CASE AND LINKING IN LANGUAGE COMPREHENSION

STUDIES IN THEORETICAL PSYCHOLINGUISTICS

VOLUME 34

The titles published in this series are listed at the end of this volume.

CASE AND LINKING IN LANGUAGE COMPREHENSION

Evidence from German

MARKUS BADER
University of Konstanz, Germany

and

JOSEF BAYER
University of Konstanz, Germany

Springer

A C.I.P. Catalogue record for this book is available from the Library of Congress.

ISBN-10 1-4020-4343-0 (HB)
ISBN-13 978-1-4020-4343-7 (HB)
ISBN-10 1-4020-4344-9 (e-book)
ISBN-13 978-1-4020-4344-4 (e-book)

Published by Springer,
P.O. Box 17, 3300 AA Dordrecht, The Netherlands.
www.springer.com

Printed on acid-free paper

Contents

List of Figures

List of Tables

Preface

German is a language which has received a lot of attention in linguistics, and data from German had a substantial influence on the formation of linguistic theory. The influence this language had so far on psycholinguistics and on syntactic processing in particular is much more limited, although the last 10 years have seen a growing interest in psycholinguistic investigations of German. The present monograph will build on earlier work and develop it further toward an account of syntactic comprehension on the basis of theoretical as well as experimental investigations. The verb-final nature, the free order of constituents, and the morphological Case system of German offer a rich domain for explorations which will be shown to reshape our knowledge about human sentence processing in general.

Much of the research which led to this monograph has been carried out at the Friedrich Schiller University Jena and has been concluded at Konstanz University. Our research has been supported between 1997 and 2005 by grant Ba 1178/4 of the Deutsche Forschungsgemeinschaft (DFG) under the title *Language Comprehension and Variable Word Order - Syntactic and Extrasyntactic Factors in Processing German Sentences*. We are indebted to the DFG for this continuous support over the years, and in particular to Dr. Manfred Briegel and Dr. Susanne Anschütz for their administrative help.

Different parts of this research have been presented at the Universities of Düsseldorf, Freiburg, Köln, Padua, Potsdam, at NELS 26, workshops in Groningen, Konstanz, Leipzig, Potsdam, Utrecht, various Annual CUNY Conferences on Human Sentence Processing, Annual Meetings of the German Linguistic Society (DGfS) and conferences on Architectures and Mechanisms for Language Processing (AMLaP). We have benefitted from the questions and suggestions from the various audiences.

As will be visible throughout this book, invaluable contributions to the research presented here have been made by Michael Meng, Jens-Max Hopf and, more recently, Jana Häussler. We are greatly indebted to them.

For important comments on earlier versions of the manuscript we want to thank Chuck Clifton, Lyn Frazier, Janet Fodor, Jana Häussler, Britta Stolterfoth and an anonymous reviewer.

A large number of people have shown their interest in our work by asking critical questions and making helpful suggestions. We remember in particular: Petra Augurzky, Ina Bornkessel, Ellen Brandner, Anne Breitbarth, Ulrike Demske, Gisbert Fanselow, Stefan Frisch, Peter Gallmann, Hubert Haider, Barbara Hemforth, Agnes Jäger, Lars Konieczny, Aditi Lahiri, Uli Lutz, Sandra Muckel, Frans Plank, Christoph Scheepers, Matthias Schlesewsky, Tanja Schmid, Markus Steinbach, Peter Suchsland, Susanne Trissler, Ralf Vogel, Dieter Wunderlich.

We would finally want to thank our respective wives Sandra and Jogamaya for their constant support.

Markus Bader
Josef Bayer Konstanz, September 2005

Chapter 1

INTRODUCTION

1. Computing Syntactic Structures

To a first approximation, the sentences we hear or read inform us about "who did what to whom". In order to extract this information from the auditive or visual input signal, several tasks have to be accomplished. The input signal has to be broken down into a string of words, this string has to be parsed into a syntactic structure, and the syntactic structure has to be interpreted semantically. In this monograph, we will be concerned with the task mediating between the recognition of words and the semantic interpretation of sentences, that is, the task of computing syntactic structures. Thus, the question we will try to answer is this: What are the mental processes that are responsible for computing syntactic structures during language comprehension?

