (ideational: precedence), with the second action on the time axis (re-install) being focussed on (textual: S_1 -nuclear). Yet, the intention expressed differs: While in the original text fragment (8.48)

and the first paraphrase (8.49a), the speaker merely informs the reader about a sequence of events (interpersonal: increase understanding), example (8.49b) carries additional meaning. Here, the attitude of the speaker towards the relation expressed comes into play; she tries to affect the hearer's opinion of the topic (interpersonal: increase-regard). Further, the succeeding action (the nucleus in this case) is presented as appearing too quickly, that is, it is given a negative flavour by the speaker. This is in opposition to all other examples discussed so far, where the speaker is neutral with respect to the propositions expressed, and motivates the interpersonal opposition of nuclear-neutral vs. nuclear-negative vs. nuclear-positive. Finally, the examples give rise to another distinction at the discourse level. Take examples (8.48) and (8.49a): Interpersonal and textual aspects are the same, yet, the temporal relation expressed in both examples somewhat differs. The use of *sobald* in example (8.49a) suggests that both situations follow each other immediately, while this cannot be read off example (8.48). The other examples given above support this claim. Consequently, I assume two subtypes of precedence, which correspond to the ideational relations hypothesized in Section 8.2: Before and Meets.

In short, the variations observed in these instances of temporal precedence suggest the following oppositions as candidates for choices in the coherence relation network: before vs. meets in the ideational region; increase-understanding/ability/willingness vs. increase-regard and nucleus-neutral vs. nucleus-negative in the interpersonal realm; and S_0 -nuclear vs. S_1 -nuclear vs. multinuclear in the textual region. These again conform to the features predicted from analysing the context (Section 8.2) and also to the inventory of features derived in the analysis of causal relations.

As pointed out in Section 8.2 the second broad class of temporal relations is that of Co-occurrence relations. They are signaled by a set of temporal discourse markers that is (in most cases) disjunct from the set of precedence markers (compare analysis of temporal markers in Chapter 6). Therefore, I take precedence vs. co-occurrence as the least delicate opposition in the temporal region. The textual distinctions introduced so far also hold in the context of co-occurring relations:

(8.50)

- a. **Während** der Wiedergabe der Ansage wird automatisch eine
During the reproduction of the recording is automatically a
Reservekopie der Ansage auf Band gespeichert. (TC.5)
reserve copy of the recording on tape saved.
'While reproducing the recording, a reserve copy is automatically saved on tape.'
- b. **Während** der automatischen Speicherung der Reservekopie der Ansage auf Band wird
die Ansage wiedergegeben.
- c. Die Ansage wird wiedergegeben **und** es wird automatisch eine Reservekopie der Ansage
auf Band gespeichert.

Sentence (8.50a) realizes an S_1 -nucleus, sentence (8.50b) presents S_0 as more important, and finally, example (8.50c) gives a multinuclear version of the temporal relation.

Instances of temporal simultaneity encountered in the corpus further motivate more fine-grained distinctions of co-occurring relations. Consider the following example from the corpus:

- (8.51) **Beim** *Drehen den Deckel nicht niederdrücken.* (TC.25)
 While turning the cap not press down.
 ‘Do not press down the cap while turning.’

Here, the two actions do not merely overlap, but have the same extension in time, that is, have the same beginning and end. Paraphrases that indicate the same intention and textual relations (interpersonal: increase-ability; textual: S_1 -nuclear), but signal a different type of co-occurrence relation can easily be constructed:

- (8.52)
- a. **Sobald** *Sie den Deckel drehen, den Deckel nicht niederdrücken.* (as soon as)
 - b. **Seitdem** *Sie den Deckel drehen, den Deckel nicht niederdrücken.* (since)
 - c. **Solange** *Sie den Deckel drehen, den Deckel nicht niederdrücken.* (as long as)
 - d. **Nachdem** *Sie den Deckel drehen, den Deckel nicht niederdrücken.* (as soon as)
 - e. **Während** *Sie den Deckel drehen, den Deckel nicht niederdrücken.* (while)

Examples (8.52a) to (8.52d) are specific to the type of simultaneity expressed: Examples (8.52a) and (8.52b) highlight the beginning of the shared time span, while example (8.52c) signals the common ending of both situations, and sentence (8.52d) expresses a partial overlap. In contrast, the use of *während* (while) in example (8.52e) does not allow for a more specific reading than co-occurrence. Possible network features resulting from these instances of temporal co-occurrence are Allen’s relations as proposed in Section 8.2: Equals, Starts, Finishes, During and Overlaps (see [Allen 1984]).

In Section 8.2 I observed that just like causal relations, temporal relations may also be described as always holding (being obligatory) or potentially holding (occurring potentially), compare example (8.22b) in Section 8.2. Hence, this opposition cross-classifies with temporal relations, too. Further, example (8.22c) (also Section 8.2) is an instance of a temporal relation between the occurrence of the situation denoted by S_0 and the non-occurrence of the one expressed by S_1 , which can be captured by the realis/irrealis opposition. Finally, the positive/negative pair also applies to temporal relations, as the following variation of example (8.51) above illustrates, where all aspects of the coherence relation except for the polarity of the nucleus stay the same:

- (8.53) **Beim** *Drehen den Deckel niederdrücken.*
 While turning the cap press down.
 ‘Press down the cap while turning.’

To conclude, variation in the verbalization of temporal relations suggests the following inventory of features and minimal pairs:

ideational temporal	causal vs. temporal vs. additive preceding vs. co-occurring positive vs. negative realis vs. irrealis certain vs. possible
preceding co-occurring	before vs. meets during vs. overlaps vs. finishes vs. starts vs. equals
interpersonal	increase understanding/ability/willingness vs. increase regard nuclear-neutral vs. nuclear-negative
textual	S_0 -nuclear vs. S_1 -nuclear vs. multinuclear

8.3.1.3 Other relations

For completeness, I very briefly examine the remaining ideational relations. In Section 8.2 I proposed a third group of ideational relations, additive links. Three types of additive relations have been encountered in the corpus: Conjunction, Disjunction and Contrast. The positive/negative opposition also applies to additive relations: Disjunctions can be described as negative conjunction, and Contrast as a Similarity relation with a negative polarity. This manifests itself in the surface forms *und*, *oder* (and, or) and *wie*, *aber* (as, but). Further, examples (8.23) to (8.25) can easily be re-expressed as to signal the realized/unrealized and certain/possible oppositions. This is left to the reader. Variation regarding the interpersonal purposes is also possible, as examples (8.23) and (8.24b) and paraphrases reveal:

(8.54)

- a. *Sie stellte den gewünschten Röstgrad mit dem Röstgradwähler ein. Sie legte das Brot ein.*
(no marker)
- b. *Die Antenne kann gedreht **oder** es kann der Winkel verändert werden.* (or)

Hence, the interpersonal variation also cuts across additive relations. Matters are different with respect to textual purposes: Additive relations are per definition multinuclear; realizations expressing a nucleus-satellite distribution cannot be observed. Here are the oppositions that I assume for additive purposes:

ideational additive	causal vs. temporal vs. additive conjunction vs. similarity positive vs. negative realis vs. irrealis certain vs. possible
interpersonal	increase understanding/ability/willingness vs. increase regard nuclear-neutral vs. nuclear-negative

Finally, there are expansion relations, which, according to [Hobbs 1990], do not move discourse forward by linking in new information, but elaborate on a subject-matter already introduced. I identified two subtypes: Circumstance and Elaboration. Since I have not examined them any further, I can make no statements at this point as to the occurrence of negative, unrealized, etc. instances of these relations.

8.3.1.4 Interpersonal relations

The inventory of features belonging to the interpersonal region has already been discussed above, so that no further examples are required. In a nutshell, I assume two groups of features: First, those relating to the intention of the speaker, namely increase-understanding, increase-ability, increase-willingness and increase-regard; and second, those expressing the speaker's attitude towards the nucleus, namely nuclear-neutral and nuclear-negative. All intentions can cross-classify with the speaker's attitude, not only increase-regard which has been discussed above. For instance, in Section 8.2 I introduced the goal *Decrease willingness* (as in example (8.31)); this can be composed of increase-willingness and nuclear-negative. The table summarizes the interpersonal feature classification:

interpersonal	increase-understanding vs. increase-ability vs. increase-willingness vs. increase-regard nuclear-neutral vs. nuclear-negative
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8.3.1.5 Textual relations

Likewise, the candidates for features in the textual region have already been discussed at length. A major opposition is that between the three types of nuclearity. Additionally, in Section 8.2 I proposed two textual relations whose purpose it is to restate content already introduced: Summary and Rephrasing. In brief, the following features have been motivated by examples from the domain and by linguistic variation:

textual	S_0 -nuclear vs. S_1 -nuclear vs. multinuclear rephrasing vs. summary
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8.3.2 The system network

Given the sets of major choices at the discourse level, I can now design the system network. The approach is that of merging, or unifying, the sets of features and oppositions derived from examining the different types of ideational relations. The resulting paradigmatic representation of coherence relations is given in Figure 8.2. The network in Figure 8.2 is only one among other possible classifications, as has been pointed out in Chapter 7, Section 7.2, when discussing the limitations of the typological perspective. The system network of coherence relations takes Bateman and Rondhuis's initial network as a starting

point (see [Bateman and Rondhuis 1997, p38] and Figure 3.7 in Chapter 3), and extends or modifies it where required. Features in italics indicate my changes and additions to their representation. The majority of ‘pure’ relations identified in the analysis step enter the system network as most delicate features, intermediary features are added to group those features that present oppositions, thereby making generalizations across categories and imposing a hierarchy. Since the features denote relations between two discourse segments S_0 and S_1 I use SMALL CAPS when referring to them.

The ideational part gives the cross-classifications of features identified for CAUSAL, TEMPORAL, and ADDITIVE relations. Since the POSITIVE/NEGATIVE, REALIS/IRREALIS and CERTAIN/POSSIBLE oppositions apply to these three groups of ideational relations alike, they are represented in the network as choices parallel to the causal/temporal/additive opposition. CAUSAL, TEMPORAL and ADDITIVE relations are all subsumed by the OCCASION relation defined by [Hobbs 1990]: These relations move forward in discourse, as opposed to the EXPANSION relations, that expand on information already introduced. ELABORATION and CIRCUMSTANCE refine the EXPANSION branch of the network. ELABORATION has two subtypes: GENERAL-SPECIFIC and OBJECT-ATTRIBUTE. Note that the positive/negative and the realis/irrealis oppositions can also hold for EXPANSION relations, but since no instances of negative or unrealized expansions occur in the technical domain, they are not accounted for in the network.

Naturally, this set of relations is not exhaustive, as the discussion above suggests. For instance, relations like Barker’s *Entailment* [Barker 1994] or DiEugenio’s *Goal-maintenance* [DiEugenio 1993] may be included. However, the network is intended to reflect the choices in the present domain, technical instructions, and thus the *field* variable of this genre. Therefore, for the time being these relations are not integrated into the network.

Regarding the interpersonal region, features and choices derived from the analysis above are already contained in Bateman and Rondhuis’ network; only the terminology differs. The correspondences between my features and the terminal features in Bateman and Rondhuis’s network are as follows:

my feature candidates	features in [Bateman and Rondhuis 1997]
increase-understanding	UNDERSTANDING
increase-ability	ABILITY
increase-willingness	INTENTION
increase-regard	REGARD

I also adopt their hierarchy proposed in the interpersonal-expansion branch, and the system capturing the speaker’s attitude towards the nucleus [Bateman and Rondhuis 1997, p38]. The interpersonal-occasion part has been deleted from the network. I could actually reduce the options in the interpersonal system network even further to reflect the *tenor* of the current text type, for instance, affecting the hearer’s beliefs is not an issue in the present domain; this kind of relation pertains to argumentative texts.

The textual network given by [Bateman and Rondhuis 1997] already reflects variation in nuclearity; my SUMMARY and REPHRASING relations are added as subtypes of the RE-

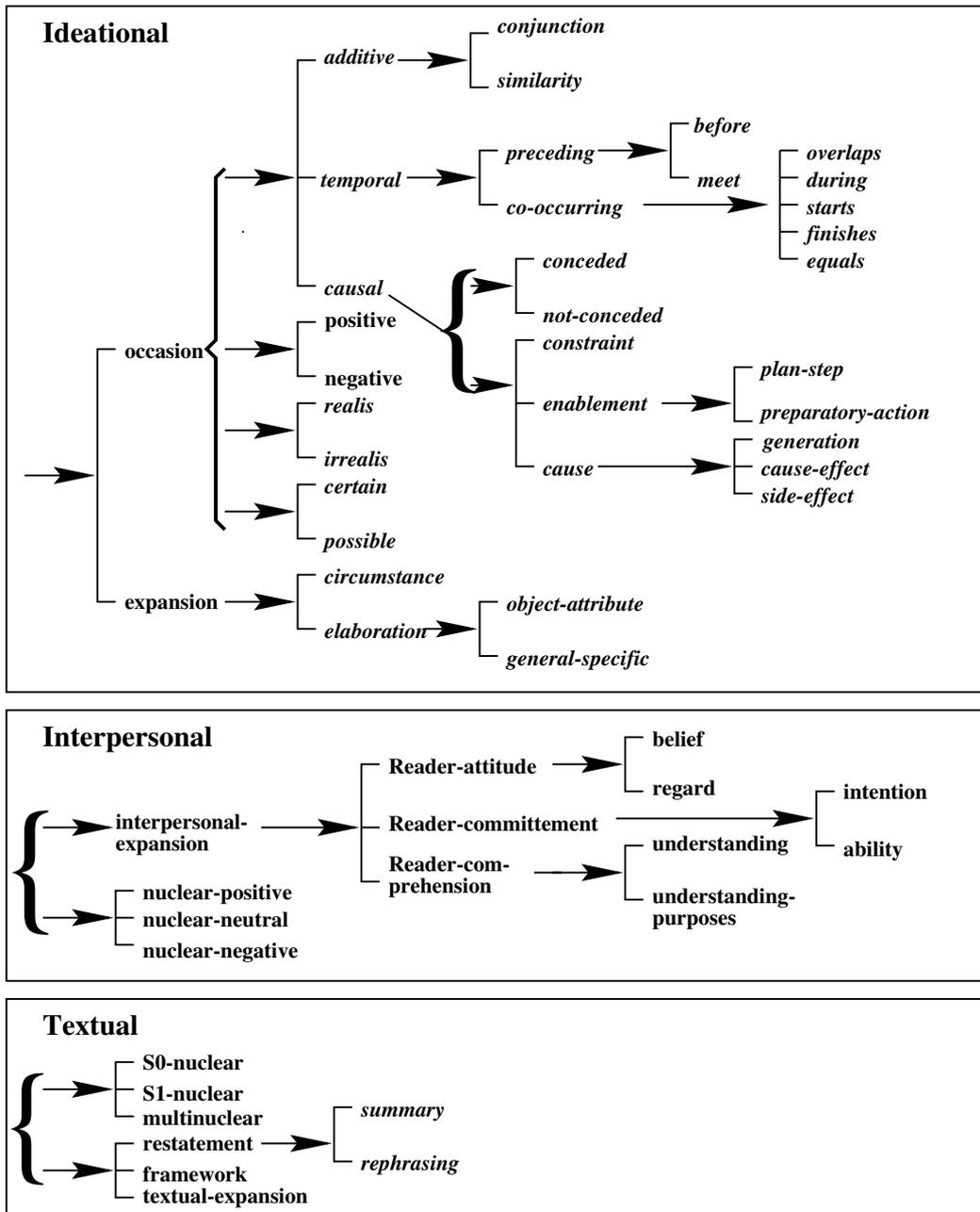


Figure 8.2: Paradigmatic network representing the coherence relations in technical instructional texts

Ex.	Composite coherence relation	RST relation
(8.1a)	[GENERATION, POSITIVE, REALIS, CERTAIN, NOT-CONCEDED, UNDERSTANDING, NUCLEAR-NEUTRAL, MULTINUCLEAR]	SEQUENCE(S_0, S_1)
(8.1b)	[GENERATION, POSITIVE, REALIS, CERTAIN, NOT-CONCEDED, UNDERSTANDING, NUCLEAR-NEUTRAL, S_0 -NUCLEAR]	VOLITIONAL-RESULT(S_0, S_1)
(8.1c)	[GENERATION, POSITIVE, REALIS, CERTAIN, NOT-CONCEDED, INTENTION, NUCLEAR-NEUTRAL, S_0 -NUCLEAR]	PURPOSE(S_0, S_1)
(8.1d)	[GENERATION, POSITIVE, REALIS, CERTAIN, NOT-CONCEDED, UNDERSTANDING, NUCLEAR-NEUTRAL, S_1 -NUCLEAR]	VOLITIONAL-CAUSE(S_1, S_0)

Table 8.4: Example (8.1) in feature representation

STATEMENT relation. Note again that this is only an initial classification, geared towards a particular text type, but no complete paradigmatic description of discourse functions.

Recall the example (8.1) given at the beginning of this chapter. Using the choices in the system networks depicted in Figure 8.2, the coherence relations holding in examples (8.1a) to (8.1d) are now described in terms of feature bundles, as given in Table 8.4. Compare this representation and the RST relations assigned to the examples:⁹ The different RST subject-matter relations seem to suggest that different ideational relations hold, whereas by teasing apart the various dimensions incorporated in RST's definitions, I can say more about how discourse segments are related. Composite relation definitions reveal the common ideational link (GENERATION, POSITIVE, REALIS, CERTAIN, NOT-CONCEDED) while at the same time making the interpersonal and textual purposes explicit (which are left implicit in the RST account). Moreover, they relate the variation in surface realization to variation in intentional and textual structure. See Section 8.5 below for a comparison of the discourse representation based on RST and the feature-based approach.

8.4 Discourse structure

Before I can present a sample analysis of a text, I need to say a few words on the structure of a discourse representation that spans an entire text.

In my approach, coherence relations are defined as feature bundles, which result from choices in the system network of rhetorical relations (see Figure 8.2). The system network is part of the paradigmatic description of possible coherence relations holding in text, the syntagmatic structure is given by configurations of these relations, generated by selecting from the system network. In other words, the

paradigmatic representation [...] maintains three metafunctionally distinct kinds of

⁹Note that the correspondences between composite relations and RST relations in the table only hold for the present text type and the particular context in which the utterances occur.

information, whereas the syntagmatic discourse structure serves, as in the grammar, as the point of unification of such information. [Bateman and Rondhuis 1997, p37]

The shape of the syntagmatic representation has not been addressed in [Bateman and Rondhuis 1997]; however, since I take the discourse structure as the starting point for discourse marker selection strategies, which should eventually be employed in multilingual text generation, I have to provide a definition of the syntagmatic structure of discourse.

So the question is: What does the discourse structure look like once we turn away from an atomic definition of discourse relations? As the development of a discourse structure is not the concern of my thesis, I make the following assumptions about the discourse structure for the time being:

1. **Tree.** The discourse structure can be represented as a tree structure, more specifically, as binary tree, similar to an RST-tree. Exceptions are, of course, multinuclear relations.
2. **Nodes.** Terminal nodes, or leaf nodes, denote elementary discourse segments. As with RST, non-terminal, i.e. internal, nodes reflect relations between discourse segments. They are, in contrast to RST, feature bundles, i.e. selection expressions resulting from choices in the three parallel rhetorical relation networks. The non-terminal nodes thus unify information from different sources (metafunctional regions in the system network), and, again in contrast to RST, make these different meaning contributions explicit.
3. **Ordering.** Nodes in the tree are partially ordered, i.e. the discourse tree is still underspecified with respect to ordering. Ordering constraints can, for instance, be derived from the underlying content representation, and also interact with the text type under consideration. They can be captured by heuristics, as has been done by, among others, [Scott and de Souza 1990]. However, I do not explore this topic in my thesis.
4. **Minimal units.** Minimal discourse segments, i.e. leaf nodes in the tree, denote single propositions. These can eventually be expressed as clauses, or as parts of clauses (PPs) in the text.
5. **Nucleus promotion.** Whenever two large discourse spans are connected through a coherence relation, this relation also holds between the most salient parts, i.e. the nuclei, of the constituent spans (see [Marcu 1996]).
6. **Span.** Relations belonging to the different discourse functions cover the same discourse segment, in other words, the metafunctional analysis acknowledges the same minimal units.
7. **Direction.** Nucleus/Satellite distribution is the same for relations from different metafunctions which conjoin the same discourse segments.

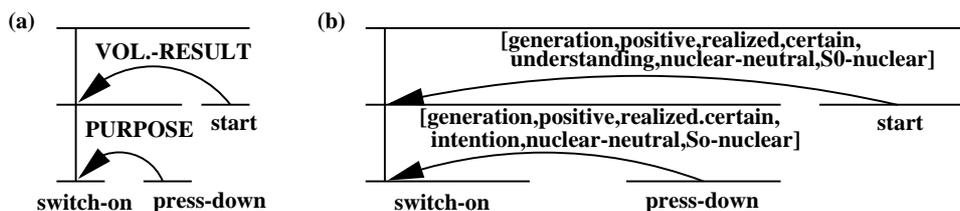


Figure 8.3: RST-representation and my feature-based representation for example (8.55)

To give an examples of this discourse structure representation, consider the following text:

- (8.55) *Zum Einschalten des Toasters die Aufzugstaste nach unten drücken.*
 To switch on the toaster the lever towards down press.
Damit beginnt der Toastvorgang.
 Thereby starts the toasting process.
 ‘To switch on the toaster, press down the lever. This starts the toasting process.’

Figure 8.3 shows the RST-structure (a), and my feature-based discourse structure using the features from Figure 8.2 (b). Leaf nodes are complex representations of propositions (in my case situation specifications, see Chapter 10), non-terminal nodes are described by feature bundles.

8.5 Applying coherence relations to text: Sample text analyses

Using the conventions on discourse structure and the feature classification given in the rhetorical relation networks in Figure 8.2, I can now proceed to build a discourse representation for texts from the technical instruction corpus (Section 8.5.1). Applying the coherence relations to real text is a test for the descriptive adequacy and the coverage of the proposed sets of features, as depicted in Figure 8.2, and their definitions. Section 8.5.2 then addresses the question of how coherence relations and their verbalization by means of discourse markers relate.

8.5.1 Sample text analyses

I discuss two texts from the technical corpus in detail: (1) a monolingual extract from the operating instructions for a Bosch toaster (example (8.56); text TC.21 from the corpus); (2) the English and German version of the paragraph describing how to add coolant to the radiator from the Honda car manual, p.104 (example (8.57); text TC.25 from the corpus).¹⁰

¹⁰Emphases in the texts are mine.

(8.56) Zuleitung in benötigter Länge abwickeln **und** einklemmen.

Gewünschte Bräunung mit stufenlosem Röstgradwähler einstellen. Brotscheiben in den Röstschacht einlegen. Aufzugstaste **bis** zum Anschlag nach unten drücken. **Mit** dem Herunterdrücken **und** Einrasten der Aufzugstaste schaltet sich das Gerät ein **und** der Toastvorgang beginnt. Durch das Gitter im Röstraum werden alle Brotstärken bis 30mm zentriert. **Hiermit** wird ein konstanter Abstand zu den Heizkörpern **sowie** eine gleichmäßige Bräunung gewährleistet. **Nach** Ablauf der Toastzeit schaltet das Gerät automatisch ab **und** die Brotscheiben werden sanft hochgeschoben. Brotscheiben entnehmen.

Sollte **während** eines Toastvorgangs das Brot zu dunkel werden, Aufzugstaste bis Anschlag nach oben ziehen. Der Toastvorgang wird **damit** unterbrochen. Der eingestellte Röstgrad bleibt unverändert.¹¹

(8.57)

- a. Warten, **bis** der Motor kalt ist, **dann** den Kühlerdeckel im Gegenuhrzeigersinn **bis** zum Anschlag drehen. **BEIM DREHEN DEN DECKEL NICHT NIEDERDRÜCKEN.** **Nachdem** der Druck abgelassen ist, den Deckel **durch** Niederdrücken **und** Drehen im Gegenuhrzeigersinn abnehmen. Kühlmittel nachfüllen, **bis** der Kühler voll ist, **dann** den Deckel wieder aufschrauben. Fest andrehen. Den Reservetank bis zur oberen Pegellinie "MAX" **bei** kaltem Motor auffüllen.
- b. Wait **until** the engine is cool, **then** turn the radiator cap clockwise **until** it stops. **DO NOT PRESS DOWN WHILE TURNING THE CAP.** **After** any remaining pressure has been relieved, remove the cap **by** pressing down **and** again turning it counterclockwise. Add enough coolant **to** fill the radiator, **and** reinstall the cap. Be sure to tighten it securely. Fill the reserve tank up to the max mark **with** the engine cold.

Bosch toaster operating instructions. Following Mann and Thompson's requirement of functional integrity [Mann and Thompson 1987, p6], the minimal units of text (8.56) are:

¹¹English translation:

Pull out the required length of cord and secure the remaining length.

Set the desired toasting level using the intensity selector. Insert bread slices into the toasting compartment. Press down the lever to the operating position. The toaster will be switched on during the lowering and clicking into place of the lever, and this will start the toasting action. All bread of thicknesses up to 30 mm will be centered within the grate in the toasting compartment so as to provide a stable distance from the heating elements throughout the continuous toasting process. When the toasting time is completed, the toaster will automatically switch off and the slices will pop up. Remove the slices.

If, during the toasting, the bread becomes too dark, pull the lever up to the stop mark. This interrupts the toasting process. The preset degree of toasting is not changed.

- [1] Zuleitung in benötigter Länge abwickeln
- [2] und einklemmen.
- [3] Gewünschte Bräunung mit stufenlosem Röstgradwähler einstellen.
- [4] Brotzscheiben in den Röstschacht einlegen.
- [5] Aufzugstaste nach unten drücken
- [6] bis zum Anschlag
- [7] Mit dem Herunterdrücken
- [8] und Einrasten der Aufzugstaste
- [9] schaltet sich das Gerät ein
- [10] und der Toastvorgang beginnt.
- [11] Durch das Gitter im Röstraum werden alle Brotstärken bis 30mm zentriert.
- [12] Hiermit wird ein konstanter Abstand zu den Heizkörpern sowie eine gleichmäßige Bräunung gewährleistet.
- [13] Nach Ablauf der Toastzeit
- [14] schaltet das Gerät automatisch ab,
- [15] und die Brotzscheiben werden sanft hochgeschoben.
- [16] Brotzscheiben entnehmen.
- [17] Sollte während eines Toastvorgangs
- [18] das Brot zu dunkel werden,
- [19] Aufzugstaste bis Anschlag nach oben ziehen.
- [20] Der Toastvorgang wird damit unterbrochen.
- [21] Der eingestellte Röstgrad bleibt unverändert.

Figure 8.4 gives an RST tree for this text: The six major steps in toasting bread (units [1], [2], [3], [4], [5] and [16]) are in a SEQUENCE relation. The last two steps are explained in more detail: The ‘switching-on’ action [5] is motivated in units [8-12]; segments [13-15] provide the setting for the ‘removing-bread’ action [16]. Units [17-21] elaborate on the entire procedure, and hence the ELABORATION relation between [1-16] and [17-21].

Figure 8.5 depicts an analysis of the toaster text using the framework proposed in this chapter (cf. the rhetorical relation network in Figure 8.2).¹² The global structure is quite similar: Again, paragraphs [1-16] and [17-21] are related by an ELABORATION; units [8-12] motivate the action denoted by segment [5] ([GENERATION,INTENTION, S_0 -NUCLEAR]), and units [13-15] enable the user’s action in segment [16] ([PREPARATORY-ACTION,ABILITY, S_1 -NUCLEAR]). Differences pertain to how the six steps in the toasting procedure are related. Instead of a single SEQUENCE relation, the different nature of the links is made explicit: Whereas the sequence between units [1] and [2] is due to a causal relationship (pulling out the cable is a preparatory action for securing the cable), the sequential ordering of [3] (setting the roasting level) and [4] (inserting the bread) is purely incidental, which is reflected in the coherence relation [CONJUNCTION,UNDERSTANDING,MULTINUCLEAR]. Both actions are a preparatory step for switching on the toaster [5-12], giving rise to the relation [PREPARATORY-ACTION,UNDERSTANDING,MULTI-NUCLEAR]. Finally, the sequence of [1-2], [3-12] and [13-16] is a temporal one, expressed by the relation [PRECEDING,UNDERSTANDING,MULTINUCLEAR].

¹²For better readability, the features [POSITIVE,REALIS,CERTAIN,NOT-CONCEDED] and [NUCLEAR-NEUTRAL] have been omitted in Figures 8.5 and 8.7. If not stated otherwise, the features hold for a relation.

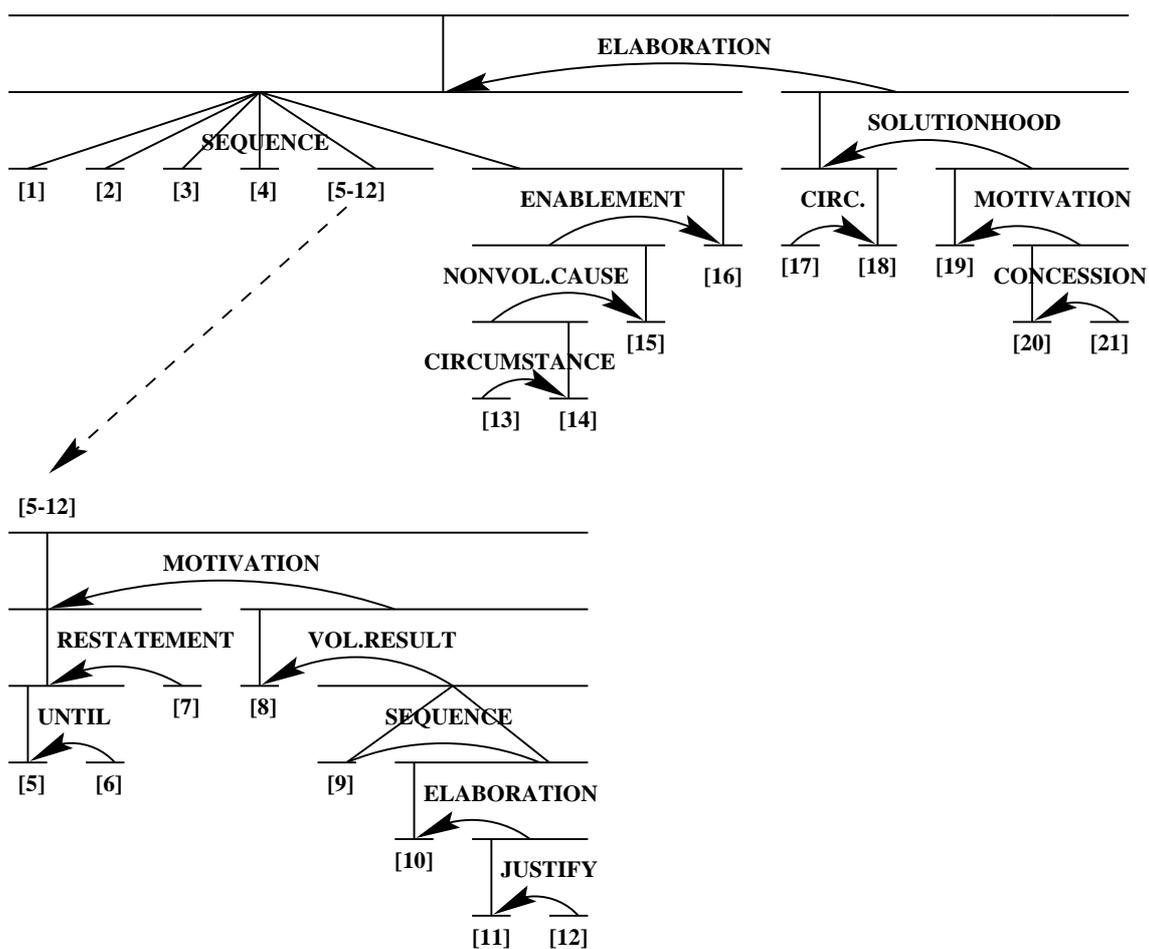
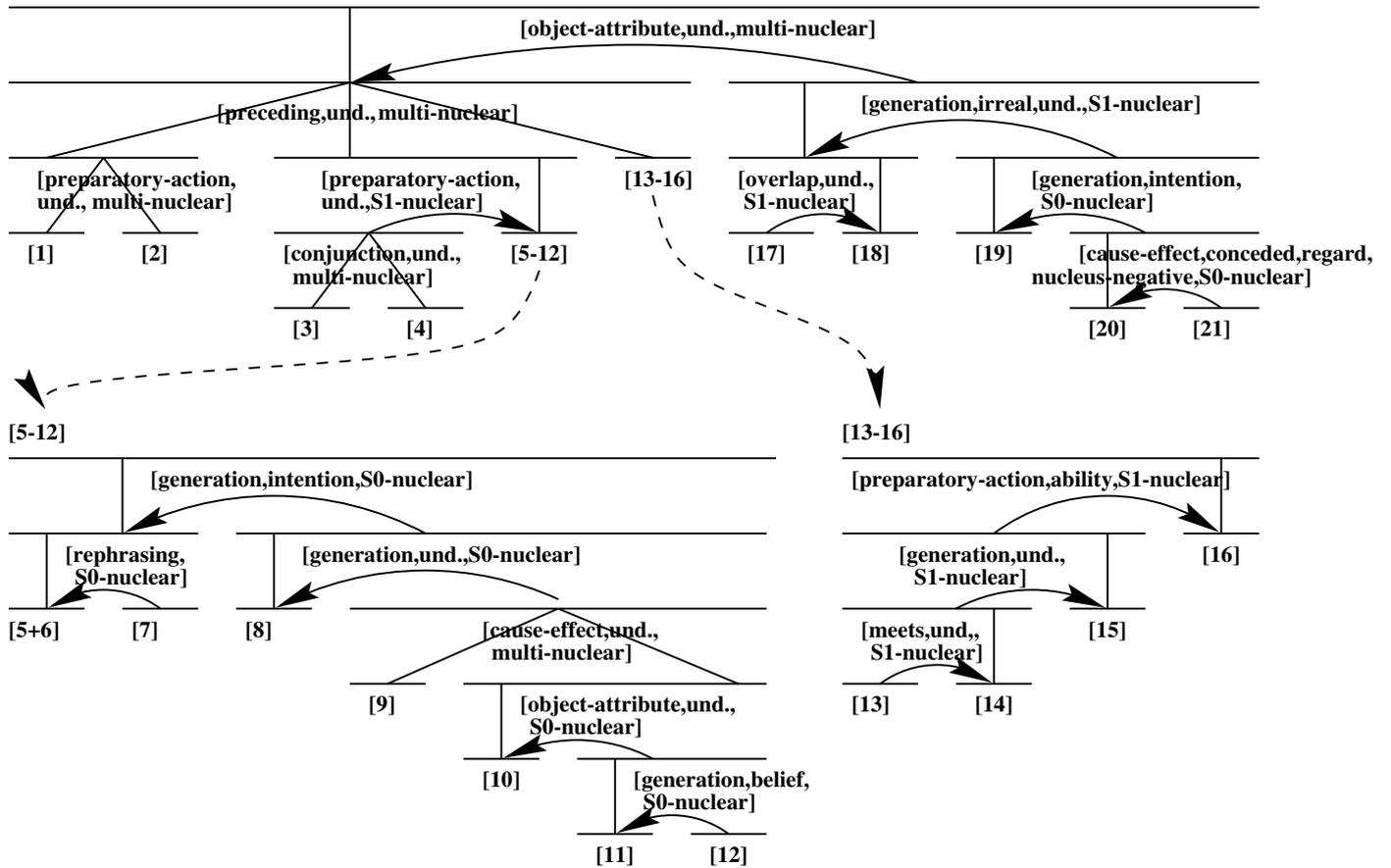


Figure 8.4: RST-analysis of toaster text, example (8.56)



KEY: und. = shorthand for understanding

Figure 8.5: Composite rhetorical relations in the toaster text, example (8.56)

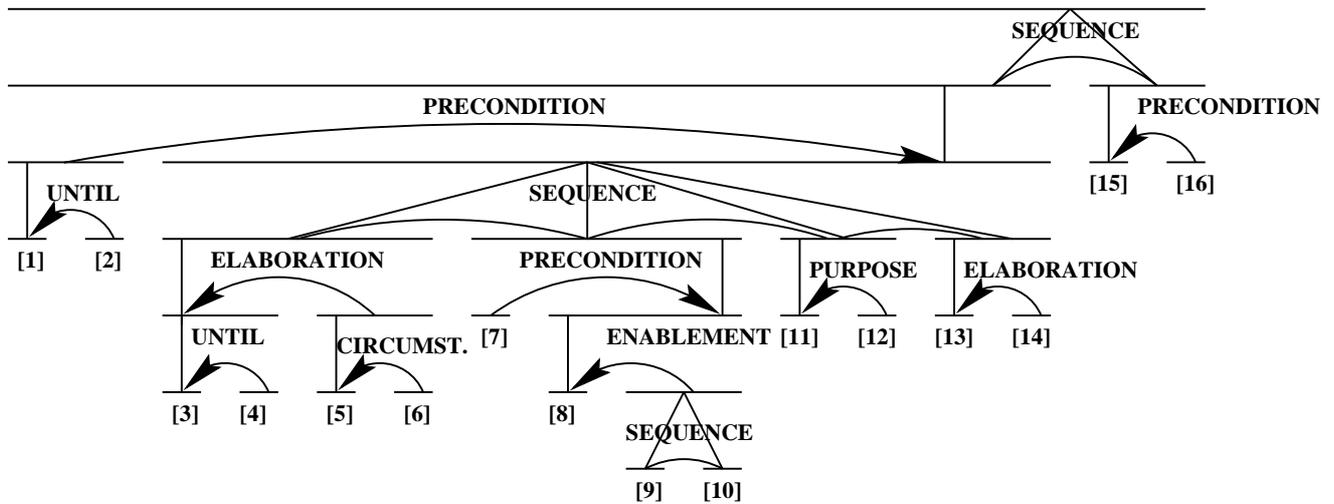


Figure 8.6: RST-analysis of the English coolant text, example (8.57a)

Adding coolan instructions from Honda car manual. The minimal units of text (8.57) are:

Warten,	[1]	Wait
bis der Motor kalt ist,	[2]	until the engine is cool,
dann den Kühlerdeckel im	[3]	then turn the radiator cap,
Gegenuhrzeigersinn drehen		clockwise
bis zum Anschlag.	[4]	until it stops.
DEN DECKEL NICHT NIEDERDRÜCKEN	[5]	DO NOT PRESS DOWN
BEIM DREHEN	[6]	WHILE TURNING THE CAP.
Nachdem der Druck abgelassen ist,	[7]	After any remaining pressure
		has been relieved,
den Deckel abnehmen	[8]	remove the cap
durch Niederdrücken	[9]	by pressing down
und Drehen im Gegenuhrzeigersinn	[10]	and again turning it counterclockwise.
Kühlmittel nachfüllen,	[11]	Add enough coolant
bis der Kühler voll ist,	[12]	to fill the radiator,
dann den Deckel wieder aufschrauben.	[13]	and reinstall the cap.
Fest andrehen.	[14]	Be sure to tighten it securely.
Den Reservetank bis zur oberen	[15]	Fill the reserve tank up
Pegellinie "MAX" auffüllen		to the max mark
bei kaltem Motor.	[16]	with the engine cold.