The complete set of these processes is traditionally called the HUMAN SENTENCE PROCESSING MECHANISM (HSPM). To illustrate the task of the HSPM, consider the sentence shown in (1). Given the peculiarities of the grammar of English, a sentence such as this can be assigned a syntactic representation on the basis of two pieces of information: the syntactic category of each word, and the linear order of the words.

(1) The teacher had pleased our Grandma.

Given these two pieces of information, sentence (1) can be parsed into a phrase-structure representation which allows to answer the question "who did what to whom". However, linear order and syntactic category information are not sufficient for successful language comprehension in all languages. Consider, for example, the German translation of (1), which is given in (2).

(2) Der Lehrer hatte unserer Oma gefallen.
The teacher-NOM had our grandma-DAT pleased
'The teacher had pleased our grandma.'

With the exception of the position of the main verb, which usually follows the object in German sentences, sentence (2) looks pretty much the same as its English counterpart. However, this similarity is only apparent. In order to determine "who will do what to whom" in (2), one cannot rely on information concerning syntactic categories and linear order alone. In addition, it is necessary to attend to the Case-marking on the different DPs.[1] Otherwise, it would be impossible to distinguish between the meaning of sentence (2) and the meaning of sentence (3).

(3) Dem Lehrer hatte unsere Oma gefallen.
The teacher-DAT had our grandma-NOM pleased
'Our grandma had pleased the teacher.'

The only tangible difference between (2) and (3) pertains to the Case marking on the DPs' determiners. In (2), the first DP is marked for nominative Case and the second DP for dative Case, and vice versa for (3). As shown by the glosses given for (2) and (3), one cannot arrive at the correct interpretation of these sentences without paying close attention to the respective Case morphology.

What examples like those in (2) and (3) show is that the HSPM must be able to cope with syntactic features—for example, Case features—in addition to linear order and syntactic categories. The necessity of this distinction—even for a language like English—has of course not gone unnoticed in the literature on the HSPM (cf. Gorrell, 1995; Mitchell, 1994). Following Mitchell (1994), we will distinguish between processes of STRUCTURE ASSEMBLY and processes of LINKING and CHECKING. How we will use these terms is defined in (4).

(4) a. STRUCTURE ASSEMBLY
Processes that compute phrase-structure trees
b. LINKING
Processes that associate phrases within the phrase-structure tree with argument structure positions
c. CHECKING
Processes that check the proper distribution of Case features and the agreement between a verb and its subject

[1] We will refer to the linguistic concept of Case with initial capitals throughout this work.

In one way or another, every viable model of the HSPM will have to provide the functionality for performing linking and checking—otherwise successful language comprehension would simply be impossible. However, the model we will develop in the current monograph will contain a stronger claim. In compliance with the methodological maxim of recursive decomposition, according to which complex informational events can be decomposed into a temporally ordered set of distinct processes (cf. Palmer, 1999, Stillings et al., 1995, and the discussion in section 3.1 of chapter 2), we will claim that the HSPM is fractionated in the particular way shown in Figure 1.1: Processes of structure assembly are followed by processes of linking which in turn are followed by processes of checking.

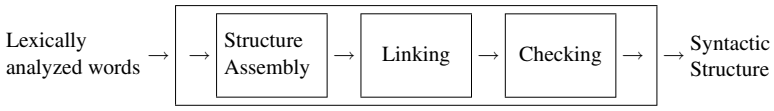


Figure 1.1. A model of the HSPM

The aim of the current work is thus twofold: first, to argue for the particular fractionating of the HSPM shown in Figure 1.1, and, second, to specify the inner workings of the boxes shown in Figure 1.1, with the major focus lying on the boxes labeled linking and checking.

An important question concerning the HSPM has always been how the mental grammar is related to the on-line processes that compute syntactic structures. The simplest assumption with regard to this question is that the syntactic representations computed by the HSPM are exactly those which are defined by the grammar, and the knowledge used in computing syntactic structures is simply the grammar itself (cf. Fodor, 1989). Such a transparent relation between the HSPM and grammar has become known under the name of the STRONG COMPETENCE HYPOTHESIS (Bresnan and Kaplan, 1982: XXXI) (for further discussion, cf. Berwick and Weinberg, 1984).

Given that our aim is to develop a theory of the linking and checking processes that follow structure assembly within the HSPM, it seems noteworthy that recent developments within syntactic theory point in a direction which brings into reach a model of the HSPM that adheres to the strong competence hypothesis. According to the current incarnation of the Principles-and-Parameter framework, the Minimalist Program (cf. Chomsky, 1995; Chomsky, 2000), the syntactic component of the language faculty consists of operations for constructing larger phrase-structural objects out of smaller ones (including lexical items), and operations for checking the ensuing phrase-structural objects with respect to the distribution of agreement and Case features. The operations which construct phrase-structure representations are the operations MERGE and MOVE;

the operation that is responsible for feature checking is the operation AGREE, which applies to both agreement features (number, person, gender features) and Case features.

With the separation of grammatical operations into structure building operations (MERGE and MOVE) and feature checking operations (AGREE), the conception of the HSPM provided in Figure 1.1—processes of structure assembly followed by processes of linking and checking—complies with the strong competence hypothesis in terms of gross architectural features.[2] As we will argue later, the close relation between grammar and parser does not stop at this point, but is also reflected in the fine-grained working of the linking and checking processes of the HSPM. However, we will not elaborate on the relation between grammar and parser at this point, since we have not yet introduced the data that will allow us to do so, and will instead turn to the phenomenon of syntactic ambiguity which will play an important role in our endeavour.

2. Syntactic Ambiguity Resolution

Investigating processes within the HSPM is not an easy task because language comprehension normally proceeds rapidly and apparently without any effort. In essence, the HSPM seems to integrate each word into an ongoing syntactic structure as soon as the word is perceived. This property of the HSPM has become known as INCREMENTAL PROCESSING. However, incremental processing also has its drawback—a drawback that has allowed important insights into the working of the HSPM. The drawback of incremental processing is that it is risky because sentences often contain syntactic ambiguities, and ambiguities may lead the syntactic analysis astray. Consider, for example, the sentence pair in (5) (cf. Frazier, 1979).[3]

(5) a. #Without her contributions would fail to come in.
    b. Without her contributions everything would fail.

The sentences in (5) are locally ambiguous. When parsing these sentences from left to right, the word *her* can be analyzed either as a pronominal object of a preposition or as a possessive pronoun. The following noun *contributions* can then either be taken as the subject of the sentence, or as part of the preposed prepositional phrase (PP).

The ambiguity stops at the fourth word: The modal verb *would* in (5-a) requires the preceding noun *contributions* to be its subject, while the quantifier *everything* in (5-b) requires the preceding noun to be part of the clause-initial PP.

[2]For a discussion of developmental dissociation between structure building and agreement checking, (cf. Roeper et al., 2001).

[3]Following Gibson (1998) and others, we indicate the status of an example as a so-called GARDEN-PATH sentence with "#" . The notion of a GARDEN-PATH will be introduced directly.

Both intuitions and experimental data from Frazier (1979) show that encountering the disambiguating word in (5-a) causes severe processing difficulties, whereas a sentence like (5-b) is processed smoothly.

A first guess as to what makes reading a sentence like (5-a) difficult might go as follows. When encountering the first word, the preposition *without*, the HSPM constructs a partial phrase marker beginning with a prepositional phrase. The next two words, *her* and *contributions*, are attached to the initial PP as soon as they are encountered. If then the fourth word arrives, the auxiliary *would*, there is no grammatically licit way to continue the structure built thus far. This auxiliary is in need of a subject, but according to the structure that has been constructed for the first three words, a subject is nowhere available. The initial analysis must therefore be abandoned, and a new one must be found. The HSPM's attempt at quickly providing a structure for the incoming words, while normally quite successful, has thus led to a dead-end for (5-a).