The only difference between the minimal units in the German and English version is that the order of units [5] and [6] is reversed: The German text gives [6] first, followed by [5].

The RST analysis of the English version of (8.57) has already been given in Chapter 3, Figure 3.3, and is reproduced in Figure 8.6 for convenience. The text describes two distinct activities—adding coolant in units [1-14] and filling up the reverse tank in units [15-16]—

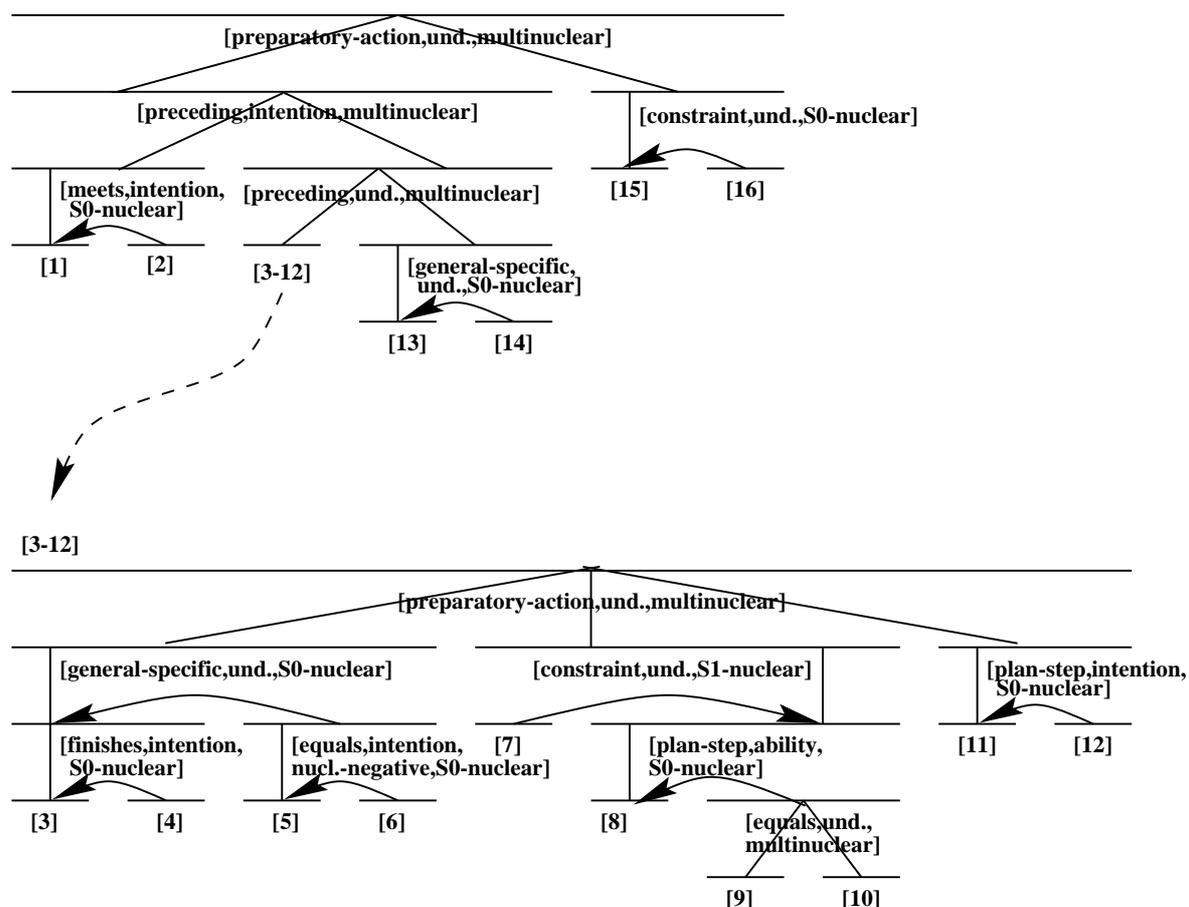


Figure 8.7: Composite rhetorical relations in the adding coolant text, example (8.57)

that are in a SEQUENCE relation. Adding coolant is a complex procedure, consisting of four steps, again in a SEQUENCE relation [3-6,7-10,11-12,13-14] and its precondition [1-2]. The RST tree for the German text differs only marginally: UNTIL(11,12) holds instead of PURPOSE(11,12).

Figure 8.7 depicts my discourse representation of the text fragment. Again, the global structure of the discourse tree is preserved, only the nature of the links between two discourse segments differs. This is the case for those links that are labelled as SEQUENCE in the RST tree: The type of sequence is made explicit, i.e. whether the sequence is due to causality ([3-6,7-12]) or temporality ([3-12,13-14] and [9,10]).

Discussion. The major difference between an RST tree and a discourse representation building on the rhetorical relation networks from Figure 8.2 is that in the latter case, the links between two discourse segments are characterized more precisely by distinguishing between the ideational, interpersonal and textual contributions to the relation. This has two major effects: First, one gets a more complete picture of the type of link by stating the

contributions from the different dimensions separately. For instance, the interpersonal and textual facets of RST's subject-matter relations are explicated. To illustrate this, consider the subject-matter relations (NON)VOLITIONAL-CAUSE, (NON)VOLITIONAL-RESULT and PURPOSE. They also realize interpersonal and textual meaning (they vary in intention and nuclearity), as coherence relations for text fragments 8.56:[13-14,15], 8.56:[8,9-12], and 8.57:[11,12] show. Indeed, the interpersonal and textual purposes actually distinguish between the relations, as the ideational link is the same (causal link). This has already been observed by [Bateman and Rondhuis 1997] in their re-analysis of RST relations.

Second, the classification of relations is more fine-grained. Consider the subject-matter relations CIRCUMSTANCE and SEQUENCE from RST. In RST, CIRCUMSTANCE describes any kind of spatial or temporal relation, and SEQUENCE describes any kind of sequencing of two discourse segments, no matter where the sequential order stems from. In my analysis, the precise nature of a circumstance is described; for instance, OVERLAP in (8.56:[17,18]) or EQUALS in (8.57:[5,6]). Likewise, the type of sequence is characterized, i.e. whether the sequential order stems from a causal relation (ideational relations CAUSE-EFFECT (8.56:[9,10-12]) or PREPARATORY-ACTION (8.56:[1,2])), is due to temporal constraints (PRECEDING in (8.56:[1-2,3-12,13-16]), EQUALS in (8.57:[9,10])) or simply signals an arbitrary order of segments, referred to as CONJUNCTION in my account (8.56:3,4)). The characterization of the coherence relation relies less on surface cues as RST is taken to do in the case of, for instance, SEQUENCE assignment. Still, the more fine-grained characterization of relations provides valuable knowledge for discourse marker choice, as the discussion in the next section will show.

8.5.2 Verbalizing coherence relations

Recall that the underlying assumption is that the discourse representation describes the rhetorical relationships holding between discourse segments independently of how these are communicated in a particular text realizing the discourse representation. At the same time, the discourse representation is the major source of information for discourse marker choice, as has been shown in Chapter 3 and argued for above. Further, I maintained that an RST tree does not provide sufficient information for motivated discourse marker choice. Now, in how far does the discourse representation proposed in this chapter support the selection of an appropriate discourse marker?

Consider those discourse segments that are linked by a SEQUENCE relation in the RST representation of the sample texts. In texts (8.56) and (8.57), these links are always verbalized by the additive marker *and* or a full stop. Here are some examples:

(8.58)

- a. *Zuleitung in benötigter Länge abwickeln **und** einklemmen.* (8.56:[1,2])
- b. *Gewünschte Bräunung mit stufenlosem Röstgradwähler einstellen. Brot scheiben in den Röstschacht einlegen.* (8.56:[3,4])

- c. ... *schaltet das Gerät automatisch ab* **und** *die Brotscheiben werden sanft hochgeschoben.* (8.56:[15,16])
- d. *Add enough coolant to fill the radiator,* **and** *reinstall the cap.* (8.57:[11-12,13])

In some cases, temporal or causal markers can be used instead of the additive ones, while in others, an additive marker is the only appropriate verbalization. Here are some paraphrases of examples (8.58a) to (8.58d), using either the temporal *danach* (then) or the causal *dieses bewirkt* (this causes):

(8.59)

- a. *Die Zuleitung in benötigter Länge abgewickeln.* **Danach** *das Kabel einklemmen.*
- b. *?Zuleitung in benötigter Länge abwickeln.* **Dieses bewirkt,** *dass das Kabel eingeklemmt wird.*
- c. *?Die gewünschte Bräunung mit stufenlosem Röstgradwähler einstellen.* **Danach** *Brotscheiben in den Röstschacht einlegen.*
- d. *?Die gewünschte Bräunung mit stufenlosem Röstgradwähler einstellen.* **Dieses bewirkt,** *dass die Brotscheiben eingelegt werden.*
- e. *Das Gerät schaltet automatisch ab.* **Danach** *werden die Brotscheiben sanft hochgeschoben.*
- f. *Das Gerät schaltet automatisch ab.* **Dieses bewirkt,** *dass die Brotscheiben sanft hochgeschoben werden.*
- g. *Add enough coolant to fill the radiator.* **Then,** *reinstall the cap.*
- h. *??Add enough coolant to fill the radiator.* **This causes** *the reinstallation of the cap.*

The discourse segments of example (8.58a) can be conjoined with a temporal marker, whereas a causal marker like *dieses bewirkt* (this causes) is odd (cf. examples (8.59a) and (8.59b)). Yet, a verbalization with *zu* (to) would also be possible. Regarding sentence (8.58b), the use of both, temporal and causal markers, instead of the additive *and* yields an ill-formed sentence: While a causal relation as implied by paraphrase (8.59d) cannot be constructed, the use of a temporal marker is possible—as one can imagine a temporal succession of the situations depicted in example (8.58b)—but adds information since the order in which the actions are performed is arbitrary. Next, (8.58c) allows for temporal and causal discourse markers to connect the two sentences (cf. examples (8.59e) and (8.59f)), whereas sentence (8.58d) again only has a temporal interpretation. Here, no causal link can be constructed (cf. (8.59g) and (8.59h)).

These conditions on the applicability of discourse markers cannot be explained by considering the RST tree of the text alone, as all links are represented as SEQUENCE relations. Yet, it can be accounted for by the coherence relations derived from the rhetorical relation network in Figure 8.2: The text fragments mainly differ in the ideational relations underlying

Composite coherence relation	Discourse marker group
[CONJUNCTIVE, UNDERSTANDING, MULTINUCLEAR]	additive: <i>und</i> , (full stop)
[PRECEDING, UNDERSTANDING, S_1 -NUCLEAR]	temporal: <i>nachdem</i> , <i>sobald</i> , <i>nach</i>
[PRECEDING, REGARD, NUCLEUS-NEGATIVE, S_1 -NUCLEAR]	temporal: <i>kaum dass</i>
[PRECEDING, UNDERSTANDING, S_0 -NUCLEAR]	temporal: <i>bevor</i> , <i>ehe</i> , <i>vor</i>
[PRECEDING, UNDERSTANDING, MULTINUCLEAR]	temporal: <i>dann</i> , <i>danach</i>
[PREPARATORY-ACTION, UNDERSTANDING, MULTINUCLEAR]	causal: <i>dann</i> , <i>damit</i> , <i>dazu</i>
[CAUSE-EFFECT, UNDERSTANDING, S_1 -NUCLEAR]	causal: <i>dieses bewirkt</i> , <i>dadurch</i>

Table 8.5: Composite coherence relations and realizing discourse markers

them, that is, in the type of relation that motivates the sequential order of the discourse segments. Example (8.59a) is interpreted as a PREPARATORY-ACTION, hence temporal markers and weak causal ones can be chosen. Example (8.58b) is a mere CONJUNCTION, since no temporal or causal link holds between the segments, which renders the use of temporal and causal markers impossible (see examples (8.59c) and (8.59d)). In contrast, (8.58c) signals a CAUSE-EFFECT relation, thus temporal and causal markers can be used to conjoin the two segments (see examples (8.59e) and (8.59f)). Finally, a temporal relation underlies example (8.58d), as the paraphrase in example (8.59g) shows. In a nutshell, by making all aspects of coherence explicit, one has more knowledge at hand on which to base a motivated discourse marker choice, and one can describe the set of possible markers given a coherence relation more precisely.

The notion of three dimensions of discourse representation also helps to classify discourse markers and account for their usage. Table 8.5 gives several coherence relations (as described in Figure 8.2) that all characterize the relation between discourse segments that have been described as SEQUENCE in the RST framework, and their most frequent realizations in the technical corpus.¹³ The classification of relations as given in Figure 8.2 already reflects some of the distinctions which influence marker usage. For example, they account for the fact that *nachdem* (after) and *kaum dass* (as soon as) realize different temporal relations (BEFORE vs. MEETS) and different speaker intentions: *Nachdem* simply informs (UNDERSTANDING), while *kaum dass* expresses a negative assessment of the nucleus (REGARD, NUCLEAR-NEGATIVE). Further, they reflect the different behaviour of *nachdem* and *bevor* (before) regarding nuclearity (S_1 -NUCLEAR vs. S_0 -NUCLEAR). In other words, the variation in interpersonal and textual structure relates systematically to variation in surface form.

The use of additive discourse markers in examples (8.58a) to (8.58d) illustrates a common phenomena in technical instructional texts: The relation indicated by linguistic means (i.e. made *explicit* in Martin's terms [Martin 1992]) is often different from the underlying

¹³The discourse markers listed in the table are only one way of signaling the relations, contextual constraints can of course trigger other realizations, such as choosing an additive discourse marker to realize a temporal relation; see discussion below.

ing coherence relation. Take example (8.58) again: The linguistic means employed in three of the four sentences is the conjunction *und* (and), clearly an additive connective, while the underlying ideational relation is one of CONJUNCTION, temporal PRECEDENCE, PREPARATORY-ACTION or CAUSE-EFFECT. This shows again that the coherence relations as such are independent of the verbalization. Various factors in addition to the coherence relation come into play in the linearization of text, which determine the facets of a relation that are explicated, and thus influence the actual choice of linguistic means. Alternative discourse markers may be employed to realize the same set of features: In example (8.59f), the coherence relation [CAUSE-EFFECT, UNDERSTANDING, S_0 -NUCLEAR] is signaled by *dieses bewirkt* (this causes). In particular contexts a causal relation as in (8.58d) may very well be realized by an additive discourse marker on the linguistic surface, thus leaving information *implicit*. Recoding causal relationships by means of temporal markers such as *dann* (then) is typical of instructional texts (constraint: text type). The additive marker *und* (and) is often used if a causal chain is expressed (constraint: discourse history). The reverse case—indicating a relation that is more informative than the one holding between discourse segments—is not possible, as the use of the temporal marker in example (8.59c) illustrates. Thus, while the link indicated on the surface may differ from the underlying coherence relation, the coherence relation still gives the range of possible markers, i.e. a coherence relation can only be expressed by discourse markers indicating relations that are comprised by that relation.

To conclude, by defining coherence relations at a language-independent level, and decoupling the coherence relations holding between discourse segments from the cohesive means employed in a single unfolding of the text, one has access to the common underlying relations, while at the same time being able to account for alternative surface forms. This is exactly the knowledge required to support a motivated choice of discourse markers in different languages in the automatic production of text. In the remaining chapters of this thesis, I elaborate on this issue and introduce my approach to discourse marker choice in multilingual text generation, where the selection procedure starts from a discourse representation as defined in this chapter.

Chapter 9

The discourse marker lexicon: A general resource for discourse marker representation

This chapter introduces the discourse marker lexicon as a general resource to encode information on discourse marker meaning and usage. Following the prevailing view in current NLP research on the lexicon, a lexicon entry consists of attribute-value pairs, and lexicon entries are related by lexical semantic relations. Lexicon entries are given in a notation adapted from the EAGLES guidelines for lexical semantic encoding.

The chapter is structured as follows: In Section 9.1 I suggest that discourse markers are best represented in a dedicated lexicon, and provide arguments in favour of this position. Section 9.2 then briefly examines the role of the lexicon in descriptive linguistics and in NLP applications, and discusses the types of information encoded in the lexicon, with a focus on discourse markers in computational lexica. Based on this, Section 9.3 presents a discourse marker lexicon following the EAGLES recommendations for lexical semantic encoding: It introduces a set of attribute-value pairs that captures marker meaning and usage, and describes the general organization of the lexicon.

9.1 Motivating a discourse marker lexicon

In this section I posit that discourse markers are best represented in the lexicon: I illustrate that discourse markers are not merely consequences of structural decisions (Section 9.1.1), and then argue that for the present application, text generation, information on discourse marker meaning and usage is best stored in a dedicated lexicon (Section 9.1.2). First of all, however, a few words on the use of the term ‘lexicon’: As [Linke *et al.* 1994, p161] note, the term ‘lexicon’ is by no means defined unambiguously. Depending on the field, quite different notions exist. For instance, within linguistics, the term ‘lexicon’ denotes the vocabulary of a language community or individuals. It defines the inventory of words in a given language

for a particular speaker and gives their semantic-pragmatic, syntactic and phonological properties [Lewandowski 1985, p684]. Outside the discipline of linguistics, a lexicon designates an encyclopaedic reference book, whereas the vocabulary is described in a dictionary: a lexicon (*Lexikon*) provides information about things; a dictionary (*Wörterbuch*) on usage of words, combinations, etc. [Bergenholtz and Kaufmann 1996, p167]. The linguistic notion of the lexicon is, however, the prevailing view in natural language processing: The grammar characterizes the syntactic well-formedness of clauses and sentences, and the role of the lexicon is to supply individual words. In this thesis, I use the term ‘lexicon’ as defined in this way.

9.1.1 Discourse markers: Lexical choice or structural decision?

The traditional distinction between *content words* and *function words* (or open-class and closed-class items) relies on the stipulation that the former have their ‘own’ meaning independent of the context they are used in, whereas the latter assume meaning only in context. As a consequence, the selection of content words is taken to be a matter of complex lexical choice procedures, whereas function words are treated as part of grammatical realization. In the context of NLP applications, this has the effect that lexical components contain content words only, and lexical choice mechanisms only deal with open-class items (this will be elaborated on below). Likewise, state-of-the-art linguistic formalisms such as HPSG [Pollard and Sag 1994] assign content words to the realm of the lexicon, and function words to the realm of the grammar.

For dealing with discourse markers, I do not regard this distinction as particularly helpful, though (cf. the discussion in Chapter 1 and Chapter 2). As shown in Chapter 6, the lexical items that are identified as discourse markers can carry a wide variety of semantic and pragmatic overtones, which render the task of selecting a marker meaning-driven, as opposed to a mere consequence of structural decisions. Further, even though discourse markers are closed-class items, they nonetheless display interesting lexical properties. A number of lexical relations customarily used to assign structure to the universe of ‘open class’ lexical items can be applied to discourse markers as well:

- **Synonymy.** The German words *obzwar* and *obschon* (both more formal variants of *obwohl* = *although*) are at least very close to being *synonyms*.
- **Plesionymy.** As for *plesionyms* (near-synonyms, cf. [Cruse 1986, p285]), *although* and *though*, according to Martin [1992], differ in formality, and *although* and *even though* differ in terms of emphasis.
- **Antonymy.** *If* and *unless* can be seen as *antonyms*, as they both express conditionality, but with opposite polarity [Barker 1994].
- **Hyponymy.** Some markers are more specific than others, thus display *hyponymy*. E.g., *but* can signal a general CONTRAST or a more specific CONCESSION.¹

¹[Knott and Mellish 1996] and [Knott 1996] thoroughly discuss the issue of ‘taxonomizing’ discourse markers.

- **Polysemy.** Other than being more or less specific, some markers can signal quite different relations; e.g., *while* can be used for TEMPORAL CO-OCCURRENCE, and also for CONTRAST. Hence, the marker is *polysemous*.

In this respect, discourse markers are not that different from ‘content words’. Therefore, I propose to view the discourse marker selection as one subtask of the general *lexical choice*. This view is shared by [Reiter and Dale 2000, 129] who state that “lexicalization includes the task of choosing appropriate cue words.” From this follows that discourse markers have to be described similar to content words, i.e. by making their syntactic, semantic and pragmatic properties explicit. The same position is held by [Rey 1997] who discusses discourse marker choice in the context of natural language processing. His aim is to

... show the extreme complexity of discourse markers and to suggest that in any NLP system (whether translation, summary, etc.) they will be as difficult to modelize as any other lexical unit because they are not mere grammatical links without meaning. [Rey 1997, p184]

Rey argues in favour of a declarative, independent resource for storing knowledge on discourse markers to be used in various NLP applications. Regarding the present application, natural language generation, I have shown in Chapter 2 that most current NLG systems realize the production of discourse markers as a mere consequence of other sentence level decisions, which is, given the complex nature of discourse markers, a simplification. In contrast, discourse marker choice is a complex task, and there is a strong interaction between discourse marker selection and other sentence planning tasks, as the following examples demonstrate:

- Ordering of related clauses (cause-effect vs. effect-cause):

(9.1)

- Because** *he was unhappy, he asked to be transferred.*
- He asked to be transferred, for he was unhappy.*
- * **For** *he was unhappy, he asked to be transferred.*

- Aggregation (no marker vs. *and*):

(9.2)

- He has quarrelled with the chairman. He resigned from his post.*
- He has quarrelled with the chairman **and** resigned from his post.*

- Delimit individual sentences (two vs. one sentences):

(9.3)

- They fought a battle. **Afterwards**, it snowed.*

- b. **After** *they fought a battle, it snowed.*
- Clause-internal structuring (hypotaxis vs. parataxis):
 - (9.4)
 - a. **Although** *he has tried hard, he failed.*
 - b. *He tried hard, but he failed.*
- Lexical choice (*to know* vs. *ignorance*):
 - (9.5)
 - a. *She died, because she didn't know the rules.*
 - b. *She died through ignorance of the rules.*
- Realizing negation:
 - (9.6)
 - a. *He will not attend unless he finishes his paper.*
 - b. *He will attend if he finishes his paper.*
- Formatting decisions (*and* vs. enumeration):
 - (9.7)
 - a. *Remove the plug and discard it.*
 - b.
 - *Remove the plug.*
 - *Discard the plug.*

I believe that when treating discourse markers as part of the grammatical realization, i.e. as mere structural decisions, one cannot account for these interactions and perform an informed choice of discourse markers in text production. In contrast, only when treating them similar to content words as one aspect of lexical choice processes, one can choose among a set of similar markers and support the choice of the most appropriate discourse marker.

9.1.2 Representing lexical information

Assuming that discourse markers are described similar to content words, how is the information on syntactic, semantic, and pragmatic characteristics (the *lexical information*) encoded? In general, there exist two approaches to representing lexical information in linguistics and computational applications:

- Lexical choice and grammatical realization are treated as distinct processes. As a consequence, there is a separation between a set of grammatical rules on the one hand, and a lexicon providing the terminal items on the other hand.

- Lexical decisions have a status no different from making grammatical decisions. This results in a joint linguistic resource for grammar and lexis.

In what follows I describe the two approaches in turn and then motivate my personal choice for representing discourse marker knowledge.

9.1.2.1 Relation between grammar and lexis

The relation between grammar as the source for syntactic constraints and the lexicon is by no means clear-cut, but theory-dependent [Weber 1996, p3]. For instance, state-of-the-art linguistic formalisms such as HPSG [Pollard and Sag 1994] and TAG [Joshi 1987] regard lexicon and grammar as separate entities and posit that lexical types can constrain the syntactic structure. In contrast, in SFL [Halliday 1994], lexis and grammar are kept in a common resource, the lexicogrammar.

The prevailing view in NLP is that of a division between grammar and lexicon: The grammar ensures the syntactic well-formedness of clauses and sentences, and the lexicon supplies the words that can take the positions specified by the grammar. Systems for machine translation such as EUROTRA, METAL, SYSTRAN, or LOGOS all have separate lexical resources [EAGLES Lexicon Interest Group 1999]; likewise, dedicated lexical components are deployed in dialogue systems, for text analysis, information retrieval and information extraction, to name only a few applications.

As regards the present application, text generation, the most common model for lexicalization in automatic text generation is one where a distinct lexical choice module

converts an input graph whose primitives are domain concepts and relations into an output graph whose primitives are words and syntactic relations. [Dale and Reiter 1995, p23]

The algorithm uses a lexical data base to relate domain primitives and linguistic primitives; in most systems the lexicon serves as a bridge between the generator input and grammatical decision-making (see also [Stede 1999, p25] and [Matthiessen 1991, p277]). Hence, lexical choice usually precedes syntactic choice. The majority of text generators has taken lexicalization as the first step, examples are MUMBLE [McDonald 1981], COMET [McKeown *et al.* 1990], and MOOSE [Stede 1999] (cf. also [Stede 1999, p30] and [Wanner 1997, p35] for an overview of the state of the art in lexicalization). As a result of sequencing these tasks, text generation systems have distinct lexical and grammatical resources. Note, however, that this relates to content words only as in the past lexical choice has mostly been restricted to the choice of open-class items. The choice of closed-class items, among them those items that can function as discourse markers, has been delegated to the grammar. As has been shown above, this is a questionable position as the choice of closed-class items such as discourse markers and particles is also constrained by lexical semantics and stylistics, and not solely by the grammar.

Finally, there has been a large effort over the past few years in developing computational lexica that present lexical information in a way that is theory- and application-independent, and that may thus be used in different NLP applications. Several EU projects aimed at the specification of standards on lexical representation, namely the Esprit Basic Research Project ACQUILEX (ESPRIT BRA 3030) and its successor ACQUILEX II (ESPRIT Project 7315), the LRE projects MULTEXT (LRE-Project 62-050), DELIS, and above all EAGLES (LE3-4244), which formulated recommendations for lexical semantic encoding (see the discussion of the projects in the [EAGLES Lexicon Interest Group 1999, 146ff]). The underlying assumption of these projects is that lexical knowledge is different from syntactic knowledge, and as such requires a dedicated resource.

Such a strict separation of grammar and lexis as advocated in the work discussed so far is rejected in other approaches, as for instance, in Systemic Functional Linguistics [Halliday 1994]. This framework has been applied in this thesis to describe discourse marker function and form; compare Chapter 7. In SFL, no sharp distinction is made between a set of grammatical rules on the one hand, and a lexicon providing the terminal items for those rules on the other hand. Making lexical decisions has a status no different from making grammatical decisions. Hence, there is only one network of *lexicogrammatical* options, the lexicogrammar [Halliday 1994]. Central to the understanding of the interaction between grammar and lexis is the notion of ‘lexis as most delicate grammar’ [Halliday 1961]. In other words, the more delicate, or specific, choices in the lexicogrammatical network tend to be realized by the choice of lexical items rather than the choice of syntactic means.

There have been a few attempts to put this idea into practice; the most prominent ones are Hasan’s exploration of the lexicogrammar of ‘acquisition’ [Hasan 1987] and Tucker’s description of the lexicogrammar of adjectives [Tucker 1997]. In fact, [Tucker 1997] states explicitly that there

is no point in a system network at which the specification of a lexical item is assigned to some other component, such as a separate lexicon. [Tucker 1997, p216]

In automated text generation, SFL-based sentence generators are popular (KPML [Bateman 1997], PENMAN [Penman 1989], COMMUNAL [Fawcett and Tucker 1989], and [Matthiessen and Bateman 1991] for an overview). However, these computational implementations of SFL do not adhere to the notion of ‘lexis as most delicate grammar’. For instance, in NIGEL, the computational lexicogrammar for English employed in the PENMAN and KOMET sentence generators, only function words such as prepositions, pronouns and conjunctions are realized by lexicalization statements, whereas content words such as verbs, nouns, and adjectives are selected in interaction with a separate lexicon. The lexicon consists of lists of properties describing usage conditions of individual lexical items.

Likewise, [Wanner 1997] maintains that existing lexicogrammatical resources are syntactically driven and therefore bear significant limitations regarding the coverage of lexical phenomena. He comes to the conclusion that lexical resources are to be represented as a ‘separate resource located between semantics and grammar’ [Wanner 1997, p154]. He assigns lexis a central place and suggests to place it as an intermediate stratum between

the semantic and the grammatical resources,² and draws on Mel'čuk's *Meaning Text Model* (MTM) [Melcuk 1996] for modelling that stratum. In this model, the lexicon plays a central role: It defines words as networks where all labels are words of 'simpler meanings' (i.e. the meaning of the words amounts to a paraphrase of simpler terms), and it contains a wealth of 'lexical functions' that specify how a word relates to others [Stede 1999, p17]. MTM-based generation grammars are frequently used for linguistic realization, for instance, in GOSSIP [Iordanskaja *et al.* 1991] and FOG [Goldberg *et al.* 1994].

9.1.2.2 Motivating a discourse marker lexicon

So far, I have sketched different approaches to treating lexical knowledge, but have not yet come to a decision on whether to encode the information accumulated on discourse markers in Chapters 6 and 7 in a dedicated lexicon or in a joint lexicogrammatical resource.

The discussion above suggests that the relation between grammar, as the source for syntactic constraints, and the lexicon is theory-dependent [Weber 1996, p3]. And, one has to add, this relation is clearly also dependent on the processing direction. With analysis, a separate lexical resource is the preferable solution, while with language production, the lexical resources of a language need not be spelled out explicitly. I argue in the following that—given my assumptions about how multilingual generation proceeds—in text generation lexical information is best represented in a dedicated lexicon. Consequently, in this thesis I advocate a separation of lexical and syntactic knowledge, and propose to store information on discourse marker meaning and usage in a discourse marker lexicon. This will be a lexicon whose main grouping criterion is function rather than grammatical category, as has already been suggested in Chapter 4 when introducing the test for discourse markers which gives a functionally motivated class of lexical items.

This decision has a number of reasons: While at first sight, it is an appealing idea to have one resource for lexical and grammatical options, at closer examination, this idea has several drawbacks: First, one encounters cases where lexical choice constrains syntactic realization, and where the notion of lexis as most delicate grammar therefore cannot be realized. As lexical decisions are not granted a distinct status, they have little power to exercise influence on other decisions, which would in practise—as demonstrated in Section 9.1.1—diminish the expressiveness of a generator.³ Second, the lexicogrammatical systems are taken to reflect ideational, interpersonal and textual meaning (cf. [Tucker 1997]). This excludes those phenomena that cannot be described in terms of their contribution to meaning such as, for instance, morphosyntactic properties of prepositions that determine the availability of a functional paradigm [Grote 2000]. Further, up to date, only small networks for limited lexical fields are available; no large-scale application that has a realistic coverage of the lexical items of a language is reported. This is also true for discourse markers: There exist functional classifications for English and Dutch connectives, but while the English account [Martin 1992] has a broad coverage, it only specifies the paradigmatic axis, and

²This proposal is rooted in Firth's work on a polysystemic model of language.

³See also [Stede 1999, p26] for a similar position. Likewise, [Wanner 1997, p155] posits that 'lexically predetermined structures are realized by grammar'.

does not account for properties of the lexicogrammatical environment of connectives. In contrast, the Dutch study considers the paradigmatic and syntagmatic axis, but examines only a small subset of discourse markers, namely five temporal connectives.

Additional reasons for rather choosing the lexicon approach over using the system networks classifying German discourse markers given in Chapter 7 follow from my assumptions about the place of lexicalization in the generation process, and the realization of lexical choice. In my understanding, lexicalization is performed in a separate sentence planning phase, where different modules tackle different sentence planning tasks (such as the ones given in Section 9.1.1). Due to the interdependencies between discourse marker choice and other sentence-planning decisions, a fixed order of making decisions will impose serious limitations on the expressiveness of the system. Accordingly, a flexible order of decision-making should be realized, as can be accomplished in a blackboard-based architecture such as proposed by DIOGENES [Nirenburg *et al.* 1989] and HEALTHDOC [Wanner and Hovy 1996]. Thus, discourse marker choice now is no longer a mere consequence of other sentence planning decisions, as is common practise in most generation systems today (cf. discussion in Chapter 2), but can also posit constraints on other decisions. The individual modules should best rely on declarative representations as much as possible; otherwise the control process becomes extremely difficult.