Because the parser is "led down the garden-path" on its initial analysis of a sentence like (5-a), such sentences have become known as GARDEN-PATH SENTENCES. The kind of processing difficulty that one experiences at the point where it becomes clear that the initial structural analysis can no longer be upheld is accordingly called a GARDEN-PATH EFFECT. A large part of what we know about the workings of the HSPM is derived from investigations of syntactic ambiguity resolution in general, and garden-path phenomena in particular (for recent overviews of the state of the art, cf. Mitchell, 1994; Pickering, 1999; Tanenhaus and Trueswell, 1995). For example, a major reason for the assumption that the HSPM works—at least to a large degree—in an incremental manner comes from the finding that garden-path effects can arise even if a lookahead of only one or two words would have been sufficient to prevent the misanalysis.

The informal account that we have just given of why (5-a), but not (5-b), causes a garden-path effect has found its way into the psycholinguistic literature under the name of SERIAL PARSING. According to serial parsing, the HSPM quickly assigns a single syntactic structure to an input sentence, basically as each word is heard or read. At points of syntactic ambiguity—that is, at choice points—one of the possible alternatives is selected, and only this alternative is pursued further. If, as in (5-a), the structure initially selected is contradicted by later material, a garden-path effect arises, triggering the search for an alternative structure. If this analysis is compatible with upcoming input material, as in (5-b), processing proceeds smoothly. However, if the initial analysis is contradicted by later input material, as in (5-a), processing difficulties will arise, giving rise to the perception of a garden-path effect. In this case, the initial structure must be reanalyzed in order to arrive at the correct analysis.

Within a serial parsing model, we can therefore distinguish between two functionally separated sets of processes. Processes of FIRST-PASS PARSING incrementally assign every sentence—be it ambiguous or not—a syntactic representation. First-pass parsing is thus not peculiar to ambiguous sentences in general, or garden-path sentences in particular. The only difference between ambiguous and unambiguous sentences with respect to first-pass parsing is that for ambiguous sentences the HSPM has to choose between syntactic alternatives whereas for unambiguous sentences it does not.

The defining characteristic of a garden-path sentence is that the ongoing structure computed on first-pass parsing is contradicted by some later input item. It is in this situation that processes of SECOND-PASS PARSING (also called processes of REANALYSIS) enter the stage. The task of these processes is to find an alternative syntactic structure which is compatible with the current input. Processes of second-pass parsing have become an important issue in research on the HSPM (as witnessed by the collection of papers in Fodor and Ferreira, 1998), and, as we will see in the next section, processes of second-pass parsing are of particular importance when it comes to linking and checking.

Before leaving the general topic of syntactic ambiguity resolution, two points have to be made. First of all, while the serial model of the HSPM seems rather natural given the existence of garden-path phenomena, it is by no means the only model which has been proposed in the psycholinguistic literature. The two main contenders of serial parsing models are PARALLEL MODELS according to which the HSPM can compute several alternative structures in parallel and MINIMAL COMMITMENT MODELS which introduce a certain amount of delay into the decision process. These two alternatives to serial parsing will be discussed in more detail in chapter 2 when we review the state of the art in research on the HSPM. The first major claim that we will make in this book is that the HSPM—despite all claims to the contrary—is a strictly serial device. Our justification for this claim will come in two parts: first, by developing a serial parsing model that can account in a natural and insightful way for the experimental results that we will present (this will make up the main part of this book), and by showing that neither parallel nor delay models can do the same (this will be the purpose of chapter 9).

A second point to note concerns the status of first- and second-pass parsing. Serial models of the HSPM are also called two-stage models: the first-stage is comprised by the processes of first-pass parsing, and the second stage by the processes of second-pass parsing. This terminology, however, is somewhat misleading because it suggests that first- and second-pass parsing are distinct sets of processes, each contained in its own box when depicted in a manner analogous to the model shown in Figure 1.1. While first- and second-pass parsing might be separated in this way, they are not necessarily so. There might be processes within the HSPM which can participate in either first- and

second pass parsing, depending on the particular context where these processes are invoked (for further discussion of this point, cf. Stevenson, 1998; Lewis, 1998). In the model we will propose, linking and checking processes are both responsible for certain first- as well as second-pass tasks. When speaking of first- and second-pass parsing in the following, we will therefore not make any commitments as to whether these two functions share processes or not, unless explicitly specified otherwise

3. Syntactic Function Ambiguities

The theory of linking and checking within the HSPM that we will present in this book will be no exception to the rule that most of what we know about the HSPM comes from investigations of syntactic ambiguity resolution. To a large degree, our theory will be based on an in-depth investigation of a particular kind of syntactic ambiguity. A first illustration of this kind of ambiguity, which we will call SYNTACTIC-FUNCTION AMBIGUITIES (SFAS), is provided by the German example in (6).

(6) Fritz hatte Maria gefallen.
Fritz had Maria pleased
Either 'Fritz had pleased Maria.' or 'Maria had pleased Fritz.'

Sentence (6) is identical to the sentences in (2) and (3) with the exception that the two DPs have been replaced by proper names. Ignoring the genitive-*s*, whose status as a Case morpheme is debatable, proper names in modern standard German are not inflected for Case.[4] As a consequence of this, sentence (6) is two-way ambiguous. It can either mean that Fritz had pleased Maria, or that Maria had pleased Fritz. The ambiguity of sentence (6) is a syntactic-function ambiguity because the syntactic functions of the two DPs *Fritz* and *Maria* are ambiguous: Given the lack of Case morphology on proper names, there is an ambiguity as to which DP is the subject, and which DP the object.

The primary goal of this monograph is to develop an explicit theory of the linking and checking processes within the HSPM, and our major tool in pursuing this goal will be syntactic function ambiguities as they are found in German. While this is not the first attempt to account for how the HSPM processes syntactic function ambiguities (e.g. Bader, 1996; Hemforth, 1993; Konieczny, 1996; Meng, 1998; Scheepers, 1996; Schlesewsky, 1996), the model to be presented in this monograph will be unique in its coverage. Whereas prior models have concentrated on specific subsets of such ambiguities, our model will cover a much broader range of processing effects caused by this type of ambiguity

[4] For further discussion of this issue, cf. chapter 3.

(many of which were discovered only after the works cited above were completed). Let us therefore take a closer look at syntactic function ambiguities.

3.1 Syntactic Function Ambiguities and Morphological Ambiguity

As already seen in the examples above, syntactic function ambiguities would not be possible without the existence of Case-ambiguous DPs. To give the reader a flavor of the morphological Case ambiguity (Case syncretism) found in German, Table 1.1 illustrates some major facts about the German morphological Case system (a more thorough presentation will follow in chapter 3).

Table 1.1. An illustration of the Case morphology found in German DPs

	Nominative	*Accusative*	*Dative*
Proper Name	Peter		
Feminine DP	die Frau		der Frau
Masculine DP	der Mann	den Mann	dem Mann

Three points are of particular importance:

- DPs without an overt determiner, like proper names, are usually completely ambiguous with respect to their Case.
- In DPs with an overt determiner, Case is usually marked on the determiner whereas the noun mostly remains uninflected.
- Masculine DPs with an overt determiner have a distinct form for each Case, whereas feminine and neuter DPs do not distinguish between nominative and accusative Case.

Given the morphological facts shown in Table 1.1, consider now (7).

(7) Welche Frau hat Fritz geliebt?
which woman has F. loved
Either 'Which woman did Fritz love?' or 'Which woman loved Fritz?'

Sentence (7) is globally ambiguous: Either the first DP is the subject and the second DP the object, or vice versa. This global ambiguity is due to the fact that the initial DP *welche Frau* ('which woman') is two-way ambiguous between

nominative and accusative Case, and the second DP, the proper name *Fritz*, is even three-way ambiguous between nominative, accusative, and dative Case.[5]

Unlike the proper name *Fritz* in (7), a definite masculine DP like *den Koch* ('the cook-ACC') or *der Koch* ('the cook-NOM') is unambiguous with respect to its Case. In contrast to the globally ambiguous sentence (7), the two sentences under (8) are therefore only locally ambiguous: The ambiguity of the initial string *welche Frau hat* is resolved by the Case morphology on the second DP.