Further, placing lexicalization in the sentence planning phase makes it possible to treat sentence generation as a black box: I do not have to commit myself to a particular sentence realization system, but can potentially deploy different front-ends.⁴ Moreover, a lexicon is appealing because information on discourse markers is represented in a uniform way, accumulated at one place, and relations between different markers are made explicit. I argued above (Section 9.1.1) that due to their characteristics, discourse markers should be treated like open class items, and their syntactic, semantic, and pragmatic properties should be made explicit. This also supports the idea of a discourse marker lexicon.

My decision in favour of a dedicated lexicon is also in line with current research on lexical databases, as pursued in various EU projects (for instance, DELIS [Heid and Emele 1994], EAGLES [EAGLES Lexicon Interest Group 1999], ACQUILEX [Copestake and Sanfilippo 1993], MULTEXT [Ide and Veronis 1994], and the Eureka-Project GENELEX [Antoni-Lay *et al.* 1994]). These projects aim at encoding lexical information in such a way that makes it capable of deployment in lexical components of a wide variety of practical NLP systems. Such a dedicated lexical resource—and especially one following a standard encoding for lexical semantic information—has many advantages: It ensures a high re-usability of lexical resources, which again reduces the overhead in building NLP systems. It further enables a joint effort in lexicon design, which may result in large lexical databases with a broad coverage, instead of having small lexicon fragments tailored to particular applications as current systems have. Moreover, a common standard justifies the effort of developing methods and tools for exploiting knowledge already available from machine-readable dictionaries and from corpus material. This again ensures a maximum coverage of the lexical resources.

⁴[Wanner 1997, p155] remarks that available lexicogrammatical resources such as the ones for German [Teich 1995] and for English [Matthiessen 1992] are syntax-driven, and thus provide a practical reason for making lexical decisions prior to grammatical ones.

Finally, all the information on lexical items is stated declaratively.

Surely, a lexicon approach also has its disadvantages, mainly due to the static definition of meaning. Lexical meaning is subject to context, and hence the meanings assigned to a word in a lexicon are always abstractions because a lexicon can never take all possible contexts into account [Seewald 1996, p110]. This major drawback of a distinct lexicon is, on the other hand, the major advantage of the systemic functional approach to language.

Still, in this thesis, I encode information on discourse markers in a dedicated discourse marker lexicon. In a nutshell, this is due to the following observations: First, I believe that in order to account for interactions and to perform an informed choice of discourse markers in text generation, an independent lexical resource where discourse marker knowledge is stated explicitly is the most suitable way of storing the information associated with individual markers. Second, current research on lexical resources, in particular the EAGLES project, argues in favour of a dedicated lexicon, i.e. a resource than can be shared among various applications.

9.2 Representing discourse marker knowledge in a lexicon

The preceding section answers the question on *where* to describe meaning and form of discourse markers (in a dedicated lexicon). This section now addresses the issue of *how* to encode the knowledge on discourse markers accumulated in earlier chapters. I first briefly survey general principles in and approaches to lexicon design, and then turn to the specific issue of discourse marker entries in existing lexica.

9.2.1 Lexicon design

Depending on the purpose of a lexicon, and again on the linguistic framework, lexica differ regarding the kinds of information they encode, and the levels of representation they assume. The prevailing view in descriptive linguistics is that a lexicon contains phonological, morphological, syntactic, and semantic information on lexical items. Additionally, it may include information on style, collocations, context, and may provide synonyms and define other lexical relations [Lewandowski 1985, Bußmann 1990, Linke *et al.* 1994].

This view is shared by approaches to lexical data bases in NLP applications: Machine translation systems specify morphological, syntactic and semantic information in the lexicon. To give an example, the EUROTRA lexical resources comprise four levels of representation, namely morphological structure, constituent structure, relational structure, and interface structure, with the latter specifying deep syntactic and semantic information (see the discussion of EUROTRA in [EAGLES Lexicon Interest Group 1999, p138]). In addition, many generation lexica contain information such as collocations, stylistic and pragmatic information, for instance, PAULINE [Hovy 1988] and COMET [McKeown *et al.* 1990] (cf.

[Wanner 1997, p18]).

Experimental computational lexica such as the ones developed for NLP applications in general (cf. ACQUILEX, DELIS, MULTEXT, and the EAGLES projects) also assume three major types of information—morphological, syntactic, semantic—which give rise to either two or three levels of representation, depending on how types of information are merged. Note that the information encoded in the lexicon strongly depends on the intended application. For instance, the MULTEXT lexica contain morphosyntactic information only, as the lexica are deployed for corpus annotation tasks such as morphosyntactic tagging and sentence boundary recognition (Details are given on the MULTEXT homepage at <http://www.lpl.univ-aix.fr/projects/multext/MUL5.html>).

A further point that needs to be considered is the organisation of the material in the lexicon. This has two facets: First, it concerns the *internal structure* of individual lexicon entries and the notation used, and second, the way lexical entries are related to each other, i.e. the *global organization* of the lexical resource.

Most lexica in NLP are word-sense based, where each lexicon entry represents a word sense. This holds for the group of experimental computational lexica introduced above, and for most machine translation lexical components. Entries in generation lexica, however, are mostly given for specific words, whereas at the other end of the scale, word nets give entries for synsets, i.e. set of synonyms. It is current practise in NLP to encode information in lexicon entries as attribute-value pairs, compare among others, the lexicon components in MT systems such as METAL or EUROTRA, and the proposals for computational lexica as put forward by the EAGLES consortium, or in the DELIS, ACQUILEX, and MULTEXT projects (see discussion in [EAGLES Lexicon Interest Group 1999]). The motivation here is to posit a representation that makes it possible to deploy the lexical resources in the lexical components of a wide variety of practical NLP systems. Lexical entries are often represented as Typed Feature Structures (TFS) following the HPSG theory of natural language syntax and semantics, and are sometimes implemented as SGML DTD (GENELEX, MULTEXT). The major drawback of these approaches is due to the formal machinery of the TFS representation language which is not suitable to distinguish between ‘constraining’ and ‘preferential’ information (cf. [EAGLES Lexicon Interest Group 1999, p154]). Thus, preferences are either ignored or treated as absolute constraints (see discussion below).

The global organisation of the lexicon relates to how the set of individual entries is structured and how lexicon entries are related. Printed dictionaries such as COBUILD and MRDs such as the *Cambridge International Dictionary of English*⁵ simply contain lists of word forms or word senses presented in alphabetical order, with lexical relations defined between individual entries. In contrast, computational lexicons such as the ones developed as part of the MULTEXT and ACQUILEX projects, and as proposed in the EAGLES guidelines, assume a more complex organization: They usually display two layers of description: a flat layer of basic descriptions of lexicon entries, and an additional structuring layer which introduces classifications and generalizations, e.g. through inheritance networks, top ontologies, basic concepts, and lexical semantic relations (see among others

⁵Available on-line at <http://dictionary.cambridge.org/>

[Copestake and Sanfilippo 1993, EAGLES Lexicon Interest Group 1999]). The TFS formalism is augmented with a default inheritance mechanism (lexical entries can inherit information from other feature structures) and derivational mechanisms such as lexical rules. For instance, feature structures (FS) in ACQUILEX are of two kinds: the default FS defining default information on a class of lexicon entries (*genus part*) and the non-default FS describing information specific to a lexical entry (*differentia part*) [Copestake and Sanfilippo 1993]. Most lexica employed in generation systems have a dictionary-like organisation which list word senses and their syntactic and semantic properties. The lexical resources are, as a rule, not organized hierarchically (see [Wanner 1997, p30]).

Whereas lexical semantic relations have only been experimentally used in projects such as ACQUILEX and DELIS and in MLG, they are the major organizational principle in those lexical databases that are subsumed by the term ‘word net’, such as WORDNET [Fellbaum 1998], EUROWORDNET (LE2-4003) [Vossen *et al.* 1998], and GERMANET [Hamp and Feldweg 1997]. Word nets organize lexical material by relating sets of synonyms (*synsets*: word senses with the same part of speech that are considered to be identical in meaning) rather than by word forms or word senses. Each synset represents one underlying concept. Hierarchical semantic relations such as taxonomy and meronymy relations, and non-hierarchical relations such as synonymy and antonymy link the synsets and thereby create a word net. The resulting network is completely relational.

9.2.2 The treatment of discourse markers in existing lexica

Unfortunately, most existing work on lexicon design does not pay much attention to function words, and most available computational lexica, lexical-semantic databases such as WORDNET, EUROWORDNET, GERMANET, and the lexical resources and guidelines for setting up lexica for NLP purposes as proposed in LRE projects—such as EAGLES, ACQUILEX, DELIS, and GENELEX—do not deal with those function words that can act as discourse markers. As a matter of fact, [Miller *et al.* 1990] explicitly exclude function words from their investigations in the context of WORDNET:

The relatively small set of English function words is omitted on the assumption (supported by observations of the speech of aphasic patients [...]) that they are probably stored separately as part of the syntactic component of language. [Miller *et al.* 1990, p2]

This position is in opposition to the view on the representation of discourse marker knowledge held in this thesis, and is mainly motivated by the fact that the WORDNET design is inspired by psycholinguistic research.

Discourse markers are accounted for in some lexical resources, though; sample entries will be given in the remainder of this section. For one thing, lexical entries for discourse markers can be obtained from descriptive linguistic resources for German and English, which are intended as reference books on the usage of words. Figure 9.1 shows the definition of *sobald* and its English equivalent *as soon as* as given in a standard German dictionary,

sobald <Konj.>: *in dem Augenblick, da;*
gleich wenn: ich rufe an, s. ich zu Hause bin

soon /su:n/, **sooner**, **soonest** [...]

2 If you say that a second thing will happen **as soon as** a first thing happens, you mean that the second thing will happen immediately after the first thing happens. EG *As soon as we get the tickets we'll send them to you... As soon as she got out of bed the telephone stopped ringing... My legs cramped up as soon as I stopped walking.*

CONJ SUBORD ↑ when

Figure 9.1: Lexicon entries for *sobald* and *as soon as*, reproduced from [Duden 1989, p1412] and [Cobuild 1987, p1389]

sobald

temporal (vorzeitig)

Die subordinierende Konjunktion *sobald* hat temporale Bedeutung im Sinne der Vorzeitigkeit: Sie drückt aus, daß der NS-Sachverhalt unmittelbar vor dem HS-Sachverhalt liegt. Die Stellung des NS is frei. Wenn der NS Vordersatz ist, kann der HS mit dem Korrelat *da* eingeleitet werden. Die Tempusformen stimmen zumeist überein, können aber auch verschieden sein (bei Gegenwarts- und Zukunftsbezug Präsens bzw. Futur I im HS und Perfekt im NS, bei Vergangenheitsbezug Präteritum im HS und Plusquamperfekt im NS). Verschiedene Tempusformen werden vor allem gebraucht, um die Abgeschlossenheit des NS-Sachverhalts zu betonen.

Gegenwart/Zukunft

Sobald man ihm den kleinen Finger gibt, nimmt er die ganz Hand.
Er wird uns Bescheid geben, sobald er genauere Information hat.
Sobald ich zu Hause angekommen bin, (da) rufe ich Dich an.

Vergangenheit

Sobald sie uns sahen, (da) liefen sie davon.
Er verließ die Werkstatt, sobald er die Arbeit beendet hatte.
Sobald er um die Ecke gebogen war, verbarg er sich in einem Hausflur.

Anmerkung:

Die Bedeutung von *sobald* kann in manchen Fällen auch so interpretiert werden, daß der Zeitpunkt des Beginns des HS-Sachverhalts zusammenfällt mit einem Zeitpunkt, zu dem der NS-Sachverhalt besteht. In diesen Fällen müßte *sobald* als Konjunktion mit temporaler Bedeutung im Sinne der Gleichzeitigkeit klassifiziert werden.

Figure 9.2: Lexicon entry for *sobald* (as soon as), reproduced from [Buscha 1995, p102/3]

Duden [Duden Universal Wörterbuch 1989],⁶ and the Cobuild dictionary [Cobuild 1987]. The information provided in both entries is sparse: Only part-of-speech and examples are given, and an additional natural language description of the usage condition of discourse markers (which is quite often simply a paraphrase of the connective). While the Duden entry is self-contained, in the Cobuild dictionary, entries refer to other entries by means of hyponymy relations.

More detailed information on individual discourse markers is provided in [Buscha 1989] and [Schröder 1990]. Although entitled *Lexikon deutscher Konjunktion* (Lexicon of German conjunctions) and *Lexikon deutscher Präpositionen* (Lexicon of prepositions), both books do not nearly resemble a computationally useful lexicon as described above. Compare Figures 9.2⁷ and 9.3⁸ for sample entries. The so-called lexica are word-based, and specify

⁶English translation *sobald* entry:

sobald (as soon as) <conj.>: *in the moment, when; just when*: I call as soon as I have arrived home

⁷English translation of the lexicon entry:

sobald (as soon as)
temporal (*anterior*)

The subordinating conjunction **sobald** (as soon as) has the temporal meaning of anteriority. It signals that the event denoted by the subordinate clause (SC) immediately precedes the main clause (MC) event. The position of the SC is not restricted. If the SC precedes the MC, the MC can be introduced with *da* (then). The verbal tenses are usually the same, but they may also differ (when referring to present and future events, simple present in the MC and present perfect in the SC, when referring to past events, simple past in the MC and past perfect in the SC). Different tempora are used above all to stress the completion of the SC event.

Present/Future

As soon as one offers the little finger, he takes the hand. (a German *saying*, the English equivalent is 'To give an inch and to take a mile.'). He will let us know as soon as he has more detailed information.

As soon as I have arrive home, (then) I call you.

Vergangenheit

As soon as they saw us, (then) they ran away.

He left the workshop as soon as he had finished his work.

As soon as he came around the corner, he hid himself in a hallway.

Note:

Sobald can sometimes be interpreted as follows: The beginning of the event denoted by MC correlates with a time point at which the SC event holds. In these cases, *sobald* would have to be classified as a conjunction that signals simultaneity.

⁸English translation of the lexicon entry:

Nach (after) DAT [...]

2. TEMPORAL

nach is used to denote a time span that has already gone by by the time the event denoted by the sentence takes place. This time span can be referred to by either content or by quantifying temporal expressions.

After the rain, everything started to blossom.

Our visitors came after the meal.

Heinrich Heine died in 1856 after a long and serious illness.

After a few seconds of absolute silence the artist received the well-deserved applause.

nach DAT [...]

2. TEMPORAL

Mit *nach* wird eine Zeitspanne wiedergegeben, die bereits vergangen ist, wenn das Satzgeschehen stattfindet. Diese Zeitspanne kann ihre Referenz haben in Sachverhalten und in quantifizierten Zeitbegriffen.

Nach dem Regen begann alles zu grünen.

Unser Besuch kommt erst nach dem Essen.

Heinrich Heine starb 1856 nach langem schweren Leiden.

Nach einigen Sekunden absoluter Ruhe erhielt der Künstler den wohlverdienten Beifall.

Nach ein paar Tagen kam er wieder.

Aber in ein paar Tagen wird er wiederkommen. Vgl. **in 2.4**.

nach [+temp, - simult, +*Rf_prae*, +period/moment, +qual term/state]

Figure 9.3: Lexicon entry for *nach* (after), reproduced from [Schröder 1990, p156]

syntactic and semantic properties of conjunctions and prepositions in an informal way. Additionally, [Schröder 1990] (Figure 9.3) defines a set of binary features, but these provide by no means a comprehensive characterization of discourse marker form and function. Note also that only the prepositions in the first three sample sentences pass my ‘Test for discourse markers in German texts’.

In short, this descriptive work on German prepositions and conjunctions does not provide helpful insights on discourse marker lexicon design. Neither do lexical components of NLP systems: Most computational lexica do not even contain discourse markers. Likewise, in most MLG systems, discourse markers have not been assigned to a separate component but have been treated as part of the grammatical resources. Generation lexica are usually restricted to open-class items; only a single use of a lexicon to represent discourse markers is reported [Stede and Umbach 1998]. Unfortunately, they do not give lexicon entries for particular markers which could be reproduced here (compare the discussion in Chapter 2).

Finally, the EU LRE projects on the design and standardization of lexical resources also focus on content words, function words only play a marginal role. For instance, the EAGLES consortium only lists two attributes in the description of prepositions, and one attribute in the description of conjunctions. As Figure 9.4 shows, attributes are restricted to syntactic properties, and are not linked. Likewise, the MULTEXT proposal for storing information on German conjunctions and prepositions (given in Figure 9.5) is restricted to

After a few days he returned.

But in the few days he will return. Cf. **in 2.4**

nach [+temp, - simult, +*Rf_prae*, +period/moment, +qual term/state]

P	ATT	VAL	C
1	Type	preposition postposition circumposition	p t c
2	Formation	simple compound	s c

P	ATT	VAL	C
1	Type	coordinating subordinating	c s

Figure 9.4: Attribute-value pairs given for adpositions and conjunctions in EAGLES documents

morphosyntactic properties, although they add new values and new attribute-value pairs to the feature set recommended in the EAGLES guidelines.

To sum up, available lexicon entries for discourse markers are either informal—this holds for the work in descriptive linguistics—or comprise only a fraction of the aspects relevant to discourse marker description, as is illustrated by the lexicon entries in Figures 9.4 and 9.5. They do not account for pragmatic overtones of discourse markers at all and only provide a rudimentary semantic characterization. Further, lexical semantic relations holding between discourse markers are not dealt with. Even worse, the majority of research on lexical semantic encoding ignores discourse markers completely [EAGLES Lexicon Interest Group 1999, p75]. In case prepositions and conjunctions are included, their characteristics are represented using attribute-value pairs.

9.3 Proposal for a discourse marker lexicon

As pointed out above, in this thesis, I use the term ‘lexicon’ as defined in linguistics to refer to the inventory of the words of a language, as opposed to the syntactic means of a language for expressing meaning (see also [Linke *et al.* 1994, p50]). Thus, a discourse marker lexicon is an inventory of those lexical items that pass my ‘Test for discourse markers in German text’ or Knott’s ‘Test for relational phrases’ (see Chapter 4). An entry for a lexical item specifies information about its spelling, grammatical status, meaning, etc.

The goal of this section is to design a lexicon for discourse markers that gives a fine-grained and explicit description of discourse marker properties, while at the same time being independent from a particular application and particular linguistic theory. The proposal made here is much inspired by the work in the EU-LRE projects on experimental computational lexica, especially the EAGLES projects and its recommendations for lexical semantic encoding. In the following chapter (Chapter 10) this ‘general’ discourse marker

Adpositions (S)			
Attribute	Value	Example	Code
Type	pre	an	p
	post	wegen	t
	circum	von...an	c
	part1	von	a
	part2	an	z
Formation	clitic	ans	c
	simple	an	s

Conjunctions (C)			
Attribute	Value	Example	Code
Type	coordinating	oder	c
	subordinating	als	s
	compar	als	v
	infinitive	um	i
	part1	entweder	a
	part2	oder	z

Figure 9.5: Attribute-value pairs stored for German Adpositions and Conjunctions in MULTEXT

lexicon is adapted to the requirements of multilingual text generation.

9.3.1 Organization of the lexicon

How does the lexicon account for the fact that discourse markers are not just a set of isolated lexical items, but that they are related systematically to one another? Here, I draw on the insights gained in the ACQUILEX and EAGLES projects. Following the EAGLES recommendations, I assume two layers of description [Menon and Modiana 1993, p24]:

- A flat layer of basic descriptions of lexicon entries.
- An additional structuring layer which introduces classifications and generalizations, e.g. through lexical semantic relations and inheritance hierarchies.

The shape of the lexicon entries is outlined in Section 9.3.2 below; the present section discusses the global organization of the lexicon. Again following EAGLES and ACQUILEX, I distinguish two ways in which lexicon entries are related: First, by means of lexical semantic relations that may hold between discourse markers, as has been illustrated in Section 9.1, and second, by means of taxonomies of values.

Lexical semantic relations. Lexical semantic relations relate individual lexicon entries. The set of lexical relations that can be applied to discourse markers has been introduced in Section 9.1. In the literature (see among others [Cruse 1986, Bußmann 1990, Lutzeier 1995, Crystal 1997]), lexical relations are defined as *sense relations* holding between senses of content words which always belong to the same word class. Yet, the functionally motivated class of discourse markers comprises lexical items from different word classes. Thus, one observes instances where two discourse markers are semantically related, but differ with respect to the syntactic properties, such as *bevor* (before, subc) and *vor* (before, prep). I thus define lexical relations in terms of those attributes in a discourse marker definition that relate to meaning, and ignore attributes and values that refer to the lexicogrammatical context. In this understanding, *bevor* and *vor* would be treated as synonyms.

In my discourse marker lexicon, two types of lexical relations are accounted for: *vertical paradigmatic relations* and *horizontal paradigmatic relations* (see [Lutzeier 1995, Cruse 1986, p73ff]). Vertical relations build hierarchy-like structures between lexical items, for instance, by means of the hyponymy relation. Horizontal ones define relations between lexemes at the same ‘level’ of abstraction, examples are synonymy and plesionymy. There is only one vertical lexical semantic relation in my lexicon:

- **Hyponymy.** *Kaum dass* (no sooner than) is a hyponym of *sobald* (as soon as), *solange* (as long as) of *während* (while), and *sobald* (as soon as) of *nachdem* (after).

This relation builds hierarchical structures between lexicon entries. Hyponyms inherit information from their superconcepts.

The following horizontal relations are accounted for in my discourse marker lexicon:

- **Synonymy.** Examples from the temporal marker class are *sobald/sowie* (as soon as) and *bevor/vor* (before, before (P)). These can be substituted by one another (see also [Knott 1996, p74]).
- **Plesionymy** (near-synonyms). For instance, *bevor* (before) and *ehe* (before, arch.) differ regarding the frequency of use, *ehe* is archaic; *although* and *though* diverge in formality.
- **Antonymy.** An example are the connectives *if* and *unless*.

Hierarchies. Marker meaning is encoded in terms of the categories defined in the coherence relation network and the subsumption relations between them (see Figure 8.2 in Chapter 8 and the discussion of attribute-value pairs below). These hierarchies are similar to the hierarchies of *basic types* or *Base Concepts* in EAGLES, ACQUILEX, CORELEX, and WORDNET that capture semantic distinctions.

9.3.2 Information contained in the discourse marker lexicon

I now turn to the issue of individual lexicon entries, their motivation, their internal structure and their representation.

9.3.2.1 Shape of a lexicon entry

Lexica are of different types: They are either word-based, word-sense based, or give a lexicon entry for a synonym set. Likewise, linguistic researchers follow quite different strategies in defining lexicon entries: Adopting Herweg's approach of two-level semantics [Herweg 1990, Herweg 1991], one would arrive at one lexicon entry for each discourse marker, that is, for each lexeme (type) that belongs to the class of discourse markers. The general idea underlying his approach is that there exists one basic meaning for every connective, which is represented at the semantic level. Other possible readings can be derived from this basic meaning. For instance, a representation of the lexeme *bevor* (before) describes this connective as indicating a temporal precedence relationship, all other possible readings, such as temporal overlap and the non-temporal likelihood, preference and conditional readings are derived from the basic temporal relation in a conceptualization step [Herweg 1991b]. At the other end of the scale one finds accounts like [Buscha 1989] which creates a separate lexicon entry for every reading of a discourse marker. That is, the number of lexicon entries for a lexeme equals the number of semantic relations that a connective can express. This yields, for instance, two lexicon entries for *bevor* (before),⁹ and four entries for *als* (as). Likewise, computational lexica such as those developed in the context of EAGLES or MULTEXT maintain that the basic information unit in a lexicon is a word sense [EAGLES Lexicon Interest Group 1999].

The strategy I adopt in this thesis is somewhat a compromise between these two extremes: I introduce a lexicon entry for every word sense that has a reflex in form, i.e. which is signaled on the linguistic surface. Therefore, different readings of one and the same marker are collapsed into one lexicon entry as long as their constraints on the linguistic environment match. Separate lexicon entries are created for those readings that show different constraints on the linguistic context. To illustrate this approach, consider the discourse marker *bevor* (before) in its temporal usage: Two lexicon entries are created for *bevor*, because lexicogrammatical constraints differ between the strict precedence reading of *bevor* and its overlap reading (see Chapter 6), although in most lexica and grammars, *bevor* is described as signaling anteriority only. In other words, lexicon entries are created whenever the linguistic surface makes it possible to differentiate between different readings of a discourse marker. As a consequence, the highly ambiguous discourse marker *während* (while), again in its temporal reading, which can realize 9 out of the 13 temporal interval relations proposed by [Allen 1984], is represented in one lexicon entry, because surface linguistic constraints do not vary. The different temporal relations that can be encoded by *während* are not made explicit on the linguistic surface, but are left implicit.

Following current practises in NLP and lexicon research (see discussion above), information

⁹Interestingly, [Buscha 1989] does not assign any non-temporal meaning to *bevor* (before).

in the discourse marker lexicon is represented as attribute-value pairs. A lexicon entry in the discourse marker lexicon consists of a set of attribute-value pairs describing the properties of individual markers. Note that the set of relevant attributes and their possible values might differ between marker classes. For instance, the appropriate usage of temporal discourse markers requires knowledge of their constraints on tense and aspect, whereas concessive markers are sensitive to the communicative goals of a speaker. Therefore, I distinguish two broad classes of attributes:

- Attributes that hold for all discourse markers (general attributes).
- Attributes that are relevant to the description of a subset of discourse markers (marker-specific attributes).

This distinction corresponds to the traditional ‘genus’ and ‘differentia’ part of lexical entries. Marker-specific attributes mostly specify constraints on the linguistic environment of a discourse marker, whereas attributes relating to aspects of marker meaning are usually valid for all marker classes. Even though the attributes are generic, their possible instantiations often differ between marker classes. For example, the ideational (semantic) relation indicated by temporal discourse markers is a temporal relation, and not the entire set of semantic relations. Hence, the values for the ideational relation attribute of temporal markers can be restricted to a subset of possible relations.¹⁰

9.3.2.2 Discourse marker lexicon entries

Attributes and values to be used in the lexicon are based on dimensions influencing discourse markers that have been motivated in Chapter 5, and the proposal for a discourse level in Chapter 8. Additional attributes are inspired by the EAGLES recommendations for lexical semantic encoding [EAGLES Lexicon Interest Group 1999]. I propose the following set of attributes and values for the discourse marker lexicon (attributes applying to all discourse markers are given first; then, additional attributes specific to temporal markers will be listed):

Generic attribute-values pairs. Some attributes do not describe properties of discourse markers themselves but pertain to the organization of the lexicon, required for managing lexicon information (cf. [EAGLES Lexicon Interest Group 1999]):

- **Word-sense-id.** The unique identifier for a lexicon entry, usually the discourse marker plus—for ambiguous markers—a suffix indicating the reading, for instance *SOBALD-ANT* vs. *SOBALD-SIM* to distinguish between the anteriority and simultaneity reading of *sobald* (as soon as).

¹⁰Of course, temporal discourse markers frequently realize other semantic relations, for instance, a causal relationship (cf. Chapter 8). However, in this case the relation signaled to the reader is *not* the causal link, but a temporal one.

- **Orthography.** The lexeme that is described in the lexicon entry. Possible feature values are members of the set of discourse markers as identified using the tests for discourse markers (see Chapter 4).
- **Language.** The language the discourse marker belongs to: **German** or **English**.
- **Example.** A sample sentence illustrating the use of the discourse marker under consideration.

The remaining attribute-value pairs characterize aspects of discourse marker meaning and usage:

- **Semantic relation.** (Also ideational relation, see Chapter 8). The semantic relation indicated by a discourse marker can be any of the features from the ideational network depicted in Figure 8.2 in the preceding chapter. As such, the values are in a taxonomy. Semantic relations provide the link from the lexicon to the discourse level and the knowledge base. Note that for most discourse marker classes, only a subset of these relations is actually relevant. Note further that the values denote those relations that are made *explicit* by a discourse marker, and not just any relation that can be realized by a discourse marker.¹¹
- **Intention.** (Also interpersonal relation) The interpersonal contribution of a discourse marker. Values are those given by the coherence relation representation in Figure 8.2; there also exist hyponymy relations between the values. Interpersonal attributes relate discourse markers to the speaker's beliefs and goals.
- **Nuclearity.** The behaviour of a discourse marker with respect to the information status of the conjoined parts: Which part of the relation is presented as central information, which one as subsidiary? Values are also given in Figure 8.2: *S₀-nuclear*, *S₁-nuclear*, *multinuclear*.
- **Presupposition.** A discourse marker's sensitivity to what information has been introduced to the discourse and can thus be assumed as common knowledge. It refers to the reader's knowledge and beliefs (the reader model), as opposed to the speaker's state of mind, which the intention attribute does. In the present scenario, this attribute describes whether the relata containing the discourse marker (and thus serving as 'anchor') can be presupposed or not presupposed (values: **presupposed**, **not-presupposed**).
- **Status.** The external/internal distinction introduced by [Halliday and Hasan 1976, Martin 1992] (values: **external**, **internal**).

¹¹To illustrate this, consider a temporal discourse marker that is used to verbalize a causal relationship holding between two situations. While it can realize this relation, it does not make it explicit. The causal relationship is left implicit; only the temporal link is signaled on the surface.

Note that the **status** attribute is not given in the system networks, as each network as a whole is defined for either external or internal relations.

In large parts, the enumeration so far corresponds to the features listed under the heading ‘marker meaning’ in the discussion of factors influencing marker choice in Chapter 2. In my account, nuclearity is added, while the rhetorical relation slot is missing. The reason is that in my understanding, coherence relations are composite items made up from choices in the ideational, interpersonal and textual regions (cf. Chapter 8); this information renders a rhetorical relation slot superfluous.

Several attributes describe the constraints a discourse marker imposes on its linguistic environment. These constraints have already been discussed in detail in the sections on dimensions of marker description in Chapter 5 and are given as constraints on the realization of network choices in the functional representation of discourse markers (Chapter 7):

- **Part of speech.** (The word class of a discourse marker.) According to the test for discourse markers, possible values are conjunctive, pronominal adverb, coordinating conjunction, subordinating conjunction, and preposition (values: **conj**, **pronadv**, **coordc**, **subc**, **prep**).
- **Ordering.** The linear ordering of the related syntactic units. It can take the following values: **preposed**, **postponed**, **verb-first**, **topicalized**. I distinguish between possible orderings, and the preferred ordering, which is the most frequent ordering observed in the corpora.
- **Position.** The position of the discourse marker in the syntactic unit it belongs to. Possible values are **initial**, **front**, **middle**, **end**. Variation is only possible for conjunctives and pronominal adverbs.
- **Modification.** The use of adverbs to further specify the meaning of a discourse marker. Discourse markers can either allow for modification, or not (values: **modifiable**, **not-modifiable**).
- **Polarity.** The polarity of the relata containing the discourse marker. Possible values are **positive** and **negative**.
- **Hypothetical.** It describes whether the relata containing the discourse marker has to be a situation that has already been realized, or whether it can also denote an unrealized situation (values: **realized**, **unrealized**).

Again, several of these attributes have also been considered in research literature, see the list ‘syntagmatic constraints’ in Chapter 2, only the terminology used differs. Additional attributes such as type restrictions regarding the realization of two relata are put forward by [Dorr and Gaasterland 1995]. Yet, as these attributes are not of a generic nature, but are specific to marker classes, they will not be considered at this point.

Finally, it has been shown in Chapter 6 that discourse markers can display stylistic preferences, which can be captured by the following attribute-value pairs:

- **Formality.** The degree of formality of a discourse marker. I draw on Hovy's rhetorical predicates (see [Hovy 1988, p34]) for possible values: **highfalutin**, **neutral** and **colloquial**.
- **Usage.** The frequency of use. That is, whether the marker is used in every-day speech, is archaic, or rare (values: **neutral**, **archaic**, **rare**).
- **Brevity.** This attribute distinguishes between discourse markers that make a concise text possible, and all others (values: **concise**, **not-concise**).

A lexicon encoding the types of information listed above reconciles information from different sources such as discourse representation (comprising semantic relations and speaker's intentions), hearer's beliefs, lexical and syntactic constraints, and stylistic properties of discourse markers. When compared to other accounts of discourse markers that use an attribute-value-based representation, two aspects are worth mentioning. First, the set of attributes proposed in this thesis is more complex than any other list encountered in the literature. Usually, accounts focus on a small group of discourse markers, and on a particular kind of variation, hence they examine only a small set of attributes (for instance, [Elhadad and McKeown 1990, Dorr and Gaasterland 1995]). Second, this list is not just an accumulation of attributes found in research literature, as is usually the case in research that provides more comprehensive lists of features (see for instance [Stede and Umbach 1998]), but is motivated by a profound linguistic analysis of discourse markers. Finally, note that attributes relating to properties of the discourse structure such as a segment's emdeddedness in discourse and segment width, as given by [DiEugenio *et al.* 1997], are missing in my list. This is not surprising as those attributes are introduced in research on marker occurrence and placement; in an account of marker selection, which I aim at, they seem to be irrelevant.

Temporal-marker-specific attribute-value pairs. Most discourse markers have additional constraints on their usage associated with them, which are not yet covered by the generic attributes introduced above. These are mainly attributes characterizing the linguistic environment, and some type restrictions on semantic properties of the relata. These attributes and their values are specific to particular marker groups of semantically related discourse markers. In this thesis, I investigated temporal discourse markers (see Part II of this thesis), and identified several additional dimensions of marker description that have to be accounted for in order to provide an adequate representation in the discourse marker lexicon and hence to ensure a correct usage of temporal markers: Aktionsart, aspect and tense are additional means to signal temporality in text, and thus need to be described for temporal discourse markers. The additional attributes have been motivated extensively in the sections on dimensions of temporal marker description in Chapter 5:

- **Semantic relation.** Temporal markers signal temporal relations; these have been discussed in Chapter 6 and used in the temporal conjunctive relation networks. The values used to describe the temporal relation in the lexicon are extracted from the

temporal subbranch of Figure 8.2. These are **before**, **meets**, **during**, **overlaps**, **starts**, **finishes**, **equals**.

Additional constraints have been identified and used in the conjunctive relation networks that further specify the temporal relation. These are **prox**, **next** and **imm**, which enter the lexicon as values of the attribute **constraints**. Further, it has been shown that *bei* (with) requires the two situations to be located at the same place, which gives rise to an additional value **same-place**. The constraint *dur* relates to the property of one relatum only, and motivates an additional attribute **extension** with the values **dur** and **not-dur**. These constraints combine with the temporal relations to describe possible marker meanings.

- **Situation type.** This attribute relates to the boundedness of a situation and to whether it is a state, an activity or an event. Hence, two attributes are required to capture the properties of the situation: **situation-type** with the values **state**, **transition**, **mom-activity**, **prot-activity**, **mom-culmination**, **prot-culmination**, and their superconcepts (cf. Section 5.3) and **boundedness** with the values **lr-bounded**, **l-bounded**, **r-bounded**, **unbounded**. The boundedness has to be specified for Sit_m and Sit_s alike, whereas it is sufficient to describe the situation type of Sit_s , as the analysis of temporal discourse markers in Chapter 6 has shown.
- **Aktionsart.** At present, the lexicon supports a subset of the Aktionsarten given in [Bußmann 1990], namely **stative**, **transformative**, **semelfactive**, **iterative**, **durative** and **resultative**.
- **Aspect.** Grammatical aspect is encoded using the values **perfective** and **imperfective**.
- **Tense.** Tense constraints are expressed using Reichenbach's BTS notation [Reichenbach 1947], and define the legal ordering between the event times $E(Sit_m)$ and $E(Sit_s)$ of the situations conjoined by the discourse marker, and the speaking time S . This motivates the attributes **event-times** and **event-speaking-time**.

9.3.3 EAGLES-like representation of discourse markers

Following the EAGLES recommendations on lexical semantic encoding, the basic information units in the lexicon are word senses [EAGLES Lexicon Interest Group 1999]. As argued above, I restrict the entries to those word senses that can be distinguished on the linguistic surface.