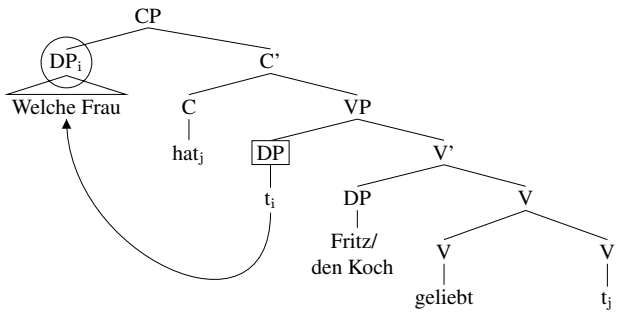
(8) a. Welche Frau hat **den** Koch geliebt?
which woman has the cook-ACC loved
'Which woman loved the cook?'
b. Welche Frau hat **der** Koch geliebt?
which woman has the cook-NOM loved
'Which woman did the cook love?'

As with all syntactic ambiguities, syntactic function ambiguities raise questions concerning first- and second pass parsing. To these questions we turn now.

3.2 Syntactic-Function Ambiguities and First-Pass Parsing

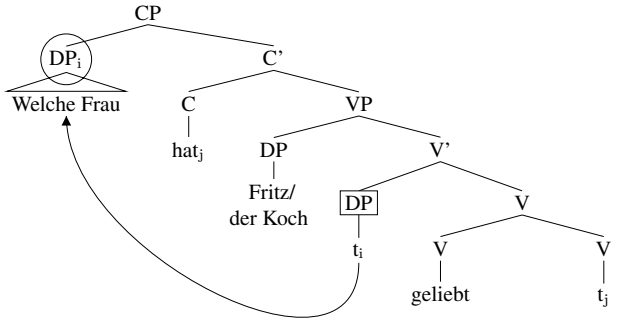
The syntactic structures associated with the subject-object and the object-subject readings of the sentences discussed so far look roughly as in (9-a) and (9-b), respectively, where VP refers to a verbal projection which includes the subject (a detailed discussion of the syntactic structures appropriate for German will be provided in chapter 3. Notice here that the finite verb has undergone movement to C.)

(9) a.



[5]Choice of dative Case is ruled out in this example because the verb *lieben* ('to love') does not subcategorize for a dative object.

b.



As a glimpse at the syntactic structures in (9) shows, the ambiguity of the sentences in (7) and (8) is an instance of what is known as a FILLER-GAP AMBIGUITY (cf. Fodor, 1978; Fodor, 1989). Two well-known examples from the vast literature on filler-gap processing in English are given in (10) (from Stowe, 1986).

(10) a. I want to know who$_i$ Ruth will bring t$_i$ home to Mom at Christmas.

b. I want to know who$_i$ Ruth will bring us home to t$_i$ at Christmas.

When working from left-to-right through these sentences, the HSPM cannot know immediately on encountering the wh-phrase *who* (= the FILLER) where the trace for this filler (= the GAP) will be located in the upcoming syntactic representation. For the two sentences in (10), the HSPM seems to try to locate the gap immediately behind the verb *bring*. This is in accordance with the continuation in (10-a). In (10-b), in contrast, a trace in the direct-object position of *bring* interferes with the actual direct object, the pronoun *us*, giving rise to the so-called FILLED-GAP EFFECT (cf. Stowe, 1986; Crain and Fodor, 1985).

To account for the filled-gap effect, as well as for numerous other findings on filler-gap processing, De Vincenzi (1991) proposed the MINIMAL CHAIN PRINCIPLE shown in (11).

(11) *Minimal Chain Principle*
Avoid postulating unnecessary chain members at S-structure, but do not delay required chain members.
(De Vincenzi 1991: 13)

According to the Minimal Chain Principle, if the HSPM recognizes the need to postulate a trace, it will postulate the trace at the earliest position possible, which is the direct-object position in (10). This correctly predicts that (10-a) is

processed smoothly whereas (10-b), where the trace position preferred by the Minimal Chain Principle is lexically filled, is not.

Coming back to the sentences in (7) and (8), we can see from the structures in (9) that these sentences contain (globally or locally) ambiguous filler-gap dependencies (in (9), the filler is contained within the circle and the gap within the box). How might the HSPM cope with the ambiguity posed by sentences like those in (7) and (8)? As an inspection of the structures shown in (9) reveals, applying the Minimal Chain Principle to sentences like those in (7) and (8) predicts that the HSPM should prefer the subject-object (SO) structure over the competing object-subject (OS) structure when encountering the ambiguity. This prediction has been borne out in numerous experiments on German, as our summary of the pertinent literature in chapter 4 will show.

Filler-gap ambiguities also exist in English, and there has been an extensive discussion as to how English filler-gap constructions are processed by the HSPM, with considerations of linking and checking by and large confined to the narrow question as to what role verb subcategorization plays in resolving such ambiguities (cf. Mitchell, 1994; Tanenhaus and Trueswell, 1995). Were all syntactic function ambiguities in German subject-object ambiguities of the sort discussed so far, we could probably stop at this point (and perhaps write a book about filler-gap ambiguities of all sorts, instead). However, not all syntactic function ambiguities involve an ambiguous filler-gap dependency. This is most clearly seen in examples like (12). In both (12-a) and (12-b), the unambiguously nominative marked pronoun *ich* ('I') is the subject, and the proper name *Fritz* must therefore be an object. Nevertheless, the sentences in (12) are locally ambiguous up to the clause-final verb.

(12) a. Ich habe Fritz immer unterstützt.
I have F. always supported
'I always supported Fritz.'
b. Ich habe Fritz immer geholfen.
I have F. always helped
'I always helped Fritz.'

This local ambiguity is due to the fact that *Fritz* is an accusative object in (12-a) but a dative object in (12-b). This difference, which is due to verb-specific subcategorization requirements, becomes visible if, instead of proper names, DPs with articles are used as objects, as in (13).

(13) a. Ich habe **den** Hausmeister immer unterstützt.
I have the janitor-ACC always supported
'I always supported the janitor.'
b. Ich habe **dem** Hausmeister immer geholfen.
I have the janitor-DAT always helped
'I always helped the janitor.'

Although there is some dispute as to the proper syntactic analysis of accusative and dative objects (on which more later), there is general agreement that in sentences with only a single object, the phrase-structural position of the object does not vary with its Case. In other words, the local ambiguity seen in (12) is neither an attachment ambiguity, nor a filler-gap ambiguity. Nevertheless, experimental investigations of object-object ambiguities have revealed that readers preferentially assign accusative Case to an ambiguous DP like *Fritz* in (12), with the result that a garden-path effect—albeit a slight one—arises when the sentence terminates in a verb requiring a dative object, as in (12-b).

Why should the HSPM prefer the assignment of accusative Case to the assignment of dative Case? Our answer to this question, which we will introduce in chapter 4, will make crucial use of the fact that the dative is a marked Case in comparison to the accusative, in a sense that will be made precise when we introduce the major facts about the German Case system in chapter 3. In a nutshell, we will propose that accusative Case is preferred to dative Case during the initial syntactic analysis of a sentence because, due to the unmarked nature of accusative Case, this provides for a simpler syntactic analysis. This proposal will bring the resolution of Case ambiguities in line with more general proposals that striving for simplicity is one of the major determinants of how the HSPM resolves syntactic ambiguities (cf. Frazier, 1979; Gorrell, 1995; Inoue and Fodor, 1995).