Given the attribute-value pairs that characterize the facets of discourse marker meaning and usage as listed in the preceding subsection, I arrive at the following lexicon definition for discourse markers. In accordance with the EAGLES guidelines for lexical semantic standards, obligatory attributes are preceded by a dash (–), and the asterisk and the plus sign (*,+) are used to indicate an expansion of types (e.g. **semantic-relation**, **intention**) into 0,...,n and 1,...,n tokens. The vertical bar (|) indicates disjunction (cf. [EAGLES Lexicon Interest Group 1999, p272]).

```

discourse-marker-entry -->
  [-ORTHOGRAPHY: string
  -WORD-SENSE-ID: word-sense-id
  -LANGUAGE: (German | English)
  EXAMPLE: string
  -SEMANTIC-RELATION: ideational-relation*
  -INTENTION: interpersonal-relation*
  -NUCLEARITY: (So-nuclear | S1-nuclear | multinuclear)
  -PRESUPPOSITION: (presupposed | not-presupposed)
  -STATUS: (internal | external)
  PART-OF-SPEECH: (conj | pronadv | coordc | subc | prep)
  ORDERING: ordering-type*
  POSITION: position-type*
  MODIFICATION: (modifiable | not-modifiable)
  POLARITY: (positive | negative)
  HYPOTHETICAL: (realized | unrealized)
  -STYLE: stylistic-preferences
  SYNONYMS: word-sense-id*
  PLESIONYMS: word-sense-id*
  ANTONYMS: word-sense-id*
  HYPONYMS: word-sense-id*
  ]

```

A word sense identifier is a unique name of a word sense. I use the discourse markers from Tables 5.1 and 5.2—plus a suffix in case the marker is polysemous—as word sense identifier. For instance, *während* (while) has a temporal and an adversative reading, motivating two lexicon entries with the word sense identifiers *waehrend-temp* and *waehrend-adv*.

Semantic relation, intention and nuclearity link discourse markers to the discourse representation level. This information is encoded in terms of the features described in the coherence relation network in Figure 8.2 in Chapter 8 and the subsumption relation among them (the more fine-grained distinctions in the hierarchy of ideational and interpersonal relations are not reproduced at this point):

```

ideational-relation --> (occasion | expansion)

occasion --> [IDEATION: ideation-type
              POLARITY: (positive | negative)
              MODALIZATION: (realis | irrealis)
              MODALITY: (certain | possible)
              ]

ideation-type --> (additive | temporal | causal)
additive --> (conjunction | similarity)
temporal --> (preceding | co-occurring)
  preceding --> (before | meets)
  co-occurring ---> (equals | starts | finishes | overlaps | during)

```

```
causal --> [CONCESSION: (conceded | not-conceded)
            CAUSE-RELATION: cause
            ]
...

expansion --> (circumstance | elaboration)
  elaboration --> (object-attribute | general-specific)

interpersonal-relation -->
  [INTERPERSONAL-EXPANSION: expansion-type
   NUCLEUS-JUDGEMENT: (nuclear-positive | nuclear-negative | nuclear-neutral)
  ]
...
```

The remaining attributes characterizing discourse markers are defined as follows:

```
ordering-type --> (preposed | postponed | verb-first | topicalized)

position-type --> (initial | front | middle | end)

stylistic-preferences -->
  [FORMALITY: (highfalutin | neutral | colloquial)
   USAGE: (neutral | archaic | rare)
   BREVITY: (concise | not-concise)
  ]
```

As maintained in the preceding subsection, specific marker classes may require information that goes beyond the information encoded for all discourse markers. This mainly pertains to additional attributes classifying the linguistic environment. The lexicon entry for temporal markers is a subtype of the discourse marker entry defined above; it inherits all its attributes (`DISCOURSE-MARKER-INFO: discourse-marker-entry`), and encodes additional information. I assume default inheritance; values can be overwritten. I exclude multiple inheritance. Sometimes, it is required to distinguish between the situation denoted by the main clause (or the sentence containing the conjunctive) and the subordinate clause (or the first sentence if a conjunctive is involved, or the PP) (cf. Chapter 5). I use `SIT-M` and `SIT-S` to refer to the different situations. Some attributes can apply to main and subordinate clause separately; these have an `MC` or `SC` suffix to mark their scope.

```
temporal-marker-entry -->
  [-DISCOURSE-MARKER-INFO: discourse-marker-entry
   -SEMANTIC-RELATION: temporal-information*
   -BOUNDEDNESS-SIT-M: boundedness-type*
   -BOUNDEDNESS-SIT-S: boundedness-type*
   -SITUATION-TYPE: situation-type*
```


Chapter 10

Selecting discourse markers

This chapter proposes my strategy for selecting discourse markers in the context of text generation. The basic assumption is that discourse markers are best represented in a lexicon, and that discourse marker choice is best performed at the sentence planning stage using this lexicon. The feasibility of this approach is demonstrated by providing examples for alternative verbalizations of temporal coherence relations holding between two situations using the selection procedure and lexicon entries for temporal discourse markers provided.

The chapter starts with discussions on the place of the discourse marker lexicon and discourse marker selection in the overall text generation process (Section 10.1.1), and on the sentence planning task (Section 10.1.2). Next, Section 10.2 introduces the generation lexicon, and Section 10.3 outlines my strategy for selecting discourse markers, emphasising the choice of temporal connectives. Further, lexicon entries for German and English temporal markers are specified, following the discourse marker lexicon definition proposed in Chapter 9. To illustrate the approach, examples of the selection of temporal discourse markers are given in Section 10.4.

10.1 Background

10.1.1 Overview of the generation architecture

The generation framework I envision is a standard architecture comprising the three major stages of text planning, sentence planning, and surface generation (see also [Bateman 1998, Reiter and Dale 2000]). It is depicted in Figure 10.1, and is discussed in the remainder of this section. Grey boxes indicate the areas that are addressed in this thesis.

The **input** to the generation process is a representation of the facts to be verbalized, of the speaker's goals, of the hearer's beliefs, etc. The nature of the domain representation does not concern us here; only two aspects are important for the discussion in this chapter. First, for the representations of propositions (situations) I adopt the ontology described

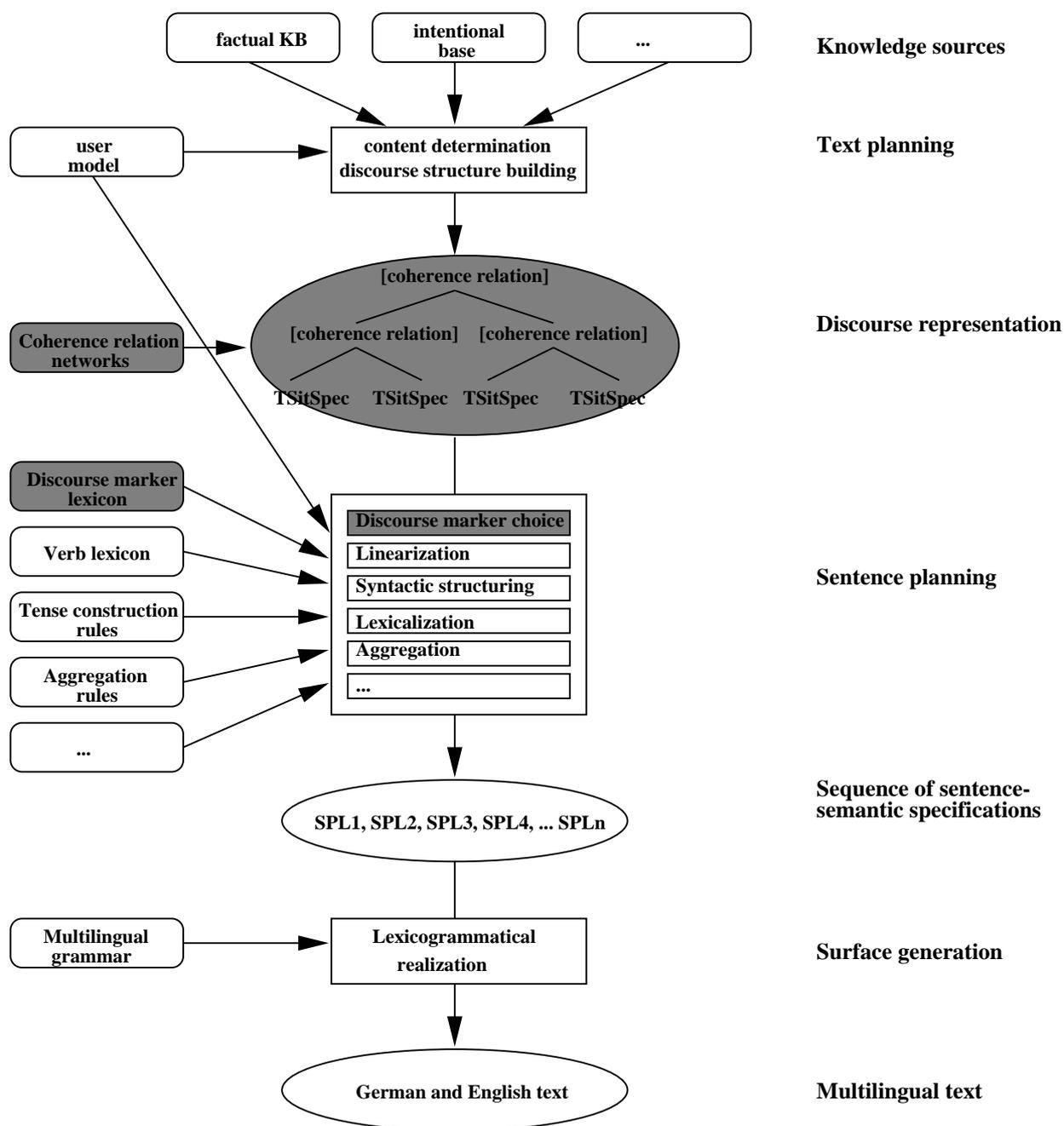


Figure 10.1: Generation architecture: Processing modules, data structures and knowledge sources

in [Stede 1999] and assume an extended type of his situation specifications (*SitSpecs*) that account for the temporal extension of situations, time-stamped situation specifications (*TSitSpecs*). These are—just like Stede’s *SitSpecs*—grounded in a factual knowledge base. More details on the *TSitSpec* representation are given in Section 10.3.1 below. Second, the factual knowledge base has to provide sufficient information to support the inference of ideational coherence relations (see below). Further knowledge sources include an intentional base, describing the speaker’s beliefs and goals, and a user model, covering the hearer’s beliefs and goals. In the present application domain, the production of technical instructional texts, an explicit representation of the speaker’s beliefs can be neglected, since I assume that the speaker believes in the facts s/he presents. The hearer’s beliefs, however, need to be accounted for, as they determine whether information can be presupposed or not, a fact that is crucial to discourse marker choice.

The **text planning module** of the generation process performs the two tasks generally ascribed to this component (see for instance [Reiter and Dale 2000, Bateman 1998, Moore and Paris 1993, Hovy 1993]): First, determining the content to be expressed in the text, and second, building the discourse structure. Both subtasks utilize the various knowledge sources introduced above. As a result of the text planning phase I envision a discourse representation as proposed in Chapter 8. This is represented as a discourse tree with a set of propositions, in my case *TSitSpecs*, as leaf nodes; internal nodes represent the composite coherence relations holding between their daughter nodes. In this thesis, I am not concerned with either of these planning tasks, but to complete the picture, a few remarks on building the discourse structure are in order. I do not assume that particular specifications are already present in some knowledge base but that they can be inferred if necessary from various knowledge bases (see also [Hovy 1993, Bateman and Rondhuis 1997]). For instance, the use of an ideational (semantic) relation can be determined by the presence of material related in a system’s factual knowledge base; the definitions of ideational relations in Chapter 8 give some ideas on how they can be mapped to knowledge base constructs. Interpersonal relations are inferred from the intention base. The output of the text planning module is a discourse structure tree as shown in Figures 8.5 and 8.7 in Chapter 8. Numbers in the tree correspond to discourse segments, and each segment corresponds to one underlying proposition, that is, one *TSitSpec*.

The **sentence planning module** takes a discourse structure as depicted in Figures 8.5 and 8.7, and transforms it into a sequence of lexicalized sentence-semantic specifications, such as *SemSpecs* [Stede 1999], based on SPL (Sentence Planning Language, [Kasper 1989]). Accordingly, sentence planning in this framework amounts to linearizing the discourse representation tree, drawing on a number of independent modules and resources, such as a lexicalization component and discourse marker choice module, various lexica, etc. (see Figure 10.1), which operate in flexible order. The next section introduces my ideas on the sentence planning step in more detail. This sequence of sentence-semantic specifications is passed on to a standard MLG front-end (**surface generator**) such as KPML [Bateman 1997] for realization in natural language, in my case in German and English. Possible target verbalizations of the input structure in Figure 8.7 are shown in Figure

[Warten]¹, bis [der Motor kalt ist]², dann [den Kühlerdeckel im Gegenuhrzeigersinn (drehen)]³ bis [zum Anschlag]⁴ (). BEIM [DREHEN]⁵ [DEN DECKEL NICHT NIEDERDRÜCKEN]⁶. Nachdem [der Druck abgelassen ist]⁷, [den Deckel (abnehmen)]⁸ durch [Niederdrücken]⁹ und [Drehen im Gegenuhrzeigersinn]¹⁰ (). [Kühlmittel nachfüllen]¹¹, bis [der Kühler voll ist]¹², dann [den Deckel wieder aufschrauben]¹³. [Fest andrehen.]¹⁴ [Den Reservetank bis zur oberen Pegellinie “MAX” (auffüllen)]¹⁵ bei [kaltem Motor]¹⁶ ().

[Wait]¹ until [the engine is cool]², then [turn the radiator cap clockwise]³ until [it stops]⁴. [DO NOT PRESS DOWN]⁶ WHILE TURNING THE CAP]⁵. After [any remaining pressure has been relieved]⁷, [remove the cap]⁸ by [pressing down]⁹ and [again turning it counterclockwise]¹⁰. [Add enough coolant]¹¹ to [fill the radiator]¹², and [reinstall the cap]¹³. [Be sure to tighten it securely]¹⁴. [Fill the reserve tank up to the max mark]¹⁵ with [the engine cold]¹⁶.

Figure 10.2: German and English realizations of the discourse tree (Text TC.25)

10.2.¹

10.1.2 Approach to sentence planning

There is broad agreement in the research literature that discourse marker choice should be performed in the sentence planning phase of the generation process: Discourse markers are regarded as lexical means that bridge the gap between discourse structure and the grammar, and as such they are part of the linearization process. However, current approaches to discourse marker choice have a number of shortcomings, as was pointed out in Chapter 2. To recapitulate, the major points of criticism are that the majority of present text generation systems realize the production of marker choice as a mere consequence of other sentence level decisions, that no flexible control is given, that the knowledge employed for discourse marker choice is not represented declaratively, and that systems only consider a subset of the sentence planning tasks.

These shortcomings motivate the approach to sentence planning adopted in this thesis:² Due to the interdependencies between discourse marker choice and other sentence planning decisions, as outlined in Chapter 9, any fixed order of making decisions in sen-

¹The text is reproduced from TC.25 of the technical instruction corpus (see Appendix A). Empty brackets () in the German text indicate the original position of the verb given in brackets. The verb has been moved in the text to avoid unconnected text segments.

²The ideas on a flexible sentence planner result from joint work with Manfred Stede; see [Grote and Stede 1998] for details.

tence planning will impose limitations on the expressiveness of a text generation system. Accordingly, I advocate a flexible order of decision-making, like the ones realized in a blackboard-based architecture (see DIOGENES [Nirenburg *et al.* 1989] and HEALTHDOC [Wanner and Hovy 1996]). The idea is that independent modules make decisions for the various sentence planning tasks, which are then ‘negotiated’ to find the best solution. For instance, one such module could be MOOSE, which takes care of lexicalization (and thus gives the Aktionsart of a verb) [Stede 1999], or a tense selection module similar to the one described in [Dorr and Gaasterland 1995] for English tenses, or in [Ehrich 1987] for simple German tenses. Sentence planning now involves interleaving discourse marker choice with the other generation decisions appropriately. Moreover, the individual modules or knowledge sources should rely on declarative representations as much as possible; otherwise the control process becomes unwieldy (compare the discussion in Chapter 9). One of the declarative sources of information is the lexicon that assembles specifically the information associated with discourse markers; other resources could be a verb lexicon, rules for constructing complex tenses, etc. (see Figure 10.1).

As mentioned in the preceding section, the input to the sentence planning module is a discourse structure tree containing coherence relation specifications as defined in Chapter 8 as non-terminal nodes, and situation specifications as leaf nodes (see Figure 10.5). In the remainder of this chapter I demonstrate how discourse markers are selected, that is, I specify the discourse marker selection module. Other sentence planning modules are not my present concern; for the time being I simply make assumptions about their decisions given the current state of the art. Examples for discourse marker selection using the strategies introduced serve to demonstrate the feasibility of the approach (cf. Section 10.4). Note further that at present, I am only concerned with the selection of discourse markers for pairs of situation specifications; thus issues related to linearizing an entire discourse tree, such as marker occurrence, can be neglected.

10.2 A generation lexicon for discourse markers

In this section, I discuss the organization of the generation lexicon for discourse markers, and propose lexicon entries for German temporal connectives and for a small set of English temporal markers.

10.2.1 Representing discourse markers for generation purposes

The goal in generation is to choose the most appropriate verbalization of a coherence relation in a given context.³ This task imposes a particular view on the information coded in a discourse marker lexicon: Attributes used to describe items in the discourse marker lexicon are to be classified with respect to when and where they come into play in the generation process. The entry point to the lexicon is the coherence relation to be signaled,

³The ideas presented in Section 10.2.1 are based on joint work with Manfred Stede, reported in [Grote and Stede 1998].

as provided by a discourse representation (see Chapter 8). Given a coherence relation, the lexicon lookup yields a range of alternatives, that is, the set of discourse markers that can realize this relation. Yet, many discourse markers have additional semantic and pragmatic constraints associated with them, as the analyses of discourse markers and their functional representation in Chapters 6 and 7 has shown. These conditions have to be verified in the input for the discourse marker to be a candidate.

Further, discourse markers also place syntactic and lexical constraints on their immediate linguistic context (see again Chapter 6 and the enumeration of constraints associated with individual discourse markers), which affect the interaction between discourse marker choice and other realization decisions. Finally, discourse markers that are still equivalent after evaluating all these constraints are subject to a choice process that utilizes stylistic criteria, such as the degree of formality, to select an appropriate discourse marker. These preferences do not affect the truth conditions of a discourse marker, instead, they differentiate between markers with the same truth conditions.⁴ From a generation perspective, these considerations lead to grouping the information coded in the discourse marker lexicon into the following three categories:

- **Applicability conditions.** The necessary conditions that need to be present in the input representation for the marker to be a candidate. Chiefly, this is the coherence relation to be expressed, and also (if applicable) attributes pertaining to presuppositions.
- **Combinability constraints.** The constraints that the marker imposes on its neighbouring linguistic constituents. These are syntactic constraints on subcategorization, ordering, and semantic type constraints, which interact with other realization decisions in sentence planning.
- **Preferences.** If preferential choice dimensions, such as style, brevity, etc., are attended to in the system, then these attributes serve to distinguish markers that are otherwise (nearly) synonymous.

Applicability conditions of a lexicon entry thus provide the link between discourse markers and discourse representation, as well as other knowledge sources such as user model and discourse history. Combinability conditions constrain the lexicogrammatical realization, and account for interactions between discourse marker choice and other generation decisions concerning the syntactic and lexical realization of an utterance, thus providing the link to the linguistic context. Finally, knowledge about the fine-grained differences between similar markers of the same relation is captured by the ‘preference’ attributes.

⁴The problems of imposing a strict sequence on generation decisions (pipeline architecture) have been discussed extensively in the text generation community. Despite its limitations, the pipeline architecture is widely used in NLG because it gives reasonable results at rather low cost.

10.2.2 Global organization of the lexicon

When aiming at a discourse marker lexicon with a comprehensive coverage of connectives, three additional questions arise: First, what are the criteria for creating a lexicon entry? Second, how does the lexicon account for the fact that discourse markers are not just a set of isolated lexical items, but that they are related systematically to one another? Third, how is multilinguality handled in the lexicon?

The first question has been discussed extensively in Section 9.3.1 and will not be repeated at this point as the arguments apply to the generation lexicon, too. The second issue concerns the relationships between individual lexicon entries. In the application-independent proposal for a discourse marker lexicon (Section 9.3.3) these relations motivated attributes in the lexicon entry definition. However, for the purpose of text generation, this information is not central: In my discourse marker lexicon, these relations are not represented explicitly, but can be inferred from the attribute-value sets for individual markers, that is, they can be defined as differences and similarities between the attribute-value sets. The horizontal lexical relations (cf. Section 9.3) hold if the following conditions are satisfied:

- Two discourse markers A and B are treated as **synonyms** if they display exactly the same applicability and preference attributes, and if all attributes have exactly the same value(s).
- Two discourse markers A and B are treated as **plesionyms** (near-synonyms) if they display exactly the same applicability attributes, and if they differ only in value instantiations from the preference zone.

The definition of the only vertical relation accounted for in the lexicon, the hyponymy relation, is less straightforward:

- Two discourse markers A and B are in a **hyponymy** relation if they share all the applicability attributes, but differ in attribute instantiations. For the diverging values, the following has to be true: Values for discourse marker A are more specific than the values for discourse marker B, in other words, the diverging values themselves have to be in a hyponymy relation (see also [Knott 1996, p73]).

A hyponymy relation between values is given in two cases: First, if one set of values is a subset of the other value set. A special case is if no values are specified for an attribute; then, any value may hold and this instantiation subsumes all more specific values. Second, if one value is a subtype of the other value. The underlying assumption here is that the values of some applicability attributes can be taxonomized. The definition of the discourse marker lexicon entry proposed in Section 9.3.3 gives taxonomies for the applicability attributes **semantic-relation**, **intention** and **situation-type**. The values for the other applicability attributes cannot be taxonomized.

Finally, there is the issue of multilinguality: The discourse marker lexicon is multilingual in that it contains lexicon entries for German and English discourse markers; the lexicon

entries themselves are monolingual. Attributes and values used to characterize discourse markers are mostly the same for different languages; language-specific values are introduced where necessary. An additional language attribute gives the language a discourse marker belongs to, at present, the choice is between English and German. Equivalences between discourse markers in different languages are defined as synonymy and plesionymy relations across language boundaries. As such, my lexicon differs from ‘inherently’ multilingual lexica, where lexicon entries themselves are multilingual, i.e. where a lexicon entry defines the properties of a word sense, which can have language-specific realizations.

10.2.3 Lexicon entry

Each lexicon entry in the generation lexicon for discourse markers consists of attribute-value pairs describing the properties of individual discourse markers. Each attribute belongs to one of the three zones of information introduced above, that is, applicability conditions, combinability constraints, and (stylistic) preferences. A fourth zone contains non-linguistic information such as the identifier of the lexicon entry, the lexeme, etc. Each attribute has a limited set of possible instantiations, its values. In general, attributes and values in the generation lexicon are the ones from Chapter 9. Differences relate to lexical relations which are not represented explicitly (see above). The remaining attributes are classified according to the four zones of lexicon entry organization posited for the generation lexicon (see Section 9.3.2 for a detailed discussion of attribute-value-pairs):

- **Non-linguistic properties.** This zone comprises the attributes *orthography*, *word-sense-id*, *language* and *example*.
- **Applicability conditions.** Applicability conditions in the lexicon are described using the following attributes: *semantic-relation*, *intention*, *nuclearity*, *pre-supposition*, *status*.
- **Combinability constraints.** Constraints on the lexicogrammatical environment of a discourse marker accounted for in the lexicon motivate the following attributes: *part-of-speech*, *ordering*, *position*, *modification*, *polarity*, *hypothetical*.
- **Preferences.** The lexicon supports the attribute *style*, which comprises three preferential attributes: *formality*, *usage*, *brevity*.

In Section 9.3.2 I identified additional marker-specific attributes that have to be described to give a complete picture of temporal markers. To recapitulate, these are:

- **Applicability conditions.** Only a subset of semantic relations is relevant to temporal markers: the temporal relation subbranch of the ideational network in Figure 8.2. Additional constraints have been identified and used in the conjunctive relation networks that further specify the temporal relation, motivating the attributes

constraints with the values `prox`, `imm`, `next` and `same-place`, and `extension` with the values `dur` and `not-dur`. Further, the attributes `situation-type` and `boundedness` are required.

- **Combinability constraints.** Aktionsart, aspect and tense are competing means to signal temporality in text, they interact with temporal marker choice. Attributes are: Aktionsart, aspect, event-times, and event-speaking-time.

10.2.4 Lexicon entries for temporal discourse markers

I am now in a position to propose lexicon entries for German temporal discourse markers. The lexicon entries follow the proposal for the definition of discourse marker lexicon entries put forward in Chapter 9, i.e. attributes and values are used as defined there. Of the two tasks in building such a lexicon, the task of accumulating the set of discourse markers to be represented in the lexicon has already been performed: The tests for discourse markers defined in Chapter 4 yield the set of lexical items to be included in a lexicon (see Table 5.5). The second task, determining values for individual temporal markers and thus providing lexicon definitions, is addressed in this chapter. As I am interested in multilingual generation, I also include some English temporal discourse markers. However, since English temporal markers are not my major concern, I rely on available work on English temporal markers, in particular [Martin 1992, Hitzeman 1995, Dorr and Gaasterland 1995] for specifying the values. Because of this approach, lexicon entries for English temporal connectives may occasionally be incomplete, as the three sources do not always supply the detailed information.

Tables 10.1 to 10.3 give the lexical entries for nine German temporal markers, the anterior markers *nachdem*, *nach*, *danach*, *sobald*, *kaum dass*, *seitdem* (after, after (P), afterwards, as soon as, no sooner than, since), the posterior *bevor* (before) and the simultaneity markers *während* (while) and *solange* (as long as). Such lists of attribute-value pairs have been derived for all markers in Table 5.5 in Chapter 6. The complete set of lexicon entries for German temporal discourse markers is given in Appendix B.

Tables 10.4 and 10.5 present the lexicon entries for the six English temporal discourse markers discussed in [Hitzeman 1995], which are also addressed in [Dorr and Gaasterland 1995] and covered by [Martin 1992]: *after*, *since*, *before*, *until*, *while* and *when*. These are only a subset of the temporal markers identified in English technical instructions (cf. Table 5.2 in Chapter 5). In Chapter 7, when comparing the functional classifications of German and English temporal markers, I argued that the language-specific classifications correspond in less delicate regions, and differ only with respect to the more fine-grained choices. Further, I showed that oppositions are the same: The English account does not introduce oppositions, i.e. systems, that are not present in the German account. In other words, to capture the usage conditions of English temporal markers, no additional sets of discriminating features are required on top of the ones given in the German networks. Thus, it seems to be reasonable to adopt the attributes used in the lexicon entries for German temporal discourse markers—based on the functional classification—for English lexicon entries. Note,

however, that although mostly equivalent, values occasionally differ. This only concerns the combinability zone of the lexicon entry, where constraints on the linguistic environment of the temporal marker are defined. For instance, the ‘English’ values are different for the **aspect** attribute, as English has a more elaborate aspect system, including the simple/progressive dichotomy (see [Dorr and Gaasterland 1995]). As lexical relations are defined in terms of the applicability conditions, different value sets in the combinability zone do not affect definitions of synonymy or hyponymy between lexicon entries.

10.2.4.1 Notational conventions

The notational conventions stated in Section 9.3.3 apply to the lexicon entries proposed in this chapter. Additionally, the following conventions hold: For markers that impose no constraint for a particular attribute, the corresponding slot in the lexicon entry remains empty. This could also be represented as a disjunction of all possible values. Note that in this case the temporal marker can be used with any of the values, but makes no specific one explicit. If only a subset of the possible values may hold, and if they are exclusive, they are given as disjunctions (indicated by the vertical bar |). For reasons of readability, I use NOT <value> for cases where all but one value may hold for a given marker, instead of listing all the ones that may hold. If an attribute slot has an entry, then the value (or one of the values) given in the slot, or a more specific value subsumed by the value under consideration, has to hold for the marker to be applicable. As mentioned above, hyponymy relations hold within value sets; these have been defined in the specification of lexicon entries for discourse markers in Sections 9.3.2 and 9.3.3.

10.2.4.2 Derivation of values

Values for individual temporal markers have been assigned on the basis of the thorough analysis of German temporal discourse markers and the temporal conjunctive relation networks presented in Chapters 6 and 7, and the proposal for a coherence relation network in Chapter 8. On a rather general level, the relation between the analysis of discourse markers and the proposal for a discourse representation on the one hand, and the lexicon entries for temporal discourse markers on the other hand is as follows.

The functional representation of temporal conjunctive relations and their realizations (the discourse markers) as described in Chapter 7 motivate attributes and values in the generation lexicon. Relevant information is of two kinds:

- **Factors that determine the path.** The reasons for choosing a particular path through the system network from the root system to a feature that has an associated realization (a discourse marker) provide the values for the applicability conditions of a lexicon entry. Knowledge sources that guide the path through the network are, among others, user model, discourse history, discourse segments, assumptions about the hearer (described as presuppositions) and most prominently, the coherence relation holding between two discourse segments (cf. Chapter 8). These properties

Attribute	Values	Values	Values
WORD-SENSE-ID ORTHOGRAPHY LANGUAGE	nachdem-ant nachdem German	nach-temp nach German	danach danach German
TEMPORAL-RELATION CONSTRAINTS EXTENSION INTENTION NUCLEARITY	before meets prox S_1 -nuclear	before meets prox S_1 -nuclear	before meets prox S_1 -nuclear multinuclear
PRESUPPOSITION STATUS BOUNDEDNESS-SIT-M BOUNDEDNESS-SIT-S SITUATION-TYPE	presupposed external l-bounded lr-bounded r-bounded lr-bounded	presupposed external l-bounded lr-bounded r-bounded lr-bounded	presupposed external l-bounded lr-bounded r-bounded lr-bounded
PART-OF-SPEECH ORDERING POSITION MODIFICATION POLARITY HYPOTHETICAL AKTIONSART-MC AKTIONSART-SC ASPECT-MC ASPECT-SC EVENT-TIMES EVENT-SPEAKING-TIME	subc front modifiable positive realized imperfective perfective E-Sits_E-Sitm E-Sits_S	prep front modifiable	pronadv preposed front modifiable positive realized E-Sits_E-Sitm E-Sits_S
FORMALITY USAGE BREVITY	neutral not-concise	neutral not-concise	neutral not-concise

Table 10.1: Lexicon entries for the German temporal markers *nachdem*, *nach* and *danach*

Attribute	Values	Values	Values
WORD-SENSE-ID ORTHOGRAPHY LANGUAGE	sobald-ant sobald German	kaum-dass kaum dass German	bevor-post bevor German
TEMPORAL-RELATION CONSTRAINTS EXTENSION INTERP.-EXPANSION NUCLEUS-JUDGEMENT NUCLEARITY PRESUPPOSITION STATUS BOUNDEDNESS-SIT-M BOUNDEDNESS-SIT-S SITUATION-TYPE	before meets prox imm next regard nuclear-negative S_1 -nuclear presupposed external l-bounded lr-bounded r-bounded lr-bounded	before meets prox imm next S_1 -nuclear presupposed external l-bounded lr-bounded r-bounded lr-bounded	before meets prox S_0 -nuclear presupposed external r-bounded lr-bounded l-bounded lr-bounded
PART-OF-SPEECH ORDERING POSITION MODIFICATION POLARITY HYPOTHETICAL AKTIONSART-MC AKTIONSART-SC ASPECT-MC ASPECT-SC EVENT-TIMES EVENT-SPEAKING-TIME	subc front not-modifiable imperfective perfective E-Sits_E-Sitm	subc front not-modifiable imperfective perfective E-Sits_E-Sitm	subc front modifiable not durative imperfective E-Sitm_E-Sits E-Sitm,E-Sits
FORMALITY USAGE BREVITY	neutral not-concise	neutral not-concise	neutral not-concise

Table 10.2: Lexicon entries for the German temporal markers *sobald*, *kaum dass* and *bevor*

Attribute	Values	Values	Values
WORD-SENSE-ID ORTHOGRAPHY LANGUAGE	seitdem-ant seitdem German	waehtend-temp wahrend German	solange solange German
TEMPORAL-RELATION CONSTRAINTS EXTENSION INTENTION NUCLEARITY PRESUPPOSITION STATUS BOUNDEDNESS-SIT-M BOUNDEDNESS-SIT-S SITUATION-TYPE	before meets prox imm next dur S_1 -nuclear presupposed external l-bounded lr-bounded r-bounded lr-bounded	equals during finishes overlaps starts S_0 -nuclear S_1 -nuclear presupposed external r-bounded lr-bounded	equals finishes S_0 -nuclear S_1 -nuclear presupposed external r-bounded lr-bounded
PART-OF-SPEECH ORDERING POSITION MODIFICATION POLARITY HYPOTHETICAL AKTIONART-MC AKTIONART-SC ASPECT-MC ASPECT-SC EVENT-TIMES EVENT-SPEAKING-TIME	subc front not-modifiable realized not resultative semelfactive transformative imperfective perfective E-Sits_E-Sitm E-Sits_S	subc front not-modifiable positive stative durative iterative E-Sits,E-Sits	subc front not-modifiable positive not resultative stative durative iterative imperfective E-Sits,E-Sitm E-Sits_S E-Sits,S E-Sitm_S
FORMALITY USAGE BREVITY	neutral not-concise	neutral not-concise	neutral not-concise

Table 10.3: Lexicon entries for the German temporal markers *seitdem*, *wahrend* and *solange*

Attribute	Values	Values	Values
WORD-SENSE-ID ORTHOGRAPHY LANGUAGE	after-post after English	since-temp since English	before-post before English
TEMPORAL-RELATION CONSTRAINTS EXTENSION INTENTION NUCLEARITY PRESUPPOSITION STATUS BOUNDEDNESS-SIT-M BOUNDEDNESS-SIT-S SITUATION-TYPE	before S_1 -nuclear presupposed external	meets before dur S_1 -nuclear presupposed external r-bounded	before S_0 -nuclear presupposed external
PART-OF-SPEECH ORDERING POSITION MODIFICATION POLARITY HYPOTHETICAL AKTIONSART-MC AKTIONSART-SC ASPECT-MC ASPECT-SC EVENT-TIMES EVENT-SPEAKING-TIME	subc front modifiable positive	subc front not-modifiable realized not resultative perfective	subc front modifiable
USAGE FORMALITY BREVITY	neutral not-concise	neutral not-concise	neutral not-concise

Table 10.4: Lexicon entries for the English temporal markers *after*, *since* and *before*

Attribute	Values	Values	Values
WORD-SENSE-ID ORTHOGRAPHY LANGUAGE	until until English	while-temp while English	when-ant when English
TEMPORAL-RELATION CONSTRAINTS EXTENSION INTENTION NUCLEARITY PRESUPPOSITION STATUS BOUNDEDNESS-SIT-M BOUNDEDNESS-SIT-S SITUATION-TYPE	meets S ₀ -nuclear presupposed external l-bounded	equals during overlaps finishes starts dur S ₀ -nuclear S ₁ -nuclear presupposed external	meets equals during finishes starts dur S ₀ -nuclear S ₁ -nuclear presupposed external mom.activity mom.culmination transition
PART-OF-SPEECH ORDERING POSITION MODIFICATION POLARITY HYPOTHETICAL AKTIONSART-MC AKTIONSART-SC ASPECT-MC ASPECT-SC EVENT-TIMES EVENT-SPEAKING-TIME	subc front modifiable positive realized not resultative	subc front not-modifiable positive	subc front not-modifiable positive semelfactive transformative
FORMALITY USAGE BREVITY	neutral not-concise	neutral not-concise	neutral not-concise

Table 10.5: Lexicon entries for the English temporal markers *until*, *while* and *when*

have been specified for individual markers in Chapter 6 and are included in the temporal conjunctive relation networks given in Chapter 7. The derivation of values for attributes of the applicability zone will be discussed in more detail below.

- **Constraints.** Constraints associated with a particular realization of the selection expression enter the lexicon as combinability conditions and preferences. Combinability conditions are simply read off the conjunctive relation networks. They are given by the constraints associated with the lexical realizations of features in the functional representation of discourse markers. The same holds for attributes of the preference zone.

To illustrate how values in the lexicon are motivated, consider the two markers *solange* (as long as) and *kaum dass* (no sooner than). The system network depicted in Figure 7.6 gives the following two selection expressions for *solange*:

1. [simultaneous:co-extensive:neutral:genuine-ending]
2. [simultaneous:overlapping:neutral:inclusion:prospective]

They describe the paths through the conjunctive relation network from the entry feature [temporal] to the features that have *solange* as realization ([genuine-ending] and [prospective]). Regarding the first selection expression, [simultaneous] and [co-extensive] define the type of temporal relation signaled by *solange*; [simultaneous] is introduced to differentiate between the broad classes of temporal markers. [Co-extensive] describes the specific type of temporal relation indicated by *solange*; this feature is selected if the coherence relation EQUALS holds.⁵ The relation is neutral with respect to nuclearity, i.e. both situations can act as nucleus. Here are the corresponding values for the lexicon entry for *solange*:

TEMPORAL-RELATION: equals
 NUCLEARITY: S0-nuclear|S1-nuclear

[Neutral] and [genuine-ending] constrain the situation type; the situation depicted in *Sit_s* has to have a right boundary. These features in the system network are selected if there exist no type constraints regarding the situation, and if it has a genuine ending. This motivates the following values:

BOUNDEDNESS-SIT-M:
 BOUNDEDNESS-SIT-S: r-bounded|lr-bounded
 SITUATION-TYPE:

The features of the second selection expression (except for [neutral]) all relate to the temporal relation expressed by *solange*; this path is chosen if the ideational component of the coherence relation is FINISHES, which gives rise to a second value for TEMPORAL-RELATION:

⁵The argument here is that the terminal features of the coherence relation networks are sufficient to describe the temporal relations; features on the path from the root to the leaf features do not add any information, and hence can be neglected in the specification of temporal relations.

TEMPORAL-RELATION: equals|finishes

For both marker readings, nuclearity, intention, constraints, and temporal extension are not specified in the network. Two additional features that I believe belong to the applicability zone (as they are determined by the context) are not described in the network: presuppositions and status. I argued above that all temporal markers require Sit_s to be shared knowledge, hence the value **presupposed** holds for *solange* and *kaum dass*. The status is defined for the entire network as external.

Here are the resulting values for the applicability attributes of *solange*, following the lexicon entry definition for discourse markers put forward in Chapter 9:

TEMPORAL-RELATION: equals|finishes
 CONSTRAINTS:
 EXTENSION:
 INTENTION:
 NUCLEARITY: S0-nuclear|S1-nuclear
 PRESUPPOSITION: presupposed
 STATUS: external
 BOUNDEDNESS-SIT-M:
 BOUNDEDNESS-SIT-S: r-bounded|lr-bounded
 SITUATION-TYPE:

Arriving at the values for the attributes of the combinability zone is a straightforward task. The combinability constraints can be read off the constraints associated with this particular realization; here, the system network refers to the usage conditions specified in the Table **solange** in Chapter 6:

verb denoting Sit_s is stative, durative or iterative
 verb denoting Sit_m is not resultative
 clause denoting Sit_s has an imperfective aspect
 same tense; $E(Sit_s) = E(Sit_m)$ where $E(Sit_s) < S$ and $E(Sit_m) < S$
 hypotactic clause complex, subordinate conjunction
 discourse marker takes front position and cannot be modified

The usage conditions can be expressed in terms of the attribute-values pairs defined for the combinability zone of temporal marker lexicon entries (cf. Chapter 9). Some attributes have no value as no usage conditions are specified:

PART-OF-SPEECH: subc
 ORDERING:
 POSITION: front
 MODIFICATION: not-modifiable
 POLARITY: positive
 HYPOTHETICAL:

AKTIONSART-MC: not resultative
 AKTIONSART-SC: stative|durative|iterative
 ASPECT-MC:
 ASPECT-SC: imperfective
 EVENT-TIMES: E-Sits,E-Sitm
 EVENT-SPEAKING-TIME: E-Sits_S|E-Sits,S|E-Sitm_S

Table 10.3 shows the complete lexicon entry for *solange*, including preferences.

To give a second example, consider the selection expressions for *kaum dass* as defined in Figure 7.4:

1. [anterior:following:neutral:immediacy:nondeictic:negative-regard]
2. [anterior:following-immediately:adjacency:nondeictic:negative-regard]

The selection expressions describe the temporal relation and the intention signaled by *kaum dass*; these are again described in the lexicon in terms of the features used in the coherence relation networks. Note that [anterior] results from ideational and textual properties of the coherence relation: the ideational relation is part of the PRECEDING branch, the nuclearity is S_1 -NUCLEAR. The selection expressions give rise to the following values for the applicability attributes of *kaum dass*:

TEMPORAL-RELATION: before|meets
 CONSTRAINTS: imm next
 EXTENSION:
 INTERPERSONAL-EXPANSION: regard
 NUCLEUS-JUDGEMENT: nuclear-negative
 NUCLEARITY: S_1 -nuclear
 PRESUPPOSITION: presupposed
 STATUS: external
 BOUNDEDNESS-SIT-M: l-bounded|lr-bounded
 BOUNDEDNESS-SIT-S: r-bounded|lr-bounded
 SITUATION-TYPE:

Again, combinability constraints can be read off the constraints associated with the features in the system network depicted in Figure 7.4 that have *kaum dass* as realizational consequence. They are:

verb denoting Sit_m is not stative
 tense sequence; $E(Sit_s) < E(Sit_m)$ where $E(Sit_s) < S$ and $E(Sit_m) < S$
 hypotactic clause complex, subordinate conjunction
 preferred ordering is preposed
 discourse marker takes front position and cannot be modified

Table 10.2 gives the complete lexicon entry for *kaum dass*.

As already stated above, I have not performed a detailed analysis of English temporal markers, but instead rely on available functional representations [Martin 1992, Hitzeman 1995] and on studies of the linguistic environment of temporal connectives such as the one by [Dorr and Gaasterland 1995] for building lexicon entries for the English temporal discourse markers given in Tables 10.4 and 10.5. Although this is not a theoretically sound approach for achieving fully specified lexical entries, it is sufficient for the goals of this thesis, i.e. to illustrate the multilingual potential of the lexicon and of the discourse marker selection procedure

10.2.4.3 Lexicon relations and descriptive adequacy

Having explained the principles for deriving values for individual temporal marker lexicon entries, let us now look at the resulting lexicon entries more closely (as given in Tables 10.1 to 10.5 and in full in Appendix B) and examine the type of relations holding between lexicon entries, i.e. the internal structure of the lexicon, and the adequacy of the description provided by individual lexicon entries. In the discussion I focus on the German part of the lexicon because there is not much to be said about the English lexicon entries, as they are not based on a thorough analysis of temporal marker properties.

Regarding the lexical relations holding between discourse markers, synonymy and hyponymy relations are frequent, whereas there occurs no instance of an antonymy relation in the context of temporal markers. According to my definition of synonymy, *sobald* and *sowie* are synonyms, also *davor* and *bevor* (as they differ only in combinability constraints). *Bevor* and *ehe*, on the other hand, are near-synonyms as they display different preferences. The lexicon entries given in Tables 10.1 to 10.3 show several instances of the hyponymy relation: *kaum dass* is a hyponym of *sobald*, as it is more specific regarding the intention signaled (values **regard** and **nuclear-negative**), whereas *sobald* has no entry for the intention attribute. Likewise, *solange* is more specific than *während*, as the semantic relation values of *solange* are a subset of those defined for *während*. Further, *sobald* is in a hyponymy relation with *nachdem*, since the temporal relations signaled by *sobald* are more specific than the relation expressed by *nachdem*: The **constraints** characterizing *sobald* are a subset of those characterizing *nachdem* (cf. lexicon entries in Tables 10.1 to 10.3).

Let us now consider the differences between marker entries more closely. Interestingly, discriminating features between markers belong to different zones depending on the marker class, i.e. on whether a marker signals a simultaneity, anteriority or posteriority relation. The major differences between lexicon entries for German temporal markers of the anterior and posterior groups concern the kind of temporal relation they signal, i.e. they relate to the applicability conditions, while there is only little variation in combinability constraints apart from syntactic differences such as ordering and syntactic category. Either no values are given for a combinability attribute, as is true for Aktionsart and polarity, or the values are the same, such as in the case of aspect. In contrast, simultaneity markers mostly show variation in combinability constraints (mainly Aktionsart).

Most temporal discourse markers display a rich set of combinability constraints, indeed,

some lexicon entries for German temporal connectives might appear to be over-constrained regarding the restrictions on the linguistic (that is, lexical and syntactic) environment. Often, examples for other ‘constellations’ of values and thus linguistic environments for a given discourse marker can be constructed which contradict the constraints given in Tables 10.1 to 10.3. Still, as my goal is the selection of discourse markers, to be more precise, the selection of discourse markers that signal a given relation *unambiguously*, my constraints aim at clearly separating one marker meaning from another, and thus to unambiguously indicate a coherence relation. Further, I understand my discourse marker lexicon as reflecting temporal marker *usage*, not just theoretical considerations. The actual instantiations of attributes (i.e. the values) are based on an extensive analysis of examples, and usually reflect the most frequent usage. Therefore, they might sometimes deviate from theoretical accounts based on intuition and introspection only, which describe a wider range of possible instantiations.

From a generation perspective, these ‘strong’ constraints are justifiable as the goal is to signal a given coherence relation as unambiguously as possible. Constraints on the linguistic environment that aim at clearly separating between marker meanings help to ensure the production of surface structures that are unambiguous, i.e. to choose discourse markers and realize lexical and syntactic constraints that leave no space for the interpretation of the meaning of a particular marker. In contrast, from an understanding perspective, this approach is over-constrained, as it would presumably miss occurrences of temporal discourse markers in text.

Finally note that Tables 10.1 to 10.5 contain representation-neutral descriptions of the lexicon entries only; the formal representation depends on the actual sentence planner used in text production.

10.3 Selecting temporal discourse markers

10.3.1 Ontological definitions

Before turning to discourse marker selection as such, some ontological definitions are required. As mentioned above, for defining the input structures to the generation framework, I build upon the ontology of situation specifications (SitSpecs) used by [Stede 1999] in the MOOSE sentence generator. The major part of the hierarchy of SITUATIONS, shown in full in Figure 10.3, has already been discussed in Chapter 5. However, this hierarchy and the situation specifications do not meet the requirements of discourse marker selection in two ways: The situation types do not account for the boundedness of situations, which has been identified in Chapter 5 as one dimension of temporal discourse marker description, nor do they comprise temporal information concerning their begin and end points, which is crucial when dealing with temporal markers (see again Chapter 5). Two extensions are thus needed: to introduce additional categories to the ontology, and to augment the input representation used for the generator with time-stamps.

Let us first consider the situation type hierarchy and how different situations are defined

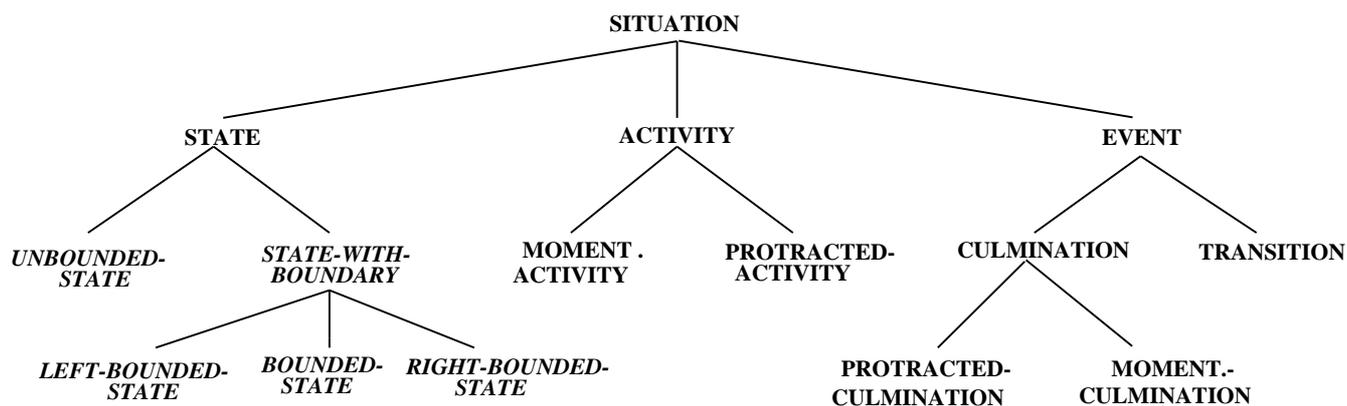


Figure 10.3: Extended situation type ontology

regarding their boundedness. Concerning STATES, [Bach 1986] distinguished between static and dynamic ones, which for the purposes of [Stede 1999] was not relevant nor required here. However, I need to introduce the additional distinctions concerning boundedness, in response to the observations by [Sinn 1991] (see Chapter 5). The boundedness dimension states whether a situation has 0, 1, or 2 *inherent* temporal limits, and given one inherent limit, whether it relates to the begin or the end point. This leads to corresponding subtypes of STATE. An example for an unbounded one (where a *from* <time> *to* <time> clause would make no sense) is *The earth is round*. A left-bounded state does not have a right boundary, that is, a contrary state cannot hold after its termination (see [Sinn 1991]). Hence, an *until* <time> clause cannot be added: *?Jim was dead until Sunday*. The inverse holds for a right-bounded state, and for a bounded state, both left and right boundaries can be present in a sentence. The remainder of the taxonomy is taken from [Stede 1999] (as in Chapter 5) as all other situation types have inherent boundaries, and so do not need to be defined explicitly: I take all activities to be bounded. Like activities, events are always bounded: a plain TRANSITION can only involve bounded states, and a CULMINATION can happen *from* <time> or *until* <time>. The extended situation type hierarchy is depicted in Figure 10.3; additions to [Stede 1999] are given in italics.

This general ontological system [Stede 1999] allows to define a domain model that holds the concepts relevant for representing situations and that specifies the exact conditions for their well-formedness. A network of instances of domain model concepts (the SitSpecs) forms the input to the sentence generator. In order to enable a principled selection of temporal markers, the original SitSpecs need to be augmented with time-stamped annotations. For present purposes, it is sufficient to use rather coarse-grained values and thus I simply take the numbers 1 to 12 as possible time-stamps. Then, STATES can have slots for begin- and end-time, depending on their boundedness. The three momentaneous situations have a single time-stamp; in the case of the TRANSITION, it marks the end of the pre-state and the beginning of the post-state, which are identical. A PROTRACTED-ACTIVITY can have begin- and end-time, and these carry over to a CULMINATION, i.e., the time-stamps of the embedded activity are the time-stamps of the entire culmination (which are identical with

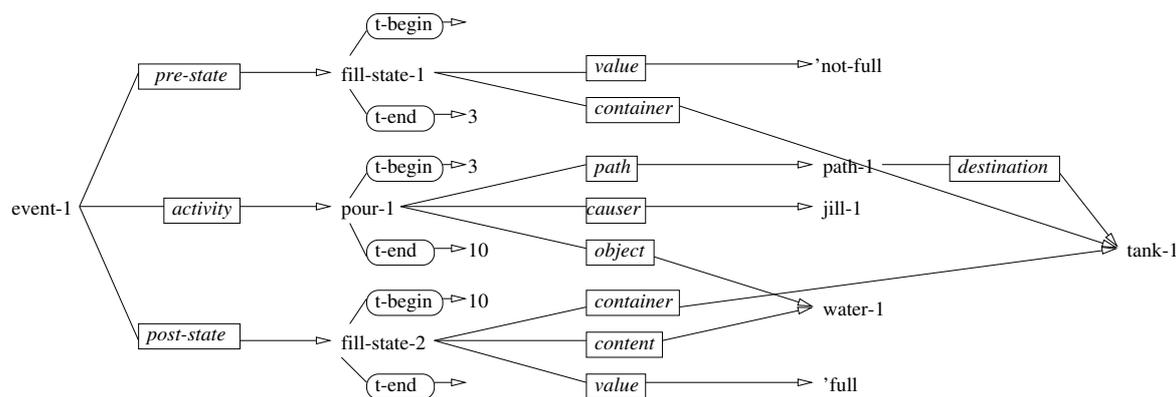


Figure 10.4: TSitSpec representing a fill-event lasting from 3 to 10

the end of the pre-state and the beginning of the post-state).

To reflect the extensions with temporal information, I call these augmented structures *TSitSpecs*. In analogy to *SitSpecs*, the root node of any *TSitSpec* is of type *SITUATION*. As an example, the *EVENT* of a person named Jill filling a tank with water is shown in Figure 10.4 in a graphical description logic notation, with relation names shown in boxes. The event combines the activity of Jill pouring water into the tank with the fill-state of the tank changing to full. The slots *t-begin* and *t-end* give the temporal extension of the situation parts, here, from 3 to 10. A verbalization of this event can emphasize either of these aspects. The idea is that denotations of verbs correspond to the structure of the event, which thus identifies the *Aktionsart* of the verb (in straightforward cases where no aspectual composition is involved): For instance, an *ACTIVITY* is expressed by a durative verb, a *TRANSITION* by a semelfactive one, a *PROTRACTED CULMINATION* by a resultative one (see [Stede 1999]).

10.3.2 General procedure for selecting discourse markers

In this section, I outline the procedure for selecting a (set of) discourse marker(s) that adequately signal(s) the coherence relation holding between given situations. The overall task of the discourse marker selection module can be described as follows: For individual non-terminal nodes in the discourse representation tree (denoting coherence relations), determine the lexicalization options (discourse markers) given a number of knowledge sources, most importantly the discourse tree, factual knowledge base, discourse marker lexicon, and decisions by other sentence planning modules. Note that this task resembles the general lexical choice task, as for instance, discussed in [Elhadad 1992] and [Stede 1999] for content words.

At present, my work is restricted to the verbalization of single coherence relations, only. Thus, at this stage of the research, the input to the procedure is a small fragment of the

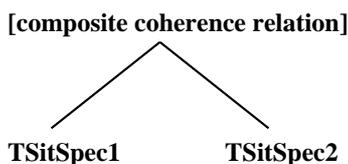


Figure 10.5: Input structure to the discourse marker selection procedure

entire discourse representation tree, namely one non-terminal node denoting a coherence relation linking leaf nodes, i.e. two TSitSpecs. Figure 10.5 gives the generic structure of the input representation.⁶

10.3.2.1 General outline

Given two TSitSpecs conjoined by a coherence relation, the steps in the discourse marker selection procedure are:

- **Determine set of candidate markers.**

The task is to find all verbalization options for discourse markers, i.e. those lexemes that can potentially signal the coherence relation. The lexicon is entered with the coherence relation and the situations given by the input representation. This information is mapped against the applicability conditions of a discourse marker lexicon entry; and the set of markers that can signal the coherence relation is returned. Discourse markers have additional semantic and pragmatic constraints associated with them, which are also given in the applicability condition zone of the lexicon entry. These conditions, such as presuppositions and semantic type constraints, also have to be verified by drawing on the different knowledge sources, such as user model, factual knowledge base, for the discourse marker to remain a candidate. In short, at this stage, the lexicon lookup yields a range of alternatives whose applicability conditions are satisfied.

- **Choosing among candidate markers.**

The set of candidate markers is entered with the preferred syntactic and lexical constraints as given by other sentence planning modules; e.g. syntactic structure, ordering of situations, tense, etc. In other words, the syntagmatic constraints associated with verbalization options are evaluated. Recall that I assume that this evaluation

⁶Eventually, the input to the discourse marker selection procedure will be two subtrees conjoined by a coherence relation, where the subtrees can either contain terminal nodes, i.e. TSitSpecs, or can be coherence relations. Yet, as [Marcu 1996] claims, whenever two large discourse spans are connected through a coherence relation, this relation also holds between the most salient parts, i.e. the nuclei, of the relata. This implies that the most prominent TSitSpec of a subtree (the ‘promoted’ nucleus) will be the one on which the selection procedure operates, and which will be used to determine semantic constraints. Assuming this, the restriction on the input to a coherence relation holding between two TSitSpecs is not that far-fetched.

is not a one-way process, but works in both directions: Sentence planning modules propose constraints that have to be met by the discourse markers; likewise, the discourse marker itself imposes constraints on the linguistic environment, which might yield a linguistic realization that is not the first choice for another sentence planning module. In brief, I regard choosing among the candidate markers as a process of negotiating between the demands of different sentence planning modules, where decisions are made in flexible order (cf. Section 10.1.2 above). Such a mechanism is required to ensure flexible and efficient sentence planning, yet, as this is not the topic of my research, I will not go into further details on this question, but simply assume its existence.

- **Preferential choice among equivalent markers.**

Markers that are still equivalent after these two steps are subject to a choice process that utilizes stylistic (preferential) criteria. These preferences come into play in the sentence generation phase to choose among equivalent markers (synonyms or near-synonyms).

The first two tasks fall into the realm of sentence planning, task three is taken care of by the surface generator.

Matters are more complicated than suggested by these three steps, because they build on the ideal case that there always exists a discourse marker that meets all conditions imposed by the input representation and that satisfies all constraints given by the linguistic environment. Yet, it might also be the case that no discourse marker applies, and that the set of candidate discourse markers is empty for a particular input representation and linguistic environment. In other words, no discourse marker seems to exist that exactly expresses a given coherence relation, or no linguistic environment can be constructed that is compatible with the constraints imposed by the candidate marker.

A rather straightforward solution to this dilemma would be not to use a discourse marker at all, and simply conjoin the two sentences or clauses by means of a full stop. However, this leaves information implicit and opens up space for all kinds of interpretations on top of the intended one. A better solution would be to employ a linguistic means that at least verbalizes part of the intended meaning, for example, by selecting the discourse marker that covers most of the conditions imposed by the input structure. In terms of the three tasks introduced above, this means the following: In a first step, always look for discourse markers that satisfy *all* the conditions or constraints imposed. In case the set of candidate markers is empty, then undo the present solution, re-enter the last step, and look for discourse markers that at least *partially* meet the requirements of the input structure, i.e. that are less specific in the meaning signaled. Regarding the combinability constraints, the option of relaxing constraints imposed by individual markers is not available: Combinability constraints of a discourse marker are hard constraints which are not negotiable. Instead, either a different marker has to be selected which meets the constraints, or the constraints imposed by other sentence planning modules have to be relaxed by considering their second or third choices. The process of negotiating the decisions made independently by different sentence planning modules, among them the discourse marker selection module, has been briefly

addressed in Section 10.1.2 above. To recapitulate, flexible control and a flexible order of making decisions have been emerged as major characteristics of the sentence planning phase. However, building a sentence planner is not my present concern and hence I will not elaborate on this topic. There already exist mechanisms and architectures (constraint-satisfaction, blackboard) that can handle this task, and future work could incorporate these.

An empty set of candidate markers may occur in two contexts:

- There exist discourse markers that exactly meet the applicability conditions, but none of the applicable markers satisfies the constraints set by the linguistic environment.

An example is *kaum dass* (no sooner than), which is the only marker that indicates an anterior relation and a speaker's judgement, but which can only be used with past tense. In case future events are involved, *kaum dass* is not available, and the interpersonal dimension (the speaker's judgement) is not expressible by means of a discourse marker. In this case, the first task would have to be re-entered and a less specific discourse marker (a hyperonym) would have to be chosen that meets the combinability constraints, for instance, *nachdem* (after).⁷

- There exists no discourse marker that exactly meets the applicability conditions, i.e., that expresses all aspects of the coherence relation and that satisfies the additional constraints.

To illustrate this, consider a precedence relation, where the focus is on the later situation (coherence relation [BEFORE, S_1 -NUCLEAR]), and where one of the situations extends to speaking time, i.e. *dur* holds. *Seitdem* (since) is the only discourse marker that indicates a durational precedence relation. Yet, it additionally requires *next* and *imm* to hold. If one or both are not given, *seitdem* cannot be employed; no marker exists that exactly meets the applicability conditions. Now, task one would be re-entered, and the search would continue for a marker that is less specific. Such a marker would be *nachdem*, which does not indicate the temporal extension of the situation, and thus subsumes *seitdem*.

A marker is also less specific than required by the input representation if its lexicon entry contains a value for a given attribute that is more general than the value required by the input expression, that is, the lexicon entry value subsumes the input value. This can hold for those attributes whose values can be taxonomized, such as **semantic-relation** and **intention**. Given that all other attributes and values are compatible, such a marker can be selected.

Finally, there is the possibility that no discourse marker exists that meets the constraints imposed by the coherence relation. Yet, this case has not been encountered in the present domain, as a lot of markers are neutral with respect to some facets of the coherence relation, i.e. are applicable in a number of contexts.

⁷Ideally, the interpersonal information that is not signaled by the discourse marker is recorded somewhere so that it can be expressed using different lexical means, e.g. by means of a degree or grading adverb. However, this question is beyond the scope of this thesis.

10.3.2.2 Representation and procedure

The comparison between constraints imposed by discourse markers and by the input structure, that is the retrieval of discourse markers given a set of constraints, can be thought of as a matching operation on two feature structures (see for instance, [Shieber 1986] on the notion of feature structures and the basic operations on feature structures). In both tasks—determining a set of candidate markers and choosing among candidate markers—the lexicon is entered with a feature structure derived from the input representation (either coherence relation and additional constraints, or sentence planning constraints), which is compared to the feature structures given by either the applicability condition zone or the combinability constraints zone of the lexicon. The equality of two feature structures can be tested by means of unification.

Let us assume two feature structures FS_{input} and FS_{marker} , where FS_{input} denotes the feature-value pairs given by the discourse fragment and the possible linguistic environment(s), and FS_{marker} the feature-value pairs that hold for a particular marker as given in the lexicon entry. A discourse marker is *applicable* iff

- FS_{input} and FS_{marker} are identical, or
- FS_{input} and FS_{marker} unify, and FS_{marker} is less specific than FS_{input} , i.e. FS_{marker} subsumes FS_{input} .

Here, less specific means that FS_{marker} has either no entry for a particular attribute—which corresponds to a disjunction of the possible values—or a value that subsumes the value given in FS_{input} , which, of course, requires a taxonomy of values (as has been defined in the EAGLES-like definition of discourse marker lexicon entries in Chapter 9).

A discourse marker is *not applicable* iff

- FS_{input} and FS_{marker} cannot be unified, or
- FS_{input} and FS_{marker} unify, and FS_{marker} is more specific than FS_{input} , i.e. FS_{marker} is subsumed by FS_{input} .

FS_{marker} is more specific than FS_{input} if FS_{marker} contains either a value for an attribute that is left unspecified in FS_{input} , or a value that is more specific than the corresponding value of FS_{input} .

A lexicon entry as introduced above (Section 10.2.4) comprises the three zones of applicability conditions, combinability constraints and preferences. In terms of feature structures, we can think of each lexicon entry as consisting of these three features and their values, which are themselves complex feature structures made up from the attribute-values pairs defined in Section 9.3. In other words, FS_{marker} comprises the three features **applicability**, **combinability**, and **preferences**, whose values are themselves feature structures, namely FS_{appl} , FS_{comb} , and FS_{pref} . To distinguish between the feature value pairs given in the

Input: two TSitSpecs (Sit_1, Sit_2) in a coherence relation (coh_rel)

1. Determine the set of possible (applicable) discourse markers by unifying information provided by the input representation FS_{appl-i} with information in the applicability condition zones of the lexicon entries FS_{appl-m} . This is done in two steps:
 - a. Use the values for the features **semantic-relation**, **intention** and **nuclearity** as given by coh_rel to retrieve a set of candidate markers from the lexicon.
 - b. Test for all candidate markers whether the additional semantic constraints given in the lexicon entry hold. Test whether Sit_1 and Sit_2 are presupposed.

This step amounts to testing the equality of the feature structures FS_{appl-i} and FS_{appl-m} . Step 1 returns the discourse markers whose feature structures FS_{appl-m} are identical to FS_{appl-i} .

In case the set of applicable discourse markers is empty, enter Step 2, otherwise proceed with Step 3.

2. Re-enter the lexicon and look for markers with a FS_{appl-m} that are less specific than FS_{appl-i} , and return set of candidate markers sorted by specificity.
3.
 - a. Accumulate syntactic and lexical constraints put forward by different sentence planning modules, and build FS_{comb-i} .
 - b. Choose from set of candidate markers by matching syntagmatic constraints against combinability constraints posited by candidate markers, that is test the equality of FS_{comb-i} and FS_{comb-m} .
In case the set of candidate markers is empty, return to Step 2.

4. Produce sentence-semantic representations for TSitSpecs and remaining discourse markers.
5. Send to surface generator.

Output: a (set of) complex clause(s) conjoined by a conjunction, pairs of sentences connected by a conjunctive, or sentence(s) containing a PP

Figure 10.6: General procedure for discourse marker selection

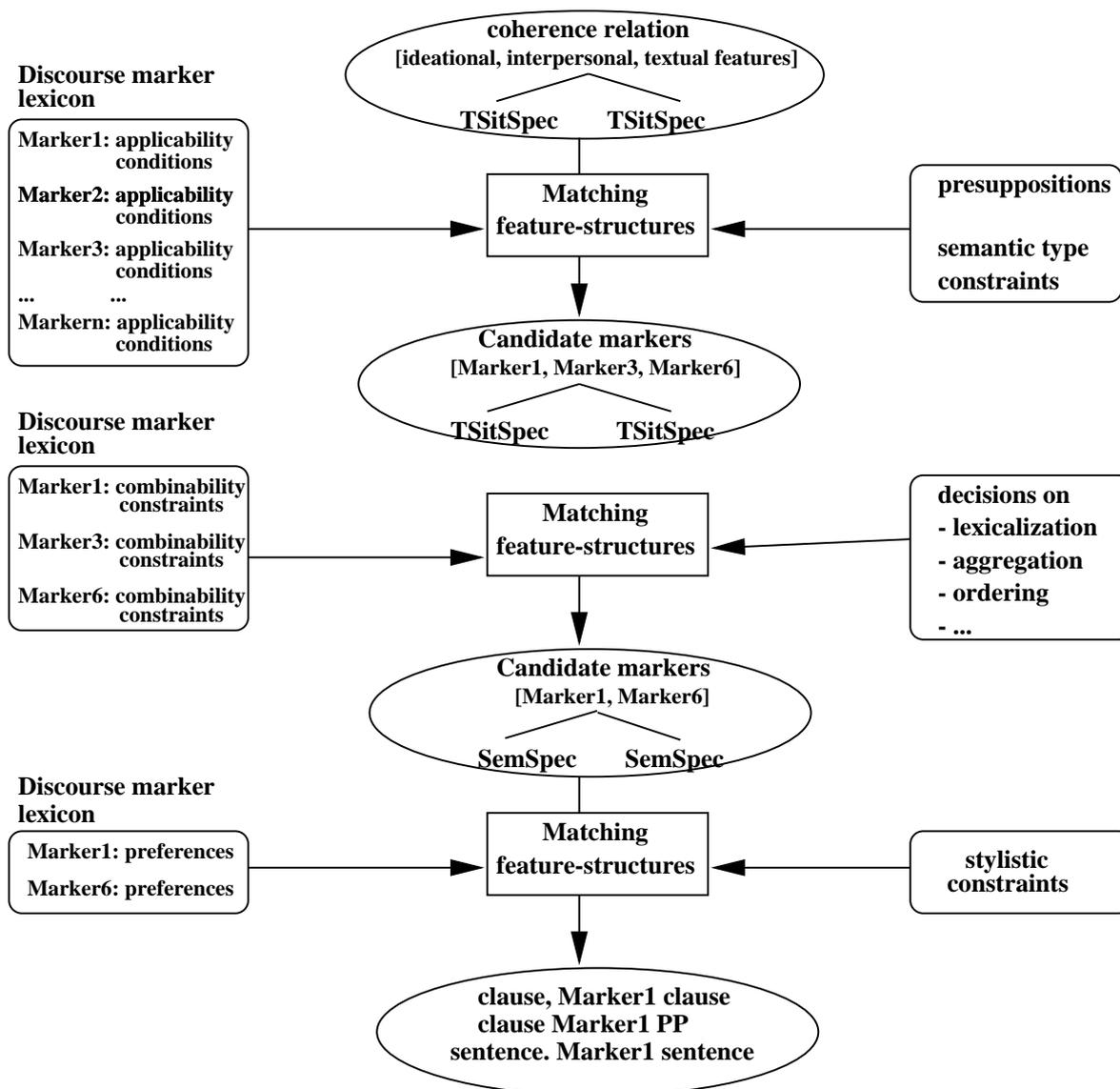


Figure 10.7: Data structures at different stages of the discourse marker selection procedure

lexicon entry FS_{marker} and those given by the requirements on the discourse marker FS_{input} (as built up during the selection process), I attach the suffix $-m$ for marker features, and $-i$ for input features (FS_{appl-m} , FS_{comb-m} , FS_{pref-m} ; FS_{appl-i} , FS_{comb-i} , FS_{pref-i}).

The general procedure for discourse marker selection along these lines is given in Figure 10.6. The input to this procedure is the output from a text planner, e.g. a discourse representation tree such as the one introduced in Chapter 8. Step 1 and Step 2 of the procedure for discourse marker choice determine the set of applicable discourse markers, at this stage regardless of the linguistic environment. The conditions imposed by the input structure are matched against the applicability condition zones of the entries in the

discourse marker lexicon; this yields a set of candidate markers. In the ideal case, this set would be ordered, giving the exact matches first, followed by less specific realizations. Note that Step 1 and Step 2 could easily be conflated. However, the number of markers that partially meet the applicability constraints may be quite large; therefore, this set should be only computed if it is actually required, i.e. if no marker exists that exactly meets the applicability conditions or the combinability constraints.

Step 3 is more complex. Here, the set of applicable markers is evaluated with regard to the decisions made by other sentence planning modules. In the proposed algorithm (cf. Figure 10.6) this is realized as follows: The combinability zones of the candidate markers are compared with the syntactic and lexical constraints put forward by other sentence planning modules, such as constraints on lexical choice, syntactic structuring, aggregation, etc. This results in a (possibly reduced) set of discourse markers. As already discussed above, the feature structure built in Step 3a (FS_{appl-i}) initially contains all the first choices of other sentence planning modules. If this linguistic environment does not meet the demands of any of the applicable discourse markers (candidate markers), then other possible, although less preferred, solutions from the sentence planning modules are considered. Only if none of them matches the requirements of the applicable markers, then Step 2 is entered.

When comparing Step 3 of the discourse marker selection procedure in Figure 10.6 with the specification of the sentence planning phase in Section 10.1.2, one notices a discrepancy between the two. In Section 10.1.2 it has been claimed that the sentence planner should support a flexible order of decision-making and that independent modules make decisions for various sentence planning tasks which are then ‘negotiated’ to find the best solution. The sentence planning phase as described in Step 3 of the marker choice procedure falls short of these claims. First, a flexible order is not given, and second, there is no negotiation of decisions. Instead, discourse marker choice comes last and is determined by all other sentence planning decisions. In other words, other sentence planning modules put forward their decisions, which are accumulated (Step 3a) and mapped against the combinability zones of the candidate markers (Step 3b). In this setting, the discourse marker choice procedure takes on part of the negotiation procedure, as it compares results from different sentence planning modules (Step 3b). Following the approach outlined in Section 10.1.2, choice mechanisms work differently. The set of applicable discourse markers, i.e. the decision made by the discourse marker choice module in step 1, is sent to an external procedure, where the best solution is determined for all decisions made by the different sentence planning modules. This includes, among others, the choice of a discourse marker from the candidate set. In this scenario, no task is foregrounded and no decision is prioritised. However, the design and incorporation of such a procedure is beyond the scope of this thesis. Therefore, in absence of a powerful negotiation procedure I turn to the intermediary solution proposed in Figure 10.6, which blends discourse marker choice tasks and more general sentence planning tasks, for the time being. Note, however, that the algorithm can be easily cleared of the general tasks once it is integrated in a more comprehensive sentence planner.

Figure 10.7 shows the data structures at the different steps of a discourse marker selection procedure that follows this approach. Boxes on the left hand side describe the feature

Point relations	Interval relation
$b_1 = b_2 \wedge e_1 = e_2$	$equal(Sit_1, Sit_2)$
$e_1 < b_2$	$before(Sit_1, Sit_2)$
$e_2 < b_1$	$after(Sit_1, Sit_2)$
$e_1 = b_2$	$meets(Sit_1, Sit_2)$
$e_2 = b_1$	$meets-i(Sit_1, Sit_2)$
$b_1 < b_2 \wedge e_1 < e_2 \wedge b_2 < e_1$	$overlaps(Sit_1, Sit_2)$
$b_2 < b_1 \wedge e_2 < e_1 \wedge b_1 < e_2$	$overlaps-i(Sit_1, Sit_2)$
$b_2 < b_1 \wedge e_1 < e_2$	$during(Sit_1, Sit_2)$
$b_1 < b_2 \wedge e_2 < e_1$	$during-i(Sit_1, Sit_2)$
$b_1 = b_2 \wedge e_1 < e_2$	$starts(Sit_1, Sit_2)$
$b_1 = b_2 \wedge e_2 < e_1$	$starts-i(Sit_1, Sit_2)$
$b_2 < b_1 \wedge e_1 = e_2$	$finishes(Sit_1, Sit_2)$
$b_1 < b_2 \wedge e_1 = e_2$	$finishes-i(Sit_1, Sit_2)$

Table 10.6: Mapping point representations to Allen’s temporal relation

structure FS_{marker} , boxes on the right and the input representation at the top of the figure provide the information for FS_{input} .

10.3.3 Procedure for selecting temporal discourse markers

In my model, generation starts from a conceptual representation which contains the facts that must be reported in the text and the temporal coherence relation holding between them. As with all other discourse markers, I do not consider the broader discourse context, and I thus ignore other possible relations signaled by temporal markers (such as causal links), which is clearly a simplification (cf. [Moens and Steedman 1988]).

The coherence relation holding between two TSitSpecs already supplies multifaceted information, as Chapter 8 shows: The ideational relation specifies the temporal relation, interpersonal and textual features name the speaker’s intention and the relatum that acts as nucleus. As pointed out in the preceding sections, these relations need not be explicitly presented in the knowledge bases but can be inferred from specifications in different knowledge sources. Take for instance the temporal relations: As TSitSpecs are time-stamped, the temporal relation holding between two TSitSpecs can be easily inferred. Given the time points $\mathbf{t}\text{-begin}$ and $\mathbf{t}\text{-end}$ for each TSitSpec, i.e. (b_1, b_2, e_1, e_2) , such that $(b_1 \leq e_1)$ and $(b_2 \leq e_2)$, and the three point relations ($=, >, <$), each of Allen’s interval relations (i.e. the temporal relations) can be described by the point relations holding between the pairs $(b_1, b_2), (b_1, e_2), (e_1, b_2)$ and (e_1, e_2) . A subset of these relations is sufficient to infer the temporal relation; the correspondences are listed in Table 10.6.

Figure 10.6 gives the general procedure for discourse marker choice. However, depending on the marker group under consideration, the set of applicable values can be delimited for

certain attributes, while at the same time, additional attributes addressing characteristic properties of that marker group have to be added. In other words, the matching procedure is tailored towards a particular marker group. Figure 10.8 shows the procedure for selecting temporal discourse markers given two TSitSpecs in a temporal coherence relation and the speaking time S as additional input, on the basis of ontological knowledge and the lexicon entries for temporal discourse markers. The marker-specific choice procedure given in Figure 10.8⁸ is a refinement of the general procedure in Figure 10.6. Refinements pertain to the following areas:

- **Coherence relation.** The type of coherence relation is confined to temporal relation (Step 1a).
- **Speaking time.** Part of the input to the procedure is the speaking time (Step 1a).
- **Semantic constraints.** The procedure names the semantic constraints that have to be verified (Step 1b).
- **Linguistic environment.** The exact constraints on the linguistic environment are given (Step 3a).

In the examples given below I focus on the role of ontological knowledge and lexical semantics in marker choice, and hence on Steps 1 to 3 of the procedure. The completion of Step 3b yields the set of temporal markers that meet the applicability conditions imposed by the two conjoined TSitSpecs or subtrees and that satisfy the combinability constraints for each relata partaking in the temporal relation. The verbalization of situations via the intermediate level of sentence-semantic specifications (*SemSpecs*), using the approach described in [Stede 1999], and of building SemSpecs for complex sentences, using lexical information on discourse markers, are beyond the scope of this thesis.

Step 1b of the procedure requires knowledge of presuppositions and additional temporal constraints. User model and discourse history provide the former information, the latter can be derived from TSitSpecs in a straightforward manner: The input structure consists of a speaking time S and two TSitSpecs (Sit_1 and Sit_2) with time points (b_1, b_2, e_1, e_2) . Using this knowledge, the four temporal constraints adapted from [Herweg 1991] (cf. Chapter 5) are defined as follows:

- *prox*(Sit_1, Sit_2) holds if Sit_2 has a time point in common with the pre-state (Sit_3) or the post-state (Sit_4) of Sit_1 : $(b_3 \leq e_2) \wedge (e_2 \leq e_3)$ or $(b_4 \leq b_2) \wedge (b_2 \leq e_4)$.
- *next*(Sit_1, Sit_2) holds if there is no other situation (Sit_3) that is located between Sit_1 and Sit_2 : $\neg \exists Sit_3 [(e_1 < b_3) \wedge (b_3 < b_2)]$.
- *imm*(Sit_1, Sit_2) realizes the idea of ‘temporal adjacency’ of two situations. I posit that one time point be the maximal time span allowed between Sit_1 and Sit_2 : $(e_1 + 1 = b_2) \vee (b_1 + 1 = b_2)$.

⁸Areas that differ from the general selection procedure are given in bold face in Figure 10.8.

Input: two TSitSpecs (Sit_1, Sit_2) in a temporal relation (coh_rel) and speaking time $S = 10$

1. Determine the set of possible (applicable) discourse markers by unifying information provided by the input representation FS_{appl-i} with information in the applicability condition zones of the lexicon entries FS_{appl-m} . This is done in two steps:
 - a. Use the values for the features **temporal-relation**, **intention** and **nuclearity** as given by coh_rel to retrieve a set of candidate markers from the lexicon.
 - b. **Test Sit_1 and Sit_2 using S for additional conditions (as required by candidate markers):** constraints, extension, boundedness-sit-m, boundedness-sit-s, situation-type and presupposition, and return a (possibly reduced) set of candidate markers.

Step 1 returns the discourse markers whose feature structures FS_{appl-m} are identical to FS_{appl-i} .

In case the set of applicable discourse markers is empty, enter Step 2, otherwise proceed with Step 3.

2. Re-enter the lexicon and look for markers with a FS_{appl-m} that are less specific than FS_{appl-i} , and return set of candidate markers sorted by specificity.
3.
 - a. Accumulate syntactic and lexical constraints put forward by different sentence planning modules, **in particular, select a verbalization of the process (yields the Aktionsart) and determine tense and aspect.** Build FS_{comb-i} .
 - b. Choose from set of candidate markers by matching syntagmatic constraints against combinability constraints posited by candidate markers, that is test the equality of FS_{comb-i} and FS_{comb-m} .

In case the set of candidate markers is empty, return to Step 2.

4. Produce sentence-semantic representations for TSitSpecs and remaining discourse markers.
5. Send to surface generator.

Output: a (set of) temporal clause complex(es) conjoined by a conjunction, pair(s) of sentences connected by a temporal conjunctive, or sentence(s) containing a temporal PP

Figure 10.8: Example for tailoring the general procedure to a specific marker class, here temporal discourse markers

- $dur(Sit_1)$ holds if the end point of Sit_1 equals or extends beyond speaking time S : $e_1 \geq S$, or if Sit_1 extends to the beginning of Sit_2 : $e_1 = b_2$, with $b_1 < e_1$ (to ensure that the situation is durative).

The lexicon entries of the candidate markers are checked for these constraints. Recall that *bei* (with) requires that the situations partaking in a temporal relation occur at the same place. The definition of this constraint is straightforward:

- $same-place(Sit_1, Sit_2)$ holds if Sit_1 occurs at the same location as Sit_2 .

Step 3a of the procedure emphasizes the role of Aktionsart, tense and aspect, because these are alternative means of expressing temporal information, which strongly interact with temporal marker choice. Step 3b again accesses the lexicon, now checking for combinability constraints. Steps 4 and 5 follow the general procedure outlined in Figure 10.6.

10.4 Examples

This section integrates the results from discourse marker analysis and discourse marker lexicon design with the discourse marker selection procedure introduced in the preceding section. It illustrates the selection of discourse markers for pairs of TSitSpecs in a coherence relation by means of several examples. Ideally, the generation process results in pairs of sentences conjoined by a conjunctive, a clause complex involving a conjunction, or a clause containing a PP denoting one of the two TSitSpecs. Since I focus on the task of discourse marker selection in this thesis, and do not deal with the actual production of the sentences, the discussion below will be restricted to Step 1 to Step 3 of the procedure outlined in Figure 10.6. Further, as I have pointed out in the preceding section, I do not go into detail on the sentence planning phase itself, but for the sake of the argument assume that a powerful sentence planner (as has been sketched above) is at work. In this section, I simply presuppose decisions put forwards by different sentence planning modules such as a lexicalization module, a syntactic structuring module, an aggregation module and so forth in order to illustrate the working of the choice procedure and the interactions between discourse marker choice and other sentence planning decisions.

I have argued at several points in this thesis that discourse marker choice is by no means a straightforward task: The same semantic relation can be expressed differently depending on interpersonal and textual decisions, and the same coherence relation can yield different verbalizations depending on constraints imposed by the linguistic environment. Further, given the same coherence relation and the same linguistic environment, the discourse marker used might vary depending on stylistic preferences. Finally, the same coherence relation can be verbalized in different languages. The claim is now that the procedure introduced above can handle all the different types of variation and can perform an informed choice among discourse markers. To meet this claim, examples in this section need to cover the entire range of variation, in particular:

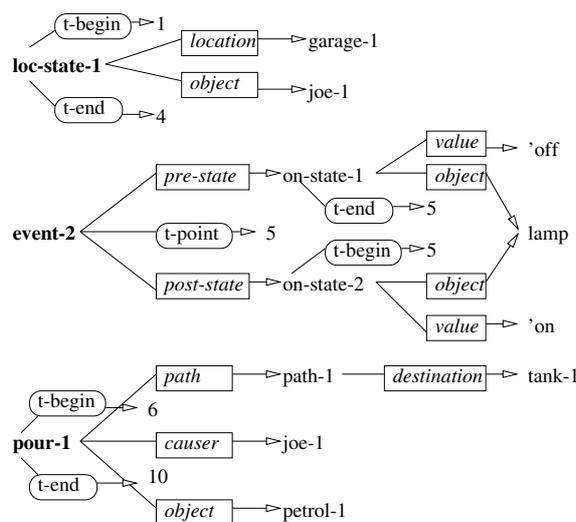


Figure 10.9: Three TSitSpecs in temporal succession

- Variation in coherence relation (and other applicability) features with constant sentence planning decisions: This shows the effect of changes in the coherence relation holding between TSitSpecs on discourse marker choice.
- Variation in sentence planning decisions with constant applicability conditions: This demonstrates how different sentence planning decisions, for instance, on Aktionsart or sentence structure, affect discourse marker choice.
- Constant applicability conditions and sentence planning decisions: This exemplifies the production of paraphrases for a pair of TSitSpecs in a coherence relation, where the discourse markers used differ with respect to preferences.

Sections 10.4.1 to 10.4.3 give constructed examples to exemplify the different types of variations mentioned above. These examples involve two TSitSpecs in a coherence relation; the coherence relation is signaled by German temporal markers only. In Section 10.4.4, I present a more complex and multilingual example, taken from an instructional text from the corpus (text TC.25). I deploy the proposed lexicon entries and the selection procedure to explain why the German and English markers used in the text are chosen, and to propose legal paraphrases.

10.4.1 Example 1: Variation in applicability conditions

Variation concerning the coherence relation is illustrated by means of markers from the anteriority group. Figure 10.9 shows three situations in temporal succession; each pair of TSitSpecs can serve as input to my procedure. Consider the two TSitSpecs LOC-STATE-1, lasting from 1 to 4, and EVENT-2, occurring at time point 5 (in the following, referred to as

example $temp_1$). Let us assume that the speaking time S is 10, and that a text planner has decided on the following coherence relation holding between the two TSitSpecs (described in terms of the feature representation proposed in Chapter 8):⁹

$$coh_rel(loc_state-1, event-2) = [BEFORE, UNDERSTANDING, NUCLEAR-NEUTRAL, S_1-NUCLEAR]$$

The selection procedure is called with $coh_rel(loc_state-1, event-2)$ and $S=10$. The additional applicability conditions that hold for temporal markers are verified in Step 1b. With the definitions from above, Step 1b determines that the relations $prox(loc_state-1, event-2)$, $imm(loc_state-1, event-2)$ and $next(loc_state-1, event-2)$ hold. These constraints, the presuppositions, and the situation types (BOUNDED-STATE and TRANSITION) yield the following set of attributes and values (FS_{appl-i}):

```

TEMPORAL-RELATION: before
CONSTRAINTS: prox next imm
EXTENSION:
INTERPERSONAL-EXPANSION: understanding
NUCLEUS-JUDGEMENT: nuclear-neutral
NUCLEARITY: S1-nuclear
PRESUPPOSITION: presupposed
BOUNDEDNESS-SIT-M: lr-bounded
BOUNDEDNESS-SIT-S: lr-bounded
SITUATION-TYPE: bounded-state

```

These conditions imposed by the coherence relation and by properties of the TSitSpecs involved (FS_{appl-i}) are matched against the applicability conditions of the lexicon entries (FS_{appl-m}) as given in Tables 10.1 to 10.3, and in Appendix B. In the present example, the matching results in the following set of candidate markers, which is the output of Step 1 of the selection procedure (cf. data structures in Figure 10.7):

Candidate markers = {*sobald*, *sowie*}

The lexicon entries for *sobald* (as soon as) and its synonym *sowie* (as soon as) do not specify the situation type, only the boundedness of the situation is of concern, hence any **situation-type** value may hold. The same is true for the features **extension** and **intention**. Note that *sobald* is applicable even though its **constraints** slot does not contain **prox**. This is due to the fact the **imm** is a more specific instance of **prox**, hence, whenever **imm** holds, **prox** holds, too (see definitions above).

All other anterior markers that meet the constraints imposed by the coherence relation alone (these are: *seitdem*, *seit*, *ab*, *nachdem*, *nach*, *danach* (since, since (P), from...on,

⁹Note that for better readability, the features POSITIVE, REALIS, CERTAIN are omitted from the coherence relation definition. If not stated otherwise, they hold for all coherence relations given in this section.

after, after (P), afterwards)) are ruled out in Step 1 for various reasons: *Seitdem* and the prepositions *seit* and *ab* fail because $dur(event-2)$ does not hold as EVENT-2 does not extend to speaking time S . In other words, *seitdem* is more specific than the conditions imposed by FS_{appl-i} . *Nachdem*, *nach*, and its conjunctive equivalent *danach* are not applicable because *next* and *imm* hold, which are not specified for any of these markers.¹⁰

Since the set of candidate markers is not empty, we proceed with Step 3. Step 3 deploys the constraints put forward by other sentence planning modules. For instance, the lexicalization module (cf. the generation architecture in Figure 10.1) might choose *angehen* (to turn on) to verbalize the process in EVENT-2, and *sein* (to be) for LOC-STATE-1, which gives the Aktionsarten semelfactive and stative. The decisions of other sentence planning modules do not concern us right now; hence FS_{comb-i} is left unspecified for all other attributes:

AKTIONSPORT-MC: semelfactive
 AKTIONSPORT-SC: stative

FS_{comb-i} is matched against the combinability constraints imposed by the candidate markers (FS_{comb-m} , cf. lexicon entries). As *sobald* and *sowie* meet the Aktionsart constraints (compare the lexicon entries given in Appendix B), the set of candidate markers at the end of Step 3 is:

Candidate markers = {*sobald*, *sowie*}

If combining all the lexical information, respecting the constraints on syntactic realization given in the lexicon entries for *sobald* and *sowie*, into sentence-semantic specifications and passing them to a sentence generator, the following sentences might be produced:

(10.1)

- a. **Sobald** *Joe in der Garage gewesen war, ging die Tankleuchte an.*
 As soon as Joe in the garage had been, turned the lamp on.
 ‘As soon as Joe had been in the garage, the lamp turned on.’
- b. **Sowie** *Joe in der Garage gewesen war, ging die Tankleuchte an.*
 As soon as Joe in the garage had been, turned the lamp on.
 ‘As soon as Joe had been in the garage, the lamp turned on.’

Choosing among these options is the task of the surface generator in Step 5, and not my present concern. The only difference that exists between *sobald* and *sowie* is in frequency of use, *sowie* is by far the less frequent marker.

Changing the interpersonal feature in the coherence relation (as part of the input representation) to [REGARD, NUCLEAR-NEGATIVE] while leaving the other features constant would

¹⁰The markers are therefore more general than the input structure, and would only be used if no other discourse marker is available.

Example *temp*₂:

Input: *coh_rel(event-2,pour-1)*, *S=10*
with *coh_rel* = [BEFORE,UNDERSTANDING,NUCLEAR-NEUTRAL,*S*₁-NUCLEAR]

Step1a: TEMPORAL-RELATION: before
 INTERPERSONAL-EXPANSION: understanding
 NUCLEUS-JUDGEMENT: nuclear-neutral
 NUCLEARITY: *S*₁-nuclear

→ *Candidates* = {*nachdem*, *nach*, *danach*, *sobald*, *sowie*, *seitdem*, *seit* (*prep*), *ab*}

Step1b: *prox(event-2,pour-1)*, *next(event-2,pour-1)*, *imm(event-2,pour-1)*, *dur(pour-1)*
Sit_s = TRANSITION, *Sit_m* = PROTRACTED-ACTIVITY; presupposed

CONSTRAINTS: *prox next imm*
 EXTENSION: *dur*
 PRESUPPOSITION: *presupposed*
 BOUNDEDNESS-SIT-M: *lr-bounded*
 BOUNDEDNESS-SIT-S: *lr-bounded*
 SITUATION-TYPE: *transition*

→ *Candidates* = {*seitdem*, *seit* (*prep*), *ab*}

Step3a: *transformative (mc)*, *durative (sc)*

AKTIONSART-MC: *transformative*
 AKTIONSART-SC: *durative*

Step3b: → *Candidates* = {*seitdem*, *seit* (*prep*), *ab*}

...

Output: **Seitdem** *die Tankleuchte angegangen ist, gießt Joe Benzin in den Tank.*
 Since the tank lamp has turned on, pours Joe petrol into the tank.
 ‘Since the tank lamp has turned on, John has been pouring petrol into the tank.’

Seit (Ab) *dem Angehen der Tankleuchte gießt Joe Benzin in den Tank.*
 Since (From...on) the turning on of the tank lamp pours Joe petrol into the tank.
 ‘Since (From...on) the turning on of the tank lamp, John has been pouring petrol into the tank.’

Figure 10.10: Results of Step 1 to Step 3 for situation pair (EVENT-2,POUR-1)

Example *temp*₃:

Input:	<i>coh_rel</i> (<i>loc-state-1,pour-1</i>), <i>S</i> =10 with <i>coh_rel</i> = [BEFORE,UNDERSTANDING,NUCLEAR-NEUTRAL, <i>S</i> ₁ -NUCLEAR]
Step1a:	TEMPORAL-RELATION: before INTERPERSONAL-EXPANSION: understanding NUCLEUS-JUDGEMENT: nuclear-neutral NUCLEARITY: <i>S</i> ₁ -nuclear → <i>Candidates</i> = { <i>nachdem, nach, danach, sobald, sowie, seitdem, seit (prep), ab</i> }
Step1b:	<i>prox</i> (<i>loc-state-1,pour-1</i>), <i>dur</i> (<i>pour-1</i>) <i>Sit_s</i> = LR-BOUNDED-STATE, <i>Sit_m</i> = PROTRACTED-ACTIVITY; presupposed CONSTRAINTS: <i>prox</i> EXTENSION: <i>dur</i> PRESUPPOSITION: presupposed BOUNDEDNESS-SIT-M: lr-bounded BOUNDEDNESS-SIT-S: lr-bounded SITUATION-TYPE: bounded-state → <i>Candidates</i> = { }
Step2	re-enter step1 and determine less specific discourse marker: → <i>Candidates</i> = { <i>nachdem, nach, danach</i> }
Step3a:	stative (<i>sc</i>), durative (<i>mc</i>); no deverbalization possible AKTIONSART-MC: durative AKTIONSART-SC: stative PART-OF-SPEECH: <i>subc</i> <i>coord</i> <i>pronadv</i>
Step3b:	→ <i>Candidates</i> = { <i>nachdem, danach</i> }
...	
Output:	Nachdem <i>Joe in der Garage gewesen ist, gießt Joe Benzin in den Tank.</i> After Joe in the garage has been, pours Joe petrol into the tank. 'After Joe has been in the garage, Joe has been pouring petrol into the tank.' <i>Joe ist in der Garage gewesen. Danach gießt Joe Benzin in den Tank.</i> Joe has in the garage been. Afterwards pours Joe petrol into the tank. 'Joe has been in the garage. Afterwards, Joe has been pouring petrol into the tank.'

Figure 10.11: Results of Step 1 to Step 3 for the situation pair (LOC-STATE-1,POUR-1)

yield *kaum dass* as the only possible realization as it is the only marker that is compatible with the NUCLEUS–JUDGEMENT: **nuclear-negative** constraint. Assuming a different nuclearity distribution [S_0 -NUCLEAR] would trigger the entire set of posterior markers; this variation will be discussed in the context of Example 3 below.

Generation of the remaining pairs (referred to as example *temp₂* and example *temp₃*) works in a similar manner, therefore I present the results of the different steps compactly in Figures 10.10 and 10.11. Note that the coherence relation is the same for all possible pairs of TSitSpecs. Differences relate to the additional semantic constraints; these trigger different sets of temporal markers. In example *temp₂* (Figure 10.10), the *dur*-constraint restricts the set of applicable markers considerably; only *seitdem*, *seit* and *ab* remain as candidate markers since their lexicon definitions contain the value **dur** for the attribute **extension** (cf. the corresponding lexicon entries). The lexicon entries given in Appendix B reveal that these markers all require bounded situations; this condition is met by TRANSITION and PROTRACTED-ACTIVITY alike (recall that they have been defined as having inherent boundaries). Since the transition can be expressed by a deverbalized process, the prepositional variants are acceptable realizations. The choice of a particular temporal marker from the set of candidate markers can either be determined by a syntactic structuring module, opting for, for instance, a hypotactic clause complex or the realization within a clause, or by the surface generator which is sensitive to the stylistic goal of a concise text (choosing a preposition).

Example *temp₃* (Figure 10.11) has a somewhat surprising outcome: Despite the fact that POUR-1 extends to speaking time (i.e. *dur(pour-1)* holds; cf. Figure 10.9), *seitdem* is ruled out, because *imm(loc-state-1,pour-1)* and *next(loc-state-1,pour-1)* do not apply. Instead, *nachdem* is chosen, as a less specific marker which does not signal the extension of POUR-1 to speaking time. The general strategy here is to choose the marker that expresses all aspects of the temporal relation; if no marker applies, then retreat to a more general marker, i.e. one that does not signal some (additional) aspects of the relation (see the discussion in the preceding section). This is the case for *nachdem*, where the temporal extension is not specified, i.e. either **dur** or **not-dur** may hold.

The examples so far illustrate how coherence relations, ontological knowledge, and complex event representations enable the selection of an adequate temporal discourse marker. In these examples, the applicability conditions are the factors motivating marker choice, whereas combinability constraints are only of minor importance for discriminating between markers.

10.4.2 Example 2: Variation in combinability constraints

Let us now consider the interactions between temporal marker choice and the lexical and syntactic environment—represented by the combinability constraints of the lexicon entries—which so far have only played a minor role. I turn to markers from the simultaneity group to exemplify this variation (example *temp₄*).

Complex events as given by culminations can be expressed in different ways, placing em-

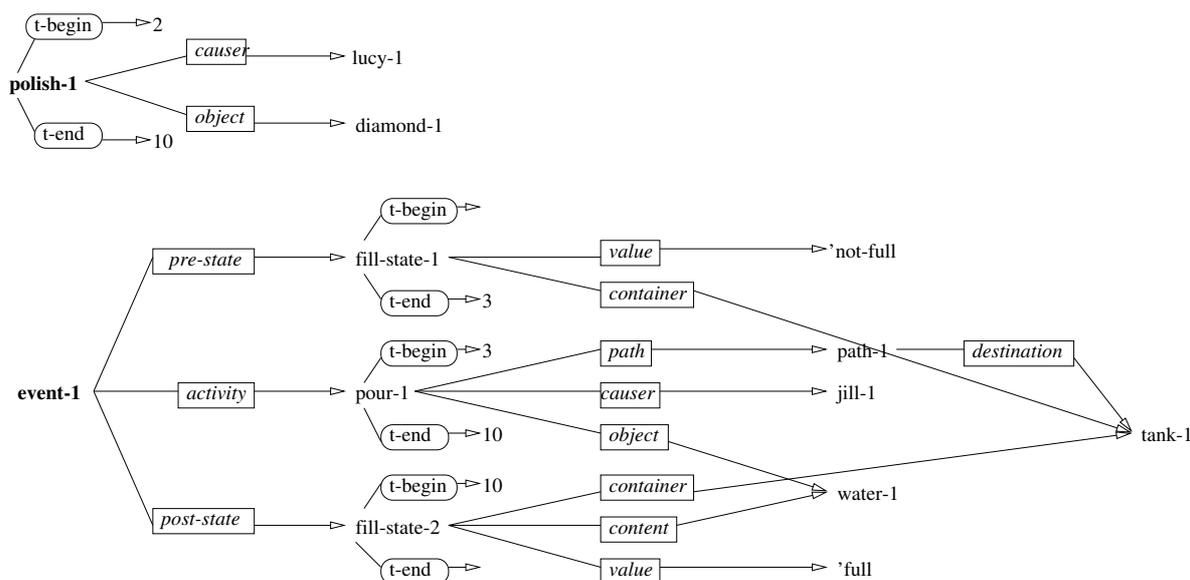


Figure 10.12: Two TSitSpecs in a simultaneity relation

phasis either on the fact that the post-state has been reached, or on the activity leading toward that post-state. For the TSitSpec *EVENT-1* given in Figure 10.12 this means, for example, a choice between *Jill filled the tank with water* and *Jill poured water into the tank*. Using this example, I demonstrate the role of Aktionsart in discourse marker selection and how it is handled in my approach.

The event *EVENT-1*, which lasts from time point 3 to 10, is combined with one of Lucy polishing diamonds, which is an *ACTIVITY* and is also represented in Figure 10.12 (*POLISH-1*). For *POLISH-1*, $t\text{-begin}=2$ and $t\text{-end}=10$ hold. In other words, the two situations are co-extensive, and end at the same time point; *POLISH-1* starts earlier than *EVENT-1*. This gives the temporal relation *finishes*. Let us assume that a text planner has decided on the following coherence relation:

$$\text{coh_rel}(\text{polish-1}, \text{event-1}) = [\text{FINISHES}, \text{UNDERSTANDING}, \text{NUCLEAR-NEUTRAL}, S_1\text{-NUCLEAR}]$$

The TSitSpec *POLISH-1*, which acts as temporal anchor for *EVENT-1*, is presupposed. This and the situation type constraints give the following list of feature-values pairs for $FS_{\text{appl}-i}$:

TEMPORAL-RELATION: finishes
 CONSTRAINTS:
 EXTENSION:
 INTERPERSONAL-EXPANSION: understanding
 NUCLEUS-JUDGEMENT: nuclear-neutral
 NUCLEARITY: S1-nuclear

PRESUPPOSITION: presupposed
 BOUNDEDNESS-SIT-M: lr-bounded
 BOUNDEDNESS-SIT-S: lr-bounded
 SITUATION-TYPE: protracted-activity

Comparing FS_{appl-i} with the applicability conditions of temporal markers (FS_{appl-m}) yields the following set (compare lexicon entries in Section 10.2.4 and in Appendix B):

Candidate markers = {*während*, *während (P)*, *währenddessen*, *solange*}

Step 3 of the marker selection procedure posits that different sentence planning modules put forward their decisions, which then interact with marker choice. For instance, in the present example, the lexicalization module might choose the verb *gießen* (pour) to express the ACTIVITY of Jill pouring water. *Gießen* is a durative verb, which gives the following constraint for FS_{comb-i} :

AKTIONSPORT-MC: durative

This combines with all candidate markers (cf. the slot AKTIONSPORT-MC in the lexicon entries):

Candidate markers = {*während*, *während (P)*, *währenddessen*, *solange*}

Choosing between these candidate markers thus relies on other combinability constraints: For instance, if the sentence structuring modules posit that two sentences are to be realized (PART-OF-SPEECH: pronadv), the selected marker is *währenddessen* (meanwhile). Alternatively, if a PP is involved (PART-OF-SPEECH: prep), only *während* (during) would remain. If a subordinate clause is chosen (PART-OF-SPEECH: subc), *während* (while) and *solange* (as long as) remain as candidate markers. In case this constraints holds, possible realizations are:

(10.2)

- a. **Während** *Lucy die Diamanten polierte, goss Jill Wasser in den Tank.*
 While Lucy the diamonds polished, poured Jill water into the tank.
 ‘While Lucy was polishing the diamonds, Jill was pouring water into the tank.’
- b. **Solange** *Lucy die Diamanten polierte, goss Jill Wasser in den Tank.*
 As long as Lucy the diamonds polished, poured Jill water into the tank.
 ‘As long as Lucy was polishing the diamonds, Jill was pouring water into the tank.’

Solange signals the co-occurring endings and thus exactly meets the constraints while the highly ambiguous *während* loses this information (signaling 9 different temporal relations).

If the lexicalization module prefers to emphasize the resulting fill-state, and chooses the verb *füllen* (to fill), then FS_{comb-i} comprises the following constraint:

AKTIONSPORT-MC: resultative

Here, *solange* is not applicable anymore, because it cannot be used with a resultative Aktionsart, as the lexicon entry reveals. Only the highly ambiguous *während* is applicable, thereby again losing the information on the simultaneous endings of both situations:

(10.3)

- a. **?Solange** *Lucy die Diamanten polierte, füllte Jill den Tank mit Wasser.*
 As long as Lucy the diamonds polished, filled Jill the tank with water.
 ‘As long as Lucy was polishing the diamonds, Jill was filling the tank with water.’
- b. **Während** *Lucy die Diamanten polierte, füllte Jill den Tank mit Wasser.*
 While Lucy the diamonds polished, filled Jill the tank with water.
 ‘While Lucy was polishing the diamonds, Jill was filling the tank with water.’

Figure 10.13 summarizes the discussion so far.

Interdependencies of Aktionsart and marker choice concerning the +/–durative variation are far more frequent than the +/–telic variation (resultative vs. not resultative) just illustrated. Most temporal markers have a durative counterpart; pairs are for instance, *nachdem/seitdem* (after/since) and *bevor/bis* (before/until). Using the complex event representation, the knowledge of how verbal Aktionsart relates to these, and the marker lexicon, one can produce pairs of temporal clauses reflecting the +/–durative opposition, as in *Nachdem die Ampel grün geworden war, ...* (After the lights turned green ...) and *Seitdem die Ampel grün war, ...* (Since the lights have been green, ...). Here, the TRANSITION in the subordinate clause can be realized by a transformative verb signaling the beginning of a state and the marker *nachdem*, or a durative verb plus the durative connective *seitdem*, highlighting the temporal extension of the state.

10.4.3 Example 3: Variation along all dimensions

Now consider the two TSitSpecs EVENT-3 and REMOVE-1 in temporal succession, depicted in Figure 10.14, with

$$coh_rel = [BEFORE, UNDERSTANDING, NUCLEAR-NEUTRAL, S_0-NUCLEAR]$$

and the partial $FS_{appl-i} =$

TEMPORAL-RELATION: before
 INTERPERSONAL-EXPANSION: understanding
 NUCLEUS-JUDGEMENT: nuclear-neutral
 NUCLEARITY: S0-nuclear

Example *temp*₄:

Input: *coh_rel*(*polish-1, event-1*), *S*=10
with *coh_rel* = [FINISHES, UNDERSTANDING, NUCLEAR-NEUTRAL, *S*₁-NUCLEAR]

Step1a: TEMPORAL-RELATION: finishes
INTERPERSONAL-EXPANSION: understanding
NUCLEUS-JUDGEMENT: nuclear-neutral
NUCLEARITY: *S*₁-nuclear

→ *Candidates* = {während, während (*prep*), währenddessen, solange}

Step1b: *Sit*_s = PROTRACTED-ACTIVITY, *Sit*_m = PROTRACTED-CULMINATION; presupposed

CONSTRAINTS:
EXTENSION:
PRESUPPOSITION: presupposed
BOUNDEDNESS-SIT-M: lr-bounded
BOUNDEDNESS-SIT-S: lr-bounded
SITUATION-TYPE: protracted-activity

→ *Candidates* = {während, während (*prep*), währenddessen, solange}

Step3a: a. durative (sc), durative (mc); subc
AKTIONSART-MC: durative
AKTIONSART-SC: durative
PART-OF-SPEECH: subc

b. durative (sc), resultative (mc); subc
AKTIONSART-MC: resultative
AKTIONSART-SC: durative
PART-OF-SPEECH: subc

Step3b: a. → *Candidates* = {während, solange}
b. → *Candidates* = {während}

...

Output: a. **Während** *Lucy die Diamanten polierte, goss Jill Wasser in den Tank.*
While Lucy the diamonds polished, poured Jill water into the tank.
'While Lucy was polishing the diamonds, Jill was pouring water into the tank.'

Solange *Lucy die Diamanten polierte, goss Jill Wasser in den Tank.*
As long as Lucy the diamonds polished, poured Jill water into the tank.
'As long as Lucy was polishing the diamonds, Jill was pouring water into the tank.'

b. **Während** *Lucy die Diamanten polierte, füllte Jill den Tank mit Wasser.*
While Lucy the diamonds polished, filled Jill the tank with water.
'While Lucy was polishing the diamonds, Jill was filling the tank with water.'

Figure 10.13: Results of Step 1 to Step 3 for situation pair (POLISH-1, EVENT-1)

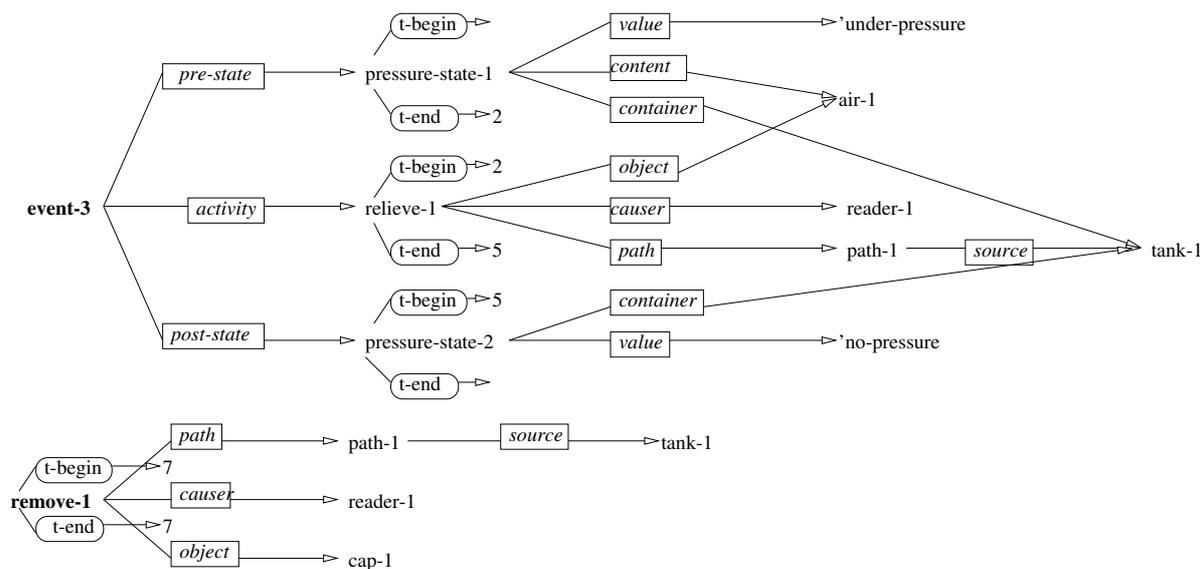


Figure 10.14: Two TSitSpecs in temporal succession

Feeding this into the procedure for temporal marker selection yields an initial set of markers from the posterior group (compare again the lexicon entries for temporal markers):

$$\text{Candidate markers} = \{\text{bevor}, \text{ehe}, \text{vor}, \text{davor}, \text{als}, \text{wenn}\}$$

These markers can all—according to their applicability conditions FS_{appl-m} —express the coherence relation. Step 1b now tests for the additional constraints. Here, proximity, presupposed, bounded Sit_m and bounded Sit_s hold. This gives the following additional conditions for FS_{appl-i} :

CONSTRAINTS: prox
 EXTENSION:
 PRESUPPOSITION: presupposed
 BOUNDEDNESS-SIT-M: lr-bounded
 BOUNDEDNESS-SIT-S: lr-bounded
 SITUATION-TYPE: momentaneous-activity

This leaves *bevor*, *ehe*, *vor*, *davor* as applicable discourse markers (compare lexicon entries in Appendix B), and, since REMOVE-1 is momentaneous, *als* and *wenn* are also applicable:

$$\text{Candidate markers} = \{\text{bevor}, \text{ehe}, \text{vor}, \text{davor}, \text{als}, \text{wenn}\}$$

Changing the interpersonal feature has no effect on the set of candidate markers as they are all unspecified regarding the INTENTION feature. Focussing on the earlier situation

(value **S0-nuclear**), however, would yield the anterior markers as candidate realizations, as discussed in the context of Example 1 above.

Possible verbalizations, observing the combinability constraints and the preferences as given in the lexicon entries of the candidate markers, are:¹¹

(10.4)

- a. *Den Druck ablassen, bevor Sie den Deckel abnehmen.*
The pressure release, before you the cap remove.
'Release the pressure before removing the cap.'
- b. *Den Druck ablassen, ehe Sie den Deckel abnehmen.*
The pressure release, before you the cap remove.
'Release the pressure before removing the cap.'
- c. *Vor Abnahme des Deckels den Druck ablassen.*
Before removal of the cap, the pressure release.
'Before the removal of the cap, release the pressure.'
- d. *Den Deckel abnehmen. Davor / Zuvor den Druck ablassen.*
The cap remove. Before, the pressure release.
'Remove the cap. Before, release the pressure.'
- e. *Sie hatte den Druck abgelassen, als sie den Deckel abnahm.*
She had the pressure released, as she the cap removed.
'She had released the pressure as she removed the cap.'
- f. *Sie hat den Druck abgelassen, wenn sie den Deckel abnimmt.*
She has the pressure released, when she the cap removes.
'She has released the pressure when she removes the cap.'

The realizations differ in more than marker choice, as different combinability constraints hold: The preferred order for *bevor*, *ehe*, *als* and *wenn* is postponed, whereas *vor* and *davor* are more often encountered in a preposed ordering. An imperfective aspect (**ASPECT-SC: imperfective**) is required in the subordinate clause with *bevor*, *ehe*, *als* and *wenn*,¹² and a perfective aspect (**ASPECT-MC: perfective**) in the main clause for *als* and *wenn* to signal posteriority. Finally, *als* and *wenn* cannot be used in an imperative construction, hence the somewhat odd declarative paraphrases.

Now, how do combinability constraints and preferences support a motivated choice between these alternatives? Depending on choices made by other sentence planning modules, different subsets of temporal markers remain. Take, for instance, possible choices made by a module responsible for deciding on the syntactic structure. In case two sentences are

¹¹Given the text type 'technical instructions', I choose an imperative mood. Note that this realization is not possible with *als* and *wenn*: They can only be used in the declarative mood; a constraint not yet represented in the lexicon.

¹²Used with a perfective aspect, *bevor* and *ehe* would signal simultaneity.

[Wait]¹ **until** [the engine is cool]², **then** [turn the radiator cap counterclockwise]³
until [it stops]⁴. [DO NOT PRESS DOWN]⁵ **WHILE** [TURNING THE CAP]⁶.

[Warten]¹ **bis** [der Motor kalt ist]², **dann** [den Kühlerdeckel im Gegenuhrzeigersinn
drehen]³ **bis** [zum Anschlag ()]⁴. **BEIM** [DREHEN]⁶ [DEN DECKEL NICHT
NIEDERDRÜCKEN]⁵.

Figure 10.15: Extract from the ‘Adding coolant’ text (TC.25)

intended (PART-OF-SPEECH: *pronadv*), *davor* (example 10.4d) is the only possible realization. If a clause complex is preferred (PART-OF-SPEECH: *subc|coordc*), *bevor*, *ehe*, *als* and *wenn* (examples 10.4a/b/e/f) are applicable; in case of a PP (PART-OF-SPEECH: *prep*), *vor* (10.4c) would be chosen. Another sentence planning decision concerns the inclusion of a modifier. If MODIFICATION: *modifiable* holds, only *bevor* and *vor* (10.4a/c) remain. Further, considering events in the past (EVENT-SPEAKING-TIME: *E-Sitm_S E-Sits_S*) rules out *wenn* (10.4f), events in the present (EVENT-SPEAKING-TIME: *E-Sitm,S E-Sits,S*) exclude *als* (10.4e). The Aktionsart is also a distinguishing parameter: If a lexicalization module selects a semelfactive verb for the momentaneous activity REMOVE-1 (AKTIONSPORT-MC: *semelfactive*), all candidate markers are applicable (cf. lexicon entries). However, in examples such as

- (10.5) ***Als** *sie den Deckel abschraubte, hatte sie den Druck abgelassen.*
As she the cap unscrewed, had she the pressure released.
‘When she unscrewed the cap, she had released the pressure.’

where the subordinate clause situation has a duration and is denoted by a durative verb (here *abschrauben*; AKTIONSPORT-SC: *durative*), *als* cannot be used, whereas *bevor*, *vor*, *ehe*, *davor* yield well-formed sentences. The discussion so far might invoke the impression that the sentence planning modules make their decisions in strict sequence. This is due to the fact that I want to demonstrate the effects of particular decisions. However, as has been suggested in the discussion of the sentence planning phase in Section 10.1.2 above, in the ideal case, constraints are put forward simultaneously and the best solution is then determined.

As for the preferences, if brevity is a stylistic concern (BREVITY: *concise*), and the process in the subordinate clause (REMOVE-1) can be deverbalized, a phrasal realization with the preposition *vor* is selected (10.4c). If, on the other hand, a more formal realization is the overall goal given to the generator (FORMALITY: *highfalutin*), *ehe* (10.4b) would be chosen.

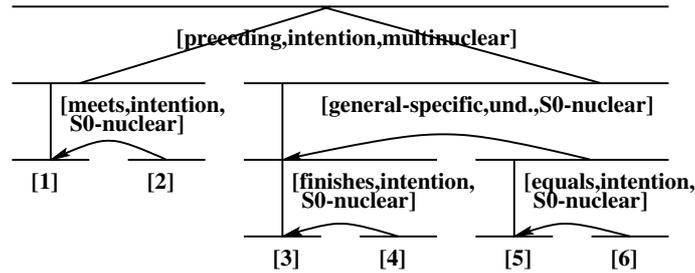


Figure 10.16: Coherence relations holding in the ‘Adding coolant’ text

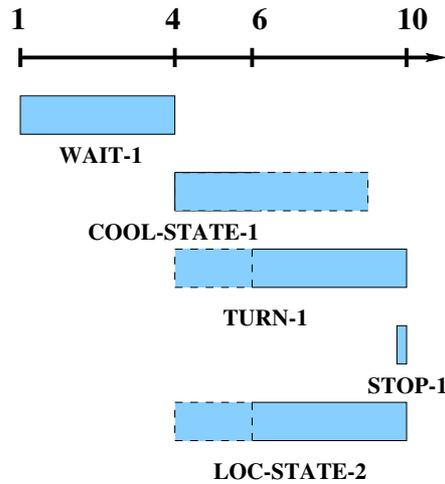


Figure 10.17: Situations expressed in the coolant text ordered on the time axis

10.4.4 Example 4: Multilingual example from the corpus

Finally, consider a segment from a bilingual technical instructional text—the checking coolant instruction from the Honda car manual (TC.25)—which is given in Figure 10.2. Let us examine the first three sentences from this text more closely, where temporal relations and hence temporal markers dominate. Figure 10.15 shows the German and English texts, partitioned into discourse segments. Temporal markers are given in boldface. Figure 10.16 depicts the corresponding discourse representation, reproduced from Figure 8.7 in Chapter 8.

To select an appropriate temporal discourse marker, we need not only know the coherence relations holding between the situations denoted by the text segments [1] to [6], but moreover their begin and end points. In contrast to the examples given so far, I do not present the complete TSitSpecs, and only give their position on the time axis (cf. Figure 10.17). The time points ascribed to the situations are fictitious numbers to illustrate the temporal relations between the situations. These time points do not make any assumptions about the actual extension of the situations in reality. Note that discourse segments [3] and [5] refer to the same situation, the activity of turning the cap (TURN-1).

In the following, I discuss how discourse markers are selected for those pairs of situations verbalized in the sample text that are in a temporal relation. I demonstrate that the discourse marker selection procedure proposed in this thesis supports the selection of an appropriate temporal marker when fed with the coherence relation and the situation types, and when having access to the discourse marker lexicon and to the decisions made by other sentence planning modules. Ideally, the temporal markers proposed by my selection procedure include the temporal marker employed in the source text; and utterances containing other selected temporal markers (i.e. members of the set of candidate markers) form legal paraphrases of the original text. If no other markers are proposed that yield ill-formed sentences, then we can argue that the selection procedure works appropriately.

The applicability conditions for temporal markers are derived from the input to the selection procedure: above all, the coherence relation and the properties of the conjoined situations. But what about the combinability constraints? In a generation scenario, these constraints are given by other sentence planning modules; and the constraints have consequences for the syntactic and lexical realization of an utterance containing a discourse marker. The existing constraints can thus be read off the the lexical and syntactic properties of the resulting text. In short, in the following example the constraints posited by sentence planning modules are inferred from the lexical and syntactic properties of the source text. If my discourse marker selection procedure works correctly, these constraints should support the choice of an adequate temporal marker.

To return to the discussion of the sample text: Temporal relations hold, according to Figure 10.16, between text segments [1] and [2], [3] and [4], [5] and [6], and the non-terminal text segments [1-2] and [3-6]. Text segments [3-4] and [5-6] are in an ELABORATION relation, hence they will not be discussed here. Note that the selection of English temporal markers is only explained for those examples where lexicon entries for English markers exist; *then* and *bis* in its simultaneity reading are not in the lexicon. Due to the larger number of German temporal markers, the major part of the discussion relates to the selection of German connectives.

Text segments [1] and [2]. Let us first consider text segments [1] and [2], which denote the protracted activity of waiting (WAIT-1) and the state of being cool (COOL-STATE-1). In text TC.25, this constellation is realized as:

(10.6)

- a. *Warten, **bis** der Motor kalt ist.*
- b. *Wait **until** the engine is cool.*

According to Figures 10.16 and 10.17, the input to my discourse marker selection procedure is:

$$\text{coh_rel}(\text{wait-1}, \text{cool-state-1}) = [\text{MEETS}, \text{INTENTION}, S_0\text{-NUCLEAR}]$$

The temporal relation is MEETS because WAIT-1 lasts from 1 to 4, and COOL-STATE-1 extends from 4 onwards.

Since the text is in present tense, the speaking time is equal to the event time. The following instantiation for FS_{appl-i} holds:

TEMPORAL-RELATION: meets
 INTENTION: intention
 NUCLEARITY: SO-nuclear

Matching this with the FS_{appl-m} as given in the lexicon yields the following set of German candidate markers:

Candidate markers = {bevor, vor, ehe, davor, bis, bis (P), als, wenn}

The additional constraints are verified in Step 1b: Given the time stamps associated with WAIT-1 and COOL-STATE-1, proximity, adjacency, immediacy and duration can be calculated. These constraints, presuppositions, and the situation types (PROTRACTED-ACTIVITY and LEFT-BOUNDED-STATE) give rise to the following additional values for FS_{appl-i} :

CONSTRAINTS: prox next imm
 EXTENSION: dur
 PRESUPPOSITION: presupposed
 BOUNDEDNESS-SIT-M: r-bounded
 BOUNDEDNESS-SIT-S: l-bounded
 SITUATION-TYPE: left-bounded-state

These properties reduce the set of candidate markers considerably: *Bevor*, *vor* and *ehe* (before, before (prep), before (archaic)) are ruled out because neither *next* nor *dur* hold. A sentence such as

(10.7) *Warten, **bevor** der Motor kalt ist.*
 Wait, before the engine cool is.
 ‘Wait before the engine is cool.’

loses the information concerning the immediacy of the situations and the fact that the WAIT-activity is delimited by the COOL-state. temporal extension of the WAIT-1 activity. In contrast, *als* and *wenn* fail because they cannot be used with a left-bounded state in *Sit_s*. Hence, Step 1b returns the following markers:

Candidate markers = {bis, bis (P)}

As regards the English verbalization, only one English temporal marker meets the applicability conditions postulated so far: *until* (cf. Table 10.5).

In the coolant text, the following syntactic and lexical constraints hold: The Aktionsart for the main clause event is durative, the subordinate clause event is stative. Further, both clauses of the clause complex realize an imperfective aspect, the tense is the same in both clauses. This suggests the following combinability constraints FS_{comb-i} :

PART-OF-SPEECH: *subc*
 AKTIONSART-MC: *durative*
 AKTIONSART-SC: *stative*
 ASPECT-MC: *imperfective*
 ASPECT-SC: *imperfective*
 EVENT-TIMES: *E-Sitm,E-Sits*

If we assume that these are among the constraints posited by other sentence planning modules, which German discourse marker satisfies these constraints? In Step 3b these constraints are compared with the combinability zones in the lexicon entries of *bis* and *bis (P)*. Both candidate markers are still applicable:

Candidate markers = {bis, bis (P)}

Possible realizations hence differ with respect to the syntactic structure:

(10.8)

- a. *Warten, bis der Motor kalt ist.*
 Wait until the engine cool is.
 ‘Wait until the engine is cool.’
- b. *Warten bis zum Erkalten des Motors.*
 Wait until to cooling of the engine.
 ‘Wait until the end of the cooling down of the engine.’

Example (10.8a)—containing the discourse marker *bis* (until)—corresponds to the realization in the original text. Regarding the English discourse marker, the same syntactic and lexical constraints apply, i.e. FS_{comb-i} is the same. Only the candidate marker *until* meets these constraints (compare the lexicon entry in Table 10.5), which suggests the following realization:

(10.9) *Wait **until** the engine is cool.*

The prepositional variant is not available for English. Expressing processes as phrases is a register-specific property of German instructional texts. Note that the discourse marker selection procedure not only decides on the same temporal marker as is employed in the

original text—and thereby proves the feasibility of the approach—but moreover suggests an alternative verbalization of the underlying coherence relation. Here, the preposition *bis* is also selected (see example 10.8b).

Further paraphrases of the source text include the following German and English utterances:

(10.10)

- a. *Warten, bis der Motor abgekühlt ist.* (until)
- b. *Warten, solange der Motor abkühlt.* (as long as)
- c. *Warten, während der Motor abkühlt.* (while)
- d. **Während** *des Abkühlens des Motors warten.* (during)
- e. **Beim** *Abkühlen des Motors warten.* (during)
- f. *Der Motor kühlt ab. Währenddessen warten.* (meanwhile)
- g. *Wait until the engine has cooled down.*
- h. *Wait while the engine is cooling down.*

The major difference to the original text lies in the perspective on the ‘cooling’ event. In examples (10.10a-h), the process of cooling down is verbalized, not the state of being cool (which is the post-state of the ‘cooling-down’ event) as has been done in example (10.6) above. The process of cooling down (protracted culmination COOL-DOWN-1) takes place at the same time as WAIT-1. Reaching the state COOL-STATE-1 terminates the waiting activity. Hence, both situations extend until time point 4, and the temporal relation is that of *finishes*(wait-1,cool-down-1). The coherence relation now is:

$$\text{coh_rel}(\text{wait-1,cool-down-1}) = [\text{FINISHES,INTENTION,S}_0\text{-NUCLEAR}]$$

Steps 1a and 1b of the selection procedure give the following $FS_{\text{appl}-i}$:

TEMPORAL-RELATION: finishes
 INTENTION: intention
 NUCLEARITY: S0-nuclear
 CONSTRAINTS:
 EXTENSION: dur
 PRESUPPOSITION: presupposed
 BOUNDEDNESS-SIT-M: r-bounded
 BOUNDEDNESS-SIT-S: l-bounded
 SITUATION-TYPE: protracted-culmination

and the candidate markers:

Candidate markers = {*bis*, *bis(P)*, *während*, *während(P)*, *währenddessen*, *bei*, *solange*}

Bis and *bis (P)* would be the preferred choice, as they exactly meet the applicability conditions. Regarding English temporal connectives, only *while* meets the constraints, since the simultaneous reading of *until* is not included in the lexicon.¹³

Depending on what aspect of the protracted culmination COOL-DOWN-1 is in focus (the activity itself or reaching the post-state), a lexicalization module might select different verbs, yielding different discourse markers: If the post-state of the protracted culmination is in focus, the *resultative ist abgekühlt* (has become cold) will be preferred, yielding utterances (10.10a) and (10.10g). If the process of cooling down, i.e. the activity itself, is to be expressed, a verb with a *durative* Aktionsart such as *abkühlen* (to cool down) is selected (all other sentences of example (10.10)). Here are two possible instantiations of FS_{comb-i} . First, the resultative reading:

AKTIONSART-MC: durative
 AKTIONSART-SC: resultative
 ASPECT-MC: imperfective
 ASPECT-SC: perfective
 EVENT-TIMES: E-Sits, E-Sitm

Candidate markers = {*bis*, *bis(P)*}

A possible realization is given in example (10.10a) above. The resultative Aktionsart in the subordinate clause rules out all other temporal markers (cf. lexicon entries in Appendix B). Example (10.10g) gives the English equivalent. Note however that due to the restriction of the lexicon, the marker selection cannot be motivated at this stage. The second option yields the following FS_{comb-i} and a different set of possible markers:

AKTIONSART-MC: durative
 AKTIONSART-SC: durative
 ASPECT-MC: imperfective
 ASPECT-SC: imperfective

Candidate markers = {*während*, *während (P)*, *währenddessen*, *bei*, *solange*}

Possible verbalizations are given in examples (10.10b) to (10.10f). *Bei* (during) additionally requires that both situations take place at the same location, which need not be the case in the present example. Regarding the English realization, constraints on the syntactic and lexical environment include the following:

AKTIONSART-MC: durative
 AKTIONSART-SC: durative
 ASPECT-MC: imperfective
 ASPECT-SC: progressive

¹³Note that the English lexicon entries are limited to those temporal markers whose lexicogrammatical properties are discussed in [Hitzeman 1995] and [Dorr and Gaasterland 1995].

Given the limited set of English temporal markers, *while* is the only possible realization, as in example (10.10h) above.

Text segments [3] and [4]. According to Figure 10.17, the temporal relation between the protracted activity of turning the cap ([3], TURN-1) and the momentaneous activity of stopping this activity ([4], STOP-1) is that of *finishes*(turn-1,stop-1), with STOP-1 acting as the temporal anchor. The coherence relation holding between the two segments is, in line with my analysis in Figure 10.16, as follows:

$$\text{coh_rel}(\text{turn-1,stop-1}) = [\text{FINISHES,INTENTION,S}_0\text{-NUCLEAR}]$$

In the sample text, this coherence relation is realized as:

(10.11)

- a. [...] *den Kühlerdeckel drehen* **bis** *zum Anschlag.*
- b. [...] *turn the radiator cap counterclockwise* **until** *it stops.*

In Step 1a of the selection procedure, the following $FS_{\text{appl}-i}$ is derived, which generates the candidate markers given below:

TEMPORAL-RELATION: *finishes*
 INTENTION: *intention*
 NUCLEARITY: *S0-nuclear*

Candidate markers = {bis, bis (P), während, während (P), währenddessen, bei, solange}

No English marker applies, again due to the small coverage of the English lexicon. Additional constraints are derived in Step 1b of the selection procedure. For the present situation pair, these are:

CONSTRAINTS:
 EXTENSION: *dur*
 PRESUPPOSITION: *presupposed*
 BOUNDEDNESS-SIT-M: *r-bounded*
 BOUNDEDNESS-SIT-S: *lr-bounded*
 SITUATION-TYPE: *momentaneous-activity*

Candidate markers = {bis, bis (P)}

All markers except for *bis* and *bis (P)* leave the temporal extension of situation TURN-1 implicit. Step 3a results in a set of combinability constraints; the choices made by the different sentence planning modules can be read of from example (10.11a): The verb realizing the TURN-1 activity (*drehen*, to turn) is durative; the one expressing the STOP-1 activity (*anschlagen*) is semelfactive. Both clauses have the same tense and an imperfective aspect. Thus, $FS_{\text{comb}-i}$ looks as follows:

AKTIONSART-MC: durative
 AKTIONSART-SC: semelfactive
 ASPECT-MC: imperfective
 ASPECT-SC: imperfective
 EVENT-TIMES: E-Sitm,E-Sits

The less specific markers (those that have no entry for the **extension** attribute) *während*, *während(P)*, *währenddessen*, *bei* and *solange* (while, during, meanwhile, during, as long as) would be ruled out at this stage, because they cannot occur with a semelfactive verb in the subordinate clause. My procedure returns as possible markers

Candidate markers = {bis, bis (P)}

This might yield the following realizations:

(10.12)

- a. *Den Kühlerdeckel drehen bis zum Anschlag.*
 The coolant cap turn to the stop.
 ‘Turn the coolant cap up to its stop.’
- b. *Den Kühlerdeckel drehen bis er anschlägt.*
 The coolant cap turn until it stops.
 ‘Turn the coolant cap until it stops.’

Text segment [5] and [6]. Text segments [5] and [6] denote the protracted activity of turning (TURN-1) and the bounded state of not pressing down (LOC-STATE-2). In the sample text, these are verbalized as:

(10.13)

- a. **Beim** *Drehen den Deckel nicht niederdrücken.*
- b. *Do not press down while turning the cap.*

What motivates the selection of these discourse markers? Again, my selection procedure can account for this choice. As Figure 10.17 shows, both situations extend over exactly the same period of time: From time point 4 (or 6, see discussion below) to 10. Consequently, *equals(turn-1,loc-state-2)* holds. Note that pressing down is itself a protracted activity, but its negation denotes a state: the state of not being pressed down. The following coherence relation holds according to Figure 10.16:

coh_rel(turn-1,loc-state-2) = [EQUALS,INTENTION,S₀-NUCLEAR]

Hence, FS_{appl-i} and applicable markers at the end of Step 1a of the marker selection procedure are:

TEMPORAL-RELATION: equals
 INTENTION: intention
 NUCLEARITY: SO-nuclear

Candidate markers = {*während*, *während (P)*, *währenddessen*, *bei*, *mit*, *dabei*,
solange, *als*, *wenn*}

Applicable English connectives are *while* and *when*. Constraints given by the situation types are determined in Step 1b:

CONSTRAINTS:
 EXTENSION:
 PRESUPPOSITION: presupposed
 BOUNDEDNESS-SIT-M: lr-bounded
 BOUNDEDNESS-SIT-S: lr-bounded
 SITUATION-TYPE: bounded-state

The set of candidate markers is reduced to the following set:

Candidate markers = {*während*, *während(P)*, *währenddessen*, *bei*, *mit*, *dabei*,
solange}

With respect to English, only *while* remains as possible verbalization of the temporal coherence relation. *Als*, *wenn* (as, when) and *when* are ruled out because they are not compatible with the situation-type value.

Step 3a of the selection procedure now gathers the combinability constraints given by other sentence planning modules. As already mentioned above, I assume that the verbalization in the text reflects the sentence planning decisions, and thus take the original text as the source of combinability constraints. For the present example, FS_{comb-i} looks as follows:

AKTIONSART-MC: durative
 AKTIONSART-SC: stative
 ASPECT-MC: imperfective
 ASPECT-SC: imperfective
 EVENT-TIMES: E-Sitm,E-Sits

Only *mit* (with) is ruled out as it cannot be used with stative verbs in the subordinate clause. According to my procedure, possible realizations of the coherence relation holding between text segments [5] and [6] are:

Candidate markers = {*während*, *während (P)*, *währenddessen*, *bei*, *dabei*, *solange*}

The English *while* is also still a candidate, considering the diverging instantiation of the aspect attribute: ASPECT-SC: **progressive**. Depending on other sentence planning decisions, such as the choice of a syntactic structure, the following German realizations are possible, which are either equal (10.14a) or paraphrases (10.14b-f) of the original text given in example (10.13) above:

(10.14)

- a. **Beim Drehen den Deckel nicht niederdrücken.** (during)
PART-OF-SPEECH: prep, CONSTRAINTS: same-place
- b. **Während des Drehens den Deckel nicht niederdrücken.** (during)
PART-OF-SPEECH: prep
- c. **Während Sie drehen, den Deckel nicht niederdrücken.** (while)
PART-OF-SPEECH: subc
- d. **Solange Sie drehen, den Deckel nicht niederdrücken.** (as long as)
PART-OF-SPEECH: subc
- e. *Den Deckel drehen.* **Währenddessen** *den Deckel nicht niederdrücken.* (meanwhile)
PART-OF-SPEECH: pronadv
- f. *Den Deckel drehen.* **Dabei** *den Deckel nicht niederdrücken.* (thereby)
PART-OF-SPEECH: pronadv

Again given the small coverage of the English lexicon, only paraphrases using the discourse marker *while* could be produced:

(10.15)

- a. *Do not press down* **while** *turning the cap.*
- b. *Do not press down* **while** *you are turning the cap.*

Regardless of the availability of lexicon entries, a phrasal realization would not be chosen in the English version of the text, as this is an atypical construction in English instructions.

Text segments [1-2] and [3-6]. Finally, consider the temporal coherence relation holding between the non-terminal nodes [1-2] and [3-6]. In the sample text, this relation is not realized by a subordinate conjunction, as all the relations holding between terminal nodes discussed above, but by a conjunctive which can cover larger text spans.¹⁴

(10.16)

¹⁴Using conjunctives or pronominal adverbs to relate larger text spans is a common realization, as has already been noted by, for instance, [Rösner and Stede 1992, DiEugenio *et al.* 1997].

- a. *Warten, bis der Motor kalt ist, **dann** den Kühlerdeckel im Gegenuhrzeigersinn drehen [...]*
- b. *Wait until the engine has cooled down, **then** turn the radiator cap counterclockwise [...]*

The specific kind of temporal relation cannot be read off the temporal marker employed: *Dann* and *then* can either indicate a simple precedence relation, but can also be used for situations that immediately follow each other. This ambiguity is reflected in Figure 10.17 where two time-stamps are associated with the beginning of the TURN-1 activity: Depending on whether TURN-1 starts at time point 4 or 6, different paraphrases are possible: If it meets the WAIT-1 situation, then *sobald* (as soon as) would be an alternative realization; if there is a small interlap between the two situations, *nachdem* would be a possible choice. As a consequence, the coherence relation comprises the non-terminal [PRECEDING] as ideational relation (cf. Figure 8.2 in Chapter 8), which subsumes the more specific [MEETS] and [BEFORE]:

$$\text{coh_rel}(\text{turn-1,loc-state-2}) = [\text{PRECEDING,INTENTION,MULTINUCLEAR}]$$

Step 1a of the selection procedure again produces $FS_{\text{appl-}i}$:

TEMPORAL-RELATION: meets | before
 INTENTION: intention
 NUCLEARITY: multinuclear

Only a small number of markers apply, due to the nuclearity value:

$$\text{Candidate markers} = \{\text{dann, daraufhin, danach}\}$$

Then would be the English equivalent, but this marker is not present in the lexicon. Additional applicability conditions are derived in Step 1b, these are:

CONSTRAINTS: prox
 EXTENSION:
 PRESUPPOSITION: presupposed
 BOUNDEDNESS-SIT-M: lr-bounded
 BOUNDEDNESS-SIT-S: lr-bounded
 SITUATION-TYPE: protracted-activity

This does not alter the set of candidate markers.

As regards the constraints on the lexicogrammatical environment of the temporal marker, the following selections have been made by other sentence planning modules (as can be read off the source text):

AKTIONSART-MC: durative
 AKTIONSART-SC: durative
 ASPECT-MC: imperfective
 ASPECT-SC: imperfective
 EVENT-TIMES: E-Sitm,E-Sits

Matching this against the combinability zones of the candidate marker's lexicon entries yields:

Candidate markers = {dann, daraufhin, danach}

Possible realizations include the source text (10.17a) and paraphrases (10.17b-d):

(10.17)

- a. *Warten, bis der Motor kalt ist, dann den Kühlerdeckel*
 Wait until the engine cool is, then the coolant cap
im Gegenuhrzeigersinn drehen [...]
 counterclockwise turn [...]
 'Wait until the engine is cool, then turn the coolant cap counterclockwise [...].'
- b. *Warten, bis der Motor kalt ist. Danach den Kühlerdeckel im Gegenuhrzeigersinn drehen [...]* (afterwards)
- c. *Warten, bis der Motor kalt ist. Daraufhin den Kühlerdeckel im Gegenuhrzeigersinn drehen [...]* (thereupon)
- d. *Warten, bis der Motor kalt ist. Den Kühlerdeckel im Gegenuhrzeigersinn drehen [...]* (no marker)

The temporal markers in examples (10.16) and (10.17) leave the specific type of precedence relation open to speculation. If the nuclearity is changed to NUCLEARITY: S1-nuclear, then the exact nature of the temporal relation can be signaled:

(10.18)

- a. **Nachdem** *Sie gewartet haben, bis der Motor kalt ist, den Kühlerdeckel*
 After you waited have, until the engine cool is, the coolant cap
[...] drehen.
 [...] turn.
 'After you have waited until the engine is cool, turn the coolant cap [...].'
- b. **Sobald** *der Motor kalt ist, den Kühlerdeckel drehen.*
 As soon as the engine cool is, the coolant cap turn.
 'As soon as the engine is cool, turn the coolant cap.'

When using a pronominal adverb, an additional modifier such as *direkt danach* (immediately afterwards) has the same effect:

- (10.19) *Warten, bis der Motor kalt ist. Direkt danach den Kühlerdeckel*
 Wait, until the engine cool is. Immediately afterwards the coolant cap
[...] drehen.
 [...] turn.
 ‘Wait until the engine is cool. Immediately afterwards, turn the coolant cap [...].’

To sum up, the examples in this section demonstrate that the discourse marker selection procedure, deploying the discourse marker lexicon, supports the choice of appropriate discourse markers. Given the coherence relation and the discourse marker lexicon, it explains how the temporal markers in the sample text are selected, and moreover proposes well-formed alternative realizations. The examples have further revealed that the coherence relation to be signaled and the semantic constraints play a major role in determining applicable discourse markers. As regards the combinability constraints, Aktionsart and aspect are the most influential constraints. This is to be expected as they are competing linguistic means to express temporality. Other sentence planning decisions such as syntactic structuring and ordering only play a secondary role; they help to choose from a set of near-synonyms such as, for instance, *nachdem*, *nach*, *danach*.

Chapter 11

Summary and conclusions

11.1 Summary of the thesis research

Motivations. Current text generation systems are not very good at choosing discourse markers: They either adhere to the ‘one-relation-one-marker’ strategy, or consider only a small set of discourse markers. Yet, language offers many discourse markers to express individual coherence relations. These markers signal pragmatic and semantic aspects on top of the coherence relation itself. For instance, the concessive markers *although* and *even though* differ in emphasis, and the German temporal markers *bevor* and *ehe* in style. Not paying attention to these fine-grained meaning differences severely restricts the expressiveness of text generators, and may also decrease the readability or even endanger the correct interpretation of a text. In particular, genres such as technical instructions require that the relationships between text spans are unambiguously signaled to avoid unintended (and possibly dangerous) reader activities. More fine-grained knowledge on the behaviour of discourse markers has to be made available, and an architecture has to be designed that integrates discourse marker choice into the overall generation process in order to overcome the limitations of current text generators.

Exploiting discourse markers in text generation presupposes a detailed analysis of the function and form of a wide range of markers. However, available descriptive studies on discourse markers do not meet this demand as they usually either focus on the syntactic functions of discourse markers, or have only a small coverage. Moreover, most studies do not explicate the relation of discourse markers to coherence relations, an issue vital to discourse marker choice in text generation. This aspect of discourse marker study is thus very much a field open to research.

Both areas, linguistic research and text generation, can benefit from each other: The descriptive work on discourse marker function and form, and the representation in a uniform framework provide valuable resources for a text generator that aims at more sophisticated discourse marker choice. Likewise, knowledge-based text generation, where an abstract meaning representation is transformed into a linguistic utterance, is an excellent vehicle for testing the adequacy of theoretical accounts of discourse markers.

In the following, the thesis research is summarized. The areas of discourse marker analysis and representation are addressed first. Then, the research in the context of discourse level and discourse marker lexicon is summarized, before turning to the application of the proposed representations and resources (discourse marker selection).

Discourse marker analysis and representation. The shortcomings of text generators regarding discourse marker choice and the lack of comprehensive and at the same time detailed accounts of discourse markers motivated the descriptive part of the thesis. The first task consisted in assembling the set of linguistic items under investigation. This turned out to be rather difficult as discourse markers are a functionally homogeneous, but formally heterogeneous class. Therefore, I designed a *Test for discourse markers in German texts*, which provides—mainly functional—criteria for identifying German discourse markers in unrestricted text. Further, I enhanced the existing English test to accommodate a wider range of word classes. Subsequently, these tests were used to determine the set of German and English discourse markers in the text type under consideration, technical instructions. Next to causal markers, temporal markers turned out to be the most frequent ones in this text type. As causal markers have received considerable attention, I decided on temporal markers as the subject of this thesis.

In a subsequent step, I identified the *dimensions* of discourse marker description, that is, the properties that have to be accounted for in a comprehensive description of temporal discourse markers. Here, I drew on available research on German temporal markers; my set of dimensions is more or less an edited superset of the ones given in existing studies on German temporal discourse markers.

The major part of the purely *descriptive work* in this thesis has been devoted to the detailed discussion of those discourse markers that can signal temporal relations in text, addressing all the different dimensions that have been identified. Specifying the distinctions between discourse markers is a subtle task. I used two sources of information for accumulating knowledge on individual markers: Corpus analyses on the one hand, and available studies on temporal markers, dictionaries, grammars, and lexica on the other. I gave fine-grained descriptions of the semantic, pragmatic, and syntactic characteristics of each of the German temporal discourse markers under consideration. I then merged the results from the analysis into a single functional representation, a *classification of German temporal conjunctive relations*, similar to the one given by [Martin 1992] for English. The system network defines the possible interpretations of the temporal discourse markers, and explicates similarities and differences between individual temporal markers. A functional framework was chosen for the following reasons: First, a functional approach such as Systemic Functional Linguistics makes it possible to represent semantic and pragmatic conditions of discourse marker usage in a principled way, as is required for motivated marker choice. Second, it systematically represents environments in which a discourse marker may occur, and specifies the linguistic conditions of use. Finally, it can ensure high degree of accuracy in the description while at the same time allowing for a large coverage of linguistic means.

The descriptive part of the thesis concluded with a *contrastive study* of German, English, and Dutch temporal conjunctive relation networks, as the sharing of resources is an issue

in Systemic Functional Linguistics as well as in multilingual text generation. I claimed that a large part of the conjunctive relation networks are compatible, and that languages mainly differ in the more delicate regions of the networks. In particular, the English and German classifications are in large parts identical. The German account differs from the English account in that lexicogrammatical constraints are given, and sets itself apart from the Dutch account regarding the coverage. However, these differences do not pertain to the functional potentials of the languages under consideration, but are due to different orientations of the descriptions.

Discourse level. Discourse markers are generally said to signal coherence relations; these relations are the major constraint on discourse marker choice. Many current text generation systems use Rhetorical Structure Theory to describe the discourse structure of a text. This implies that discourse marker choice starts from this representation, as in fact it does in most systems that implement marker choice. However, I identified several shortcomings of RST that unnecessarily complicate the discourse selection task, namely the missing criteria for introducing new relations to the set, the conflation of different discourse ‘functions’ in one relation, and the unclear relation of RST-relations to surface linguistic forms.

To overcome these limitations, I proposed an alternative approach to coherence relations, based on work by [Bateman and Rondhuis 1997]: I follow their approach and assume that three dimensions of discourse representation are required to adequately describe text coherence. I adopted Bateman and Rondhuis’ classification of ‘discourse purposes’ [Bateman and Rondhuis 1997]: ideational, interpersonal, textual. I then gave evidence from one particular text type, technical instructions, and proposed *sets of ‘pure’ relations* holding at the different dimensions that I claim are sufficient to describe the coherence relations in these texts. Based on these results, I then extended the networks given by [Bateman and Rondhuis 1997] substantially. The features proposed in this thesis are grounded in non-linguistic knowledge sources such as a task or intentional structure which are assumed to underly technical instructional texts, and supported by linguistic evidence. I then successfully applied the composite coherence relations to the *analysis* of two technical instructional texts.

I further claimed that the representation of coherence relations and their communication in a single unfolding of the text are two independent matters. By *decoupling coherence relations and cohesive means*, my approach can support the selection of discourse markers in different languages. Finally, I demonstrated that the distinctions in the three dimensions of discourse representation relate to discourse marker usage in a principled way.

Discourse marker lexicon. In most current MLG systems, the selection of discourse markers is treated as a mere consequence of other sentence level decisions, which is a simplification, given the complex nature of discourse markers. To overcome this restriction, I maintained that discourse markers are best treated similarly to content words, and that discourse marker selection is viewed as a subtask of the general lexical choice procedure. Further, discourse markers should be, just like content words, represented in such a way that their syntactic, semantic, and pragmatic properties are made explicit. I argued that

due to my assumptions on the generation process, in particular on the sentence planning phase, and in order to account for the interactions between discourse markers and other sentence planning tasks, such a declarative resource should be a dedicated *discourse marker lexicon*.

I then introduced my assumptions about the lexicon: The lexicon I envisage follows current work on lexicon design and assumes two layers: First, a flat layer of basic descriptions of *lexicon entries*, where a lexicon entry consists of attribute-value pairs. Second, a *structuring layer* which introduces classifications and links entries, for instance, by means of inheritance and lexical relations. The basic units in the lexicon are word senses. I gathered the set of attributes and the sets of possible values that define a lexicon entry from the dimensions of marker description, the functional classification of temporal markers, and the coherence relation networks. Additional attributes pertaining to non-linguistic information were inspired by the EAGLES recommendations. Attributes may either hold for all markers, or be specific to a particular marker class.

Finally I presented a *definition of a general discourse marker lexicon entry*, following the guidelines for lexical semantic encoding set up by the EAGLES consortium, and defined a subtype accounting for the specific properties of German temporal markers. Contrary to my initial hypothesis (Chapter 4), it turned out that the majority of attributes is shared across marker classes, only a small set turned out to be marker specific.

Discourse marker selection in text generation. In the final chapter of the thesis, I addressed the questions of how discourse markers are selected automatically, and how the linguistic resources outlined in earlier parts of the thesis—the paradigmatic representation of coherence relations and the discourse marker lexicon—contribute to this task. I suggested that discourse marker choice is performed at the sentence planning level, and gave linguistic evidence to support this view. I then outlined the *generation architecture* I propose, and introduced the *generation lexicon*, which can be conceived as an instantiation of the generic discourse marker lexicon, tailored towards the specific needs of text generation.

Next, I gave *sample entries* to the discourse marker generation lexicon, namely for German and English temporal discourse markers. I demonstrated how the values can be derived from the functional classifications which provide all the information required for discourse marker choice, in a principled way. I then proposed a *computational model for discourse marker selection* that is situated at the sentence planning stage, and that employs the discourse marker lexicon as its central resource. In this thesis, I investigated the specific problem of signaling a temporal relationship between two situations, i.e. of two abstract meaning representations that have to be transformed into a linguistic utterance. This involved designing the abstract representation. To meet the specific demands of temporal markers, I augmented the input representation used by [Stede 1999] for the lexical choice of verbs with time stamps (*TSitSpecs*), and introduced additional categories to the ontology of situations.

Given the selection procedure, the input representation, and the discourse marker lexicon, I worked through a number of *examples*, some of them bilingual (German and English), to

demonstrate the functionality of the approach proposed. The examples showed that the procedure is capable of selecting discourse markers in different languages that convey the right semantic and communicative goals, and that respect contextual constraints.

11.2 Contributions of the thesis

As an interdisciplinary endeavour, the thesis makes contributions to the two distinct areas of linguistic description and natural language processing.

Definition of discourse markers. It has been pointed out at various places that discourse markers are a functionally homogeneous, yet formally heterogeneous class of lexical items. To my knowledge, no reliable method for identifying German discourse markers in text is available; and discourse markers are seldom regarded as a special ‘class’. Existing tests are biased towards the formal properties of discourse markers [Pasch *et al.*, in prep.]. This thesis makes substantial contributions to delimiting and characterizing the class of discourse markers by defining a *Test for identifying discourse markers in German text*, which mainly draws on functional properties of the lexical items that are discourse marker candidates (Section 4.2.1). The test provides a *definition* of the class of discourse markers by explicating the criteria for classifying a lexical item as discourse marker.

Further, as the scope of the English test designed by [Knott 1996] turned out to be insufficient, I enhanced Knott’s test by criteria that deal with prepositions (Section 4.2.1). The *revised English test* covers the same range of lexical items as the German test. This relates to the discussion on the minimal units in discourse analysis: By enhancing the test to include prepositions, I provide an answer to the question whether prepositional phrases can act as minimal units in discourse analysis.

Description of temporal marker meaning and usage. This thesis also makes a contribution to the description of German temporal discourse markers: It analyses a large group of markers, while at the same time ensuring high accuracy in the description (Chapter 6). In contrast to existing studies that usually have a small scope, I include the entire range of German temporal markers as given by [Helbig and Buscha 1991] in my study. Note that my thorough discussion of temporal markers is not intended as a re-analysis, but aims at *integrating* results from various *isolated studies* (which have high accuracy but small scope) into a single description, using a standardized terminology. Further, my description moves away from focusing on a small set of properties, and instead acknowledges a *wide range of factors* in marker characterization (Chapter 5). In brief, the contributions are threefold: identifying relevant parameters in discourse marker description; discussing a wide range of temporal markers at great detail; integrating existing selective studies.

Functional classification of German temporal markers. Another significant contribution of this thesis lies in the description of German temporal discourse markers within

the framework of Systemic Functional Linguistics (Chapter 7). While there exist functional accounts of a large range of English discourse markers [Martin 1992], and a small set of Dutch markers [Oversteegen 1993] in the shape of conjunctive relation networks, no such account was available for German discourse markers.

In this thesis, I propose a *network for German temporal conjunctive relations*, with temporal markers as realizations of system network features. This network merges the fine-grained descriptions of individual discourse markers into a single functional description, which exposes differences and commonalities between markers. The resulting system network captures the relation of discourse markers to context, and postulates constraints on their lexicogrammatical environment. It goes beyond available work in other languages in two ways: First, in contrast to the fairly comprehensive study of English temporal markers by [Martin 1992], I include *lexicogrammatical constraints* in my conjunctive relations network; and in contrast to [Oversteegen 1993] who investigate 6 Dutch temporal markers, my study has a significantly *larger coverage*.

An ultimate goal in Systemic Functional Linguistics is the provision of multilingual resources. The thesis' contribution to this goal is made by a thorough *contrastive discussion* of the German, English and Dutch accounts, which is a first step towards a joint multilingual network (Chapter 7).

Discourse relations. The questions concerning number and definitions of coherence relations, the levels of discourse representation, and the relation of coherence relations to surface linguistic means are all much debated topics in current work on coherence relations. This thesis contributes to the debate by providing answers to these open research issues against the background of a particular text type, technical instructional texts.

The first contribution lies in the design of a *strategy* for deriving a genre-specific set of 'pure' coherence relations and their definitions in a principled way: My coherence relations are firmly grounded in non-linguistic knowledge sources such as intentional structure and semantic relations which are assumed to underly technical texts, and their classification is supported by linguistic evidence (Sections 8.2 and 8.3.1). Second, taking the theoretical work by [Bateman and Rondhuis 1997] as a starting point, I presented a *paradigmatic representation* of coherence relations that describes the discourse purposes relevant to technical instructions along the three metafunctional dimensions maintained in SFL. The genre-specific classification rests on the notion of *composite* relations as posited by [Bateman and Rondhuis 1997] (Section 8.3.2). Thirdly, I illustrated how my *language-independent* composite relations, that make contributions from different 'functions' to coherence explicit, relate to discourse marker usage in a principled way (Section 8.5.2).

Discourse marker representation for text generation. In text generation, discourse marker choice is seldom regarded as a task in its own right, and discourse marker knowledge is spread over various linguistic resources. The contribution of this thesis regarding the representation of discourse markers lies first of all in the development of a *uniform and declarative resource* for storing information on discourse markers. In this thesis I propose

a novel resource, a dedicated *discourse marker lexicon* that stores all the information on discourse markers in a uniform way (Sections 9.1 and 9.2).

In line with present research on the lexicon, discourse marker properties are given as *attribute-values pairs* (Section 9.3). The set of attributes proposed in this thesis is more complex than any other list encountered in the literature. Usually, accounts focus on a small group of discourse markers, and on a particular kind of variation, hence they examine only a small set of attributes (for instance, [Elhadad and McKeown 1990] and [Dorr and Gaasterland 1995]). Further, this list is not just an accumulation of attributes found in research literature, as is usually the case in research that provides more comprehensive lists of features (see for instance [Stede and Umbach 1998]), but is motivated by a thorough linguistic analysis of discourse markers. Finally, the thesis contributes to the research on application-neutral computational lexica by providing a *lexicon definition for a particular class, discourse markers*, following the EAGLES guidelines for lexical semantic encoding (Section 9.3.3).

A further contribution of this thesis lies in the development of a general *strategy* to derive the lexicon entries from the functional classifications of discourse markers, and in the specification of *lexicon entries* for a particular marker group, German and English temporal markers (Section 10.2.4).

Automatic discourse marker selection. Most up-to-date generators do not treat discourse marker choice in a principled way. The thesis makes several contributions regarding the automatic selection of discourse markers: First, I equipped the generator with *sufficient knowledge* to support motivated choice from a set of discourse markers by providing a discourse marker lexicon. In particular, I proposed a representation of discourse markers that enables discourse marker choice and other sentence level decisions to mutually constrain each other (Section 10.2). Second, I presented a model for integrating discourse marker choice in the generation process: I proposed a general *discourse marker selection procedure* that selects (an) appropriate discourse marker(s) given a coherence relation (Section 10.3).

Temporal markers have not received much attention in text generation, with the exception being [Dorr and Gaasterland 1995] and [Klenner 1991], who, however, only discuss a small set of markers, and do not embed their approach into an overall generation framework. This thesis advances in this area by providing the required linguistic (the lexicon, coherence relations) and non-linguistic (extended situation hierarchy, TSitSpecs) knowledge sources to enable marker selection for a large range of German temporal discourse markers (Sections 10.2 and 10.3). It further demonstrated that the approach also works for other languages, such as English, given that the required knowledge sources are available.

Natural language processing. Finally, I believe that a resource such as the declarative discourse marker lexicon proposed in this thesis is not only useful for text generation, but can be applied to other NLP tasks, such as text understanding and rhetorical parsing as well. By following the EAGLES guidelines on lexico-semantic encoding in the lexicon design, the discourse marker lexicon is kept at a level general enough to be utilized by

other NLP applications. Up to now, the description of discourse markers in the context of MLG usually highlights their relation to coherence relations, and in the context of NLU focuses above all on the syntactic constraints. In contrast, my lexicon provides a comprehensive account of semantic, pragmatic, and syntactic properties, which are *per se* not tailored towards a particular application. In short, the contribution of this thesis lies in the provision of a *general resource on discourse marker knowledge* (Section 9.3).

11.3 Directions for future research

Having summarized what the thesis has achieved, I now list some of the topics that require further investigation:

Discourse marker description and representation. In this thesis, German temporal markers have been studied in great detail. The *other marker groups* listed in Chapter 5 now await a similar treatment: The analysis of discourse marker function and form, and the design of conjunctive relation networks for other marker groups is the major topic of future research. To increase the scope of German conjunctive relation networks, one can draw on the rich body of descriptive work on discourse markers. As these studies usually do not link into the discourse level, this link has to be provided by future research.

Further, multilinguality of linguistic resources is a burning issue: In this thesis, I have performed the first step in the direction of a multilingual network by presenting a contrastive study of German, English and Dutch temporal conjunctive relation networks. A logical next step is to take the three system networks and design a *multilingual resource* in the line of [Matthiessen *et al.* 1991]. Finally, a more thorough and detailed *analysis of English discourse markers* is required, especially regarding the lexicogrammatical constraints, which are not given in Martin's account [Martin 1992].

Discourse level. The set of coherence relations and their definitions have been motivated from a particular text type. The question now is in how far are the features proposed in the system network genre-specific? What additions are required to account for the coherence relations holding in texts from other genres? In a nutshell, future work includes applying the strategy proposed in this thesis to *other text types*, in order to extract the underlying 'pure' relations and arrive at a classification of discourse 'functions', similar to the paradigmatic rhetorical relation network given in this thesis. The next step would involve a thorough *comparison of networks* describing the coherence relations holding in different genres, and working out similarities and differences. A long-term goal should be the development of a *generic paradigmatic description* for coherence relations based on the genre-specific accounts, much in the way of multilingual resources that are derived from monolingual resources and the knowledge on their commonalities and divergences.

Another important topic is the *discourse structure*. In this thesis I remained deliberately vague on the actual shape of the discourse representation tree, as it was not of concern to

the goals of this thesis. Future work needs to clarify a number of open topics, in particular whether the nucleus/satellite distribution is the same for different metafunctions, and whether relations belonging to different metafunctions relate to the same minimal units.

Discourse marker lexicon. Just as the analysis and functional representation of German discourse markers grows in coverage, *more lexical entries* need to be designed. This involves for one thing to test the applicability of general lexicon attributes and values, and to identify attributes and values specific to particular marker groups. As a consequence, the lexicon definition needs to be enhanced to account for the marker-specific properties, i.e. definitions similar to the `temporal-marker-entry` definition have to be defined, which are subsumed by the general `discourse-marker-entry` definition.

Regarding the ‘contents’ of the lexicon, lexicon entries for the German discourse markers that are classified by newly-developed conjunctive relation networks have to be defined. The ultimate goal is a *comprehensive lexicon for German discourse markers* that covers the entire set of German markers. Another research topic concerns the English discourse markers: The definition of lexicon entries has been neglected so far, mainly due to the insufficient information on combinability constraints provided by existing functional classifications. As these classification become more informative, the English lexicon for discourse markers has to be enhanced accordingly.

Finally, values in the lexicon are at present ‘hard’ constraints. There is no way of distinguishing between constraints and preferences, although it seems desirable to be able to represent, for instance, the preferred order of clauses for a given discourse marker.

Discourse marker selection in text generation The emphasis in this thesis is on the sentence planning phase, and here in particular on the discourse marker selection procedure. The availability of results from other sentence planning modules has been presupposed. Future work needs to address the other modules, and work out the *sentence planning phase* in more detail, possibly building on work such as that by [Wanner and Hovy 1996]. Further, generation needs to move beyond pairs of TSitSpecs in a coherence relation. The major obstacle lies in the fact that the processes involved in *linearizing the discourse tree* are far from understood. Finally, I have not been concerned with the *computational cost* of choosing discourse markers, and with the computation of the constraints that should be posited by different sentence planning modules. A related goal is the *implementation* of the proposed procedure, possibly in connection with the MOOSE lexical option finder presented in [Stede 1999], since I believe that discourse marker choice is just one aspect of the general lexical choice task.

In this thesis, I implicitly assumed that coherence relations, and temporal relations in particular, are always signaled by discourse markers, and thereby limited the study to discourse marker *selection*. Marker *occurrence*, however, is also an important issue: First, [Hitzeman *et al.* 1995] argue that there exist temporal defaults of the kind “An event will occur just after a preceding event”; this renders the introduction of explicit markers superfluous. Second, I have only assumed pairs of time-stamped expressions, but have ignored

that they usually occur in a wider discourse situation, where other kinds of coherence relations might hold between TSitSpecs. For instance, all causal relations have some kind of temporal implicature; still, one does not want a temporal marker to signal a CAUSE-EFFECT, even though the relata are also temporally related. The question of marker occurrence hence is a further topic for future research.

Utilizing the discourse marker lexicon for other NLP tasks. It will be interesting to see in how far the information provided by the discourse marker lexicon is sufficient to *support other natural language processing tasks*, for instance, rhetorical parsing and text summarization. Likewise, future research will have to show whether the format of the lexicon, following the EAGLES guidelines, is general enough to meet the demands of applications other than text generation.

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Appendix A

Corpus of technical instructions

A.1 Monolingual texts

German texts:

TC.1 Kaffeemaschine KRUPS T10 Plus (coffee maker)

TC.2 Eingabegerät Elektro-Nigg

Source: <http://pcmedia.ch/nigg/keyboard.html>, 28.5.1999

TC.3 WinMedix

Source: <http://imd.at/INSTLANG.html>

TC.4 Telefon BaseLine: Signo, Telekom (phone)

TC.5 Philips Telefon mit Anrufbeantworter TD 9462 (phone with answering machine)

TC.6 Philips TV (television)

TC.7 Bosch Waschmaschine WFM 20.. (washing machine)

TC.8 AEG Waschautomat: Aufstell- und Anschlussanweisung (washing machine)

English texts:

TC.9 Sony Compact Disc Compact Player D-2, 1988

A.2 Bilingual texts (German, English)

- TC.10** Toaster SIEMENS TT 621 .. (Toaster)
- TC.11** Rasierapparat BRAUN 2050, BRAUN micron S, Type 5428 (razor)
- TC.12** Wasserkocher ROWENTA KE 50, KE 520 (electric kettle)
- TC.13** Original Spaetzlehobel Sonntag (Spaetzle grater)
- TC.14** Staubsauger VAMPYR COMPACT, AEG (vacuum cleaner)
- TC.15** Krups DuoMix/TurboMix (mixer)
- TC.16** Bosch Kühlschrank KTL.../KUL/KTL... ECO (refrigerator)
- TC.17** Staubsauger VAMPYR 761i,767i electronic, AEG (vacuum cleaner)
- TC.18** Sharp Stereo-Radio-Cassettenrecorder GF-454H (stereo recorder)
- TC.19** Thorens TD 126 MkIII Electronic (record player)
- TC.20** Moulinex Toaster
- TC.21** Bosch Toaster TAT 36..
- Extracts from Honda car manual:
- TC.22** Spark plugs (p. 89)
- TC.23** Engine oil (p. 97)
- TC.24** Changing oil (p. 98)
- TC.25** Checking coolant (p. 104)

Appendix B

Lexicon entries for German temporal discourse markers

Attribute	Values	Values	Values
WORD-SENSE-ID	nachdem-ant	nachdem-ing	nach-temporal
ORTHOGRAPHY	nachdem	nachdem	nach
LANGUAGE	German	German	German
TEMPORAL-RELATION	before meets	finishes during overlaps	before meets
CONSTRAINTS	prox		prox
EXTENSION			
INTENTION			
NUCLEARITY	S_1 -nuclear	S_1 -nuclear	S_1 -nuclear
PRESUPPOSITION	presupposed	presupposed	presupposed
STATUS	external	external	external
BOUNDEDNESS-SIT-M	l-bounded lr-bounded		l-bounded lr-bounded
BOUNDEDNESS-SIT-S	r-bounded lr-bounded	l-bounded lr-bounded	r-bounded lr-bounded
SITUATION-TYPE			
PART-OF-SPEECH	subc	subc	prep
ORDERING			
POSITION	front	front	front
MODIFICATION	modifiable	modifiable	modifiable
POLARITY	positive	positive	
HYPOTHETICAL	realized	realized	
AKTIONART-MC			
AKTIONART-SC		stative resultative	
ASPECT-MC	imperfective		
ASPECT-SC	perfective	imperfective	
EVENT-TIMES	E-Sits_E-Sitm	E-Sits,E-Sitm	
EVENT-SPEAKING-TIME	E-Sits_S		
FORMALITY			
USAGE	neutral	neutral	neutral
BREVITY	not-concise	not-concise	concise

Attribute	Values	Values	Values
WORD-SENSE-ID ORTHOGRAPHY LANGUAGE	danach danach German	dann dann German	daraufhin daraufhin German
TEMPORAL-RELATION CONSTRAINTS EXTENSION INTENTION NUCLEARITY PRESUPPOSITION STATUS BOUNDEDNESS-SIT-M BOUNDEDNESS-SIT-S SITUATION-TYPE	before meets prox l-bounded lr-bounded r-bounded lr-bounded	before meets prox l-bounded lr-bounded r-bounded lr-bounded	before meets prox l-bounded lr-bounded r-bounded lr-bounded
PART-OF-SPEECH ORDERING POSITION MODIFICATION POLARITY HYPOTHETICAL AKTIONART-MC AKTIONART-SC ASPECT-MC ASPECT-SC EVENT-TIMES EVENT-SPEAKING-TIME	pronadv preposed E-Sits_E-Sitm E-Sits_S	conj preposed E-Sits_E-Sitm E-Sits_S	pronadv preposed E-Sits_E-Sitm E-Sits_S
FORMALITY USAGE BREVITY	neutral not-concise	neutral not-concise	neutral not-concise

Attribute	Values	Values	Values
WORD-SENSE-ID ORTHOGRAPHY LANGUAGE	sobald-ant sobald German	sowie sowie German	kaum-dass kaum dass German
TEMPORAL-RELATION CONSTRAINTS EXTENSION INTERP.-EXPANSION NUCLEUS-JUDGEMENT NUCLEARITY PRESUPPOSITION STATUS BOUNDEDNESS-SIT-M BOUNDEDNESS-SIT-S SITUATION-TYPE	before meets prox next imm S_1 -nuclear presupposed external l-bounded lr-bounded r-bounded lr-bounded	before meets prox next imm S_1 -nuclear presupposed external l-bounded lr-bounded r-bounded lr-bounded	before meets prox next imm regard nuclear-negative S_1 -nuclear presupposed external l-bounded lr-bounded r-bounded lr-bounded
PART-OF-SPEECH ORDERING POSITION MODIFICATION POLARITY HYPOTHETICAL AKTIONART-MC AKTIONART-SC ASPECT-MC ASPECT-SC EVENT-TIMES EVENT-SPEAKING-TIME	subc front not-modifiable imperfective perfective E-Sits_E-Sitm	subc front not-modifiable imperfective perfective E-Sits_E-Sitm	subc front not-modifiable imperfective perfective E-Sits_E-Sitm E-Sits_S E-Sitm_S
FORMALITY USAGE BREVITY	neutral not-concise	neutral not-concise	neutral not-concise

Attribute	Values	Values	Values
WORD-SENSE-ID ORTHOGRAPHY LANGUAGE	seitdem-temp seitdem German	seit-temp seit German	ab-temp ab German
TEMPORAL-RELATION CONSTRAINTS EXTENSION INTENTION NUCLEARITY PRESUPPOSITION STATUS BOUNDEDNESS-SIT-M BOUNDEDNESS-SIT-S SITUATION-TYPE	before meets prox next imm dur S_1 -nuclear presupposed external l-bounded lr-bounded r-bounded lr-bounded	before meets prox next imm dur S_1 -nuclear presupposed external r-bounded lr-bounded	before meets prox next imm dur S_1 -nuclear presupposed external r-bounded lr-bounded
PART-OF-SPEECH ORDERING POSITION MODIFICATION POLARITY HYPOETHETICAL AKTIONSPORT-MC AKTIONSPORT-SC ASPECT-MC ASPECT-SC EVENT-TIMES EVENT-SPEAKING-TIME	subc front not-modifiable realized not resultative semelfactive transformative imperfective perfective E-Sits_E-Sitm E-Sits_S	prep front not-modifiable stative durative iterative	prep front not-modifiable stative durative iterative E-Sitm_S
FORMALITY USAGE BREVITY	neutral not-concise	neutral concise	neutral concise

Attribute	Values	Values	Values
WORD-SENSE-ID ORTHOGRAPHY LANGUAGE	ehe ehe German	davor-post davor German	davor-ing davor German
TEMPORAL-RELATION CONSTRAINTS EXTENSION INTENTION NUCLEARITY PRESUPPOSITION STATUS BOUNDEDNESS-SIT-M BOUNDEDNESS-SIT-S SITUATION-TYPE	before meets prox S_0 -nuclear presupposed external r-bounded lr-bounded l-bounded lr-bounded	before meets prox S_0 -nuclear multinuclear presupposed external r-bounded lr-bounded l-bounded lr-bounded	overlaps starts during S_0 -nuclear multinuclear presupposed external r-bounded lr-bounded l-bounded lr-bounded
PART-OF-SPEECH ORDERING POSITION MODIFICATION POLARITY HYPOTHETICAL AKTIONSAKT-MC AKTIONSAKT-SC ASPECT-MC ASPECT-SC EVENT-TIMES EVENT-SPEAKING-TIME	subc front not-modifiable not durative imperfective E-Sitm_E-Sits E-Sitm,E-Sits	pronadv preposed modifiable imperefective E-Sitm_E-Sits E-Sitm,E-Sits	pronadv preposed modifiable stative durative perfective E-Sitm_E-Sits E-Sitm,E-Sits
FORMALITY USAGE BREVITY	highfalutin archaic rare not-concise	neutral not-concise	neutral not-concise

Attribute	Values	Values	Values
WORD-SENSE-ID ORTHOGRAPHY LANGUAGE	bis-post bis German	bis-sim bis German	bis-temp bis German
TEMPORAL-RELATION CONSTRAINTS EXTENSION INTENTION NUCLEARITY PRESUPPOSITION STATUS BOUNDEDNESS-SIT-M BOUNDEDNESS-SIT-S SITUATION-TYPE	meets prox next dur S_0 -nuclear presupposed external r-bounded lr-bounded l-bounded lr-bounded	finishes meets dur S_0 -nuclear presupposed external r-bounded lr-bounded l-bounded lr-bounded	meets prox next dur S_0 -nuclear presupposed external r-bounded lr-bounded l-bounded lr-bounded
PART-OF-SPEECH ORDERING POSITION MODIFICATION POLARITY HYPOTHETICAL AKTIONART-MC AKTIONART-SC ASPECT-MC ASPECT-SC EVENT-TIMES EVENT-SPEAKING-TIME	subc front modifiable positive realized durative stative iterative imperfective E-Sitm,E-Sits E-Sitm_E-Sits	subc front modifiable positive realized durative stative iterative perfective E-Sitm,E-Sits	prep front modifiable not resultative
FORMALITY USAGE BREVITY	neutral not-concise	neutral not-concise	neutral concise

Attribute	Values	Values	Values
WORD-SENSE-ID ORTHOGRAPHY LANGUAGE	waehrend-temp während German	waehrend-temp-p während German	bei-temp bei German
TEMPORAL-RELATION CONSTRAINTS EXTENSION INTENTION NCULEARITY PRESUPPOSITION STATUS BOUNDEDNESS-SIT-M BOUNDEDNESS-SIT-S SITUATION-TYPE	equals during starts finishes overlaps S ₀ -nuclear S ₁ -nuclear presupposed external r-bounded lr-bounded	equals during starts finishes overlaps S ₀ -nuclear S ₁ -nuclear presupposed external r-bounded lr-bounded	equals during starts finishes overlaps same-place S ₀ -nuclear S ₁ -nuclear presupposed external r-bounded lr-bounded
PART-OF-SPEECH ORDERING POSITION MODIFICATION POLARITY HYPOTHETICAL AKTIONSART-MC AKTIONSART-SC ASPECT-MC ASPECT-SC EVENT-TIMES EVENT-SPEAKING-TIME	subc front not-modifiable positive stative durative iterative E-Sits,E-Sitm	prep front not-modifiable stative durative iterative	prep front not-modifiable stative durative iterative
FORMALITY USAGE BREVITY	neutral not-concise	neutral concise	neutral concise

Attribute	Values	Values	Values
WORD-SENSE-ID ORTHOGRAPHY LANGUAGE	mit-temp mit German	wahrenddessen währenddessen German	dabei-temp dabei German
TEMPORAL-RELATION CONSTRAINTS EXTENSION INTENTION NUCLEARITY PRESUPPOSITION STATUS BOUNDEDNESS-SIT-M BOUNDEDNESS-SIT-S SITUATION-TYPE	equals finishes starts S ₁ -nuclear presupposed external lr-bounded	equals during starts finishes overlaps S ₀ -nuclear S ₁ -nuclear multinuclear presupposed external lr-bounded	equals during starts finishes overlaps same-place S ₀ -nuclear S ₁ -nuclear multinuclear presupposed external
PART-OF-SPEECH ORDERING POSITION MODIFICATION POLARITY HYPOTHETICAL AKTIONSART-MC AKTIONSART-SC ASPECT-MC ASPECT-SC EVENT-TIMES EVENT-SPEAKING-TIME	prep front not-modifiable semelfactive transformative	pronadv preposed not-modifiable stative durative iterative E-Sits,E-Sitm	pronadv preposed stative durative iterative
FORMALITY USAGE BREVITY	neutral concise	neutral not-concise	neutral not-concise

Attribute	Values	Values	Values
WORD-SENSE-ID ORTHOGRAPHY LANGUAGE	sobald sobald German	solange solange German	seitdem seitdem German
TEMPORAL-RELATION CONSTRAINTS EXTENSION INTENTION NUCLEARITY PRESUPPOSITION STATUS BOUNDEDNESS-SIT-M BOUNDEDNESS-SIT-S SITUATION-TYPE	starts S_0 -nuclear S_1 -nuclear presupposed external l-bounded lr-bounded l-bounded lr-bounded	equals finishes S_0 -nuclear S_1 -nuclear presupposed external l-bounded lr-bounded	starts dur S_0 -nuclear S_1 -nuclear presupposed external l-bounded lr-bounded l-bounded lr-bounded
PART-OF-SPEECH ORDERING POSITION MODIFICATION POLARITY HYPOTHETICAL AKTIONART-MC AKTIONART-SC ASPECT-MC ASPECT-SC EVENT-TIMES EVENT-SPEAKING-TIME	subc front not-modifiable not stative E-Sits,E-Sitm	subc front not-modifiable positive not resultative stative durative iterative imperfective E-Sits,E-Sitm E-Sits_S E-Sitm_S	subc front not-modifiable realized not resultative stative durative iterative imperfective E-Sits,E-Sitm E-Sits_S E-Sits,S E-Sitm_S
FORMALITY USAGE BREVITY	neutral not-concise	neutral not-concise	neutral not-concise

Attribute	Values	Values	Values
WORD-SENSE-ID ORTHOGRAPHY LANGUAGE	als-sim als German	als-ant als German	als-post als German
TEMPORAL-RELATION CONSTRAINTS EXTENSION INTENTION NUCLEARITY PRESUPPOSITION STATUS BOUNDEDNESS-SIT-M BOUNDEDNESS-SIT-S SITUATION-TYPE	equals during finishes starts transition mom.activity mom.culmination	before meets prox transition mom.activity mom.culmination	before meets prox transition mom.activity mom.culmination
PART-OF-SPEECH ORDERING POSITION MODIFICATION POLARITY HYPOTHETICAL AKTIONART-MC AKTIONART-SC ASPECT-MC ASPECT-SC EVENT-TIMES EVENT-SPEAKING-TIME	subc front not-modifiable transformative semelfactive imperfective E-Sits,E-Sitm E-Sits_S E-Sitm_S	subc front not-modifiable transformative semelfactive perfective E-Sits_E-Sitm E-Sits_S E-Sitm_S	subc front not-modifiable transformative semelfactive imperfective E-Sitm_E-Sits E-Sits_S E-Sitm_S
FORMALITY USAGE BREVITY	neutral not-concise	neutral not-concise	neutral not-concise

Attribute	Values	Values	Values
WORD-SENSE-ID ORTHOGRAPHY LANGUAGE	wenn-sim wenn German	wenn-ant wenn German	wenn-post wenn German
TEMPORAL-RELATION CONSTRAINTS EXTENSION INTENTION NUCLEARITY PRESUPPOSITION STATUS BOUNDEDNESS-SIT-M BOUNDEDNESS-SIT-S SITUATION-TYPE	equals during finishes starts transition mom.activity mom.culmination	before meets prox transition mom.activity mom.culmination	before meets prox transition mom.activity mom.culmination
PART-OF-SPEECH ORDERING POSITION MODIFICATION POLARITY HYPOTHETICAL AKTIONSART-MC AKTIONSART-SC ASPECT-MC ASPECT-SC EVENT-TIMES EVENT-SPEAKING-TIME	subc front not-modifiable transformative semelfactive imperfective E-Sits,E-Sitm E-Sits,S S_E-Sits E-Sitm,S S_E-Sitm	subc front not-modifiable transformative semelfactive perfective E-Sits_E-Sitm E-Sits,S S_E-Sits E-Sitm,S S_E-Sitm	subc front not-modifiable transformative semelfactive imperfective E-Sitm_E-Sits E-Sits,S S_E-Sits E-Sitm,S S_E-Sitm
FORMALITY USAGE BREVITY	neutral not-concise	neutral not-concise	neutral not-concise