The finding of an accusative preference in sentences like (12), and its associated explanation in terms of dative Case being more marked than accusative Case, gives a first idea of the second major claim made by the present work: In the grammar of German (as in various other languages, too), dative Case plays a special role in comparison with nominative and accusative Case.[6] This special role is reflected in a number of puzzling processing phenomena which at first sight appear to be unrelated or even contradictory but which reveal a coherent pattern as soon as the grammar of Case in general, and the role of dative Case in particular, is given its proper role within a theory of the HSPM. The grammar

[6] We will generally ignore the genitive although there are examples of verb-governed genitives which resemble datives with respect to their structural properties. The reason is that verb-governed genitives are very rare and will not play a role in the experimental studies to be presented in this monograph.

of Case will thus be a prime example of a transparent relationship between grammar and parser, as postulated by the Strong Competence Hypothesis.

3.3 Syntactic-Function Ambiguities and Second-Pass Parsing

In addition to accounting for the HSPM's preferences in resolving syntactic ambiguities, a second task of a theory of the HSPM consists in specifying the processes of reanalysis that have to be invoked if the preferred structure is contradicted by later material. One of the most interesting aspects of syntactic function ambiguities is that they can lead to garden-path effects of widely varying strengths, even in sentences which share the same basic phrase structure.

To illustrate this point, let us consider the two sentences in (14). (14-a) repeats our example of an OS-sentence exhibiting a filler-gap ambiguity from above (cf. (8)). (14-b) has exactly the same syntactic structure as (14-a) and only differs from it with respect to number marking on the subject and the finite verb which have to agree in number. Subject and finite verb are both singular in (14-a) (*der Koch* ('the cook') and *hat* ('has')), whereas they are both plural in (14-b) (*die Köche* ('the cooks') and *haben* ('have')).

(14) a. Welche Frau$_i$ hat **der** Koch t$_i$ geliebt?
which woman has the cook loved
'Which woman did the cook love?'
b. Welche Frau$_i$ **haben** die Köche t$_i$ geliebt?
which woman have the cooks loved
'Which woman did the cooks love?'

The sentences in (14) do not differ with respect to their syntactic structure: both involve exactly the same ambiguous filler-gap dependency. However, they differ with respect to the means by which disambiguation is achieved. While (14-a) is disambiguated by the unambiguous nominative morphology on the second DP, (14-b) is disambiguated by the number marking on the finite verb *haben*. Several experimental investigations have shown that despite their identical syntactic structure, these sentences differ severely when it comes to garden-path strength (cf. Meng, 1998; Meng and Bader, 2000a): While sentences disambiguated by Case morphology on the second DP cause only barely measurable garden-path effects, sentences disambiguated by number marking on the finite verb produce quite substantial processing difficulties. This is a striking finding because—contrary to expectation—an earlier disambiguation leads to a stronger garden-path effect than a later disambiguation: In (14-b) the ambiguity is resolved at the earliest point possible, namely at the auxiliary which immediately follows the ambiguous DP, whereas the ambiguity persists in (14-a) across the auxiliary until the second DP is encountered. This contrasts with other types of local

syntactic ambiguities for which it has been shown that garden-path strength increases with increasing distance between point of ambiguity and point of disambiguation (e.g., Frazier and Rayner, 1982; Ferreira and Henderson, 1991).

Furthermore, the repair operations necessary to revise the initial subject-object structure toward the correct OS-structure are basically the same in both (14-a) and (14-b). Since there are nevertheless substantial differences in garden-path strength—(14-a) causing a weak garden-path effect, (14-b) causing a strong one—a contrast like this one is of particular relevance for current debates on the nature of the HSPM's second-pass parsing capabilities. One central question of these debates concerns the source of the processing difficulties caused by garden-path sentences: Are these difficulties due to the complexity of the necessary repair operations, or do they come about because the HSPM has problems in diagnosing (to use a term introduced by Frazier and Rayner (1982) and Fodor and Inoue (1994)) what went wrong on the first-pass, and what has to be done in order to arrive at the final correct structure? A contrast like the one shown in (14) strongly suggests that the latter is correct, and that the linking and checking processes of the HSPM play a crucial role for garden-path recovery. After all, (14-a) and (14-b) do not differ crucially with respect to the structural changes that have to be made to the original phrase-structure tree in order to arrive at the correct object-before-subject structure. Instead, the crucial difference between (14-a) and (14-b) pertains to the means by which the garden-path is signaled (by a Case-mismatch in (14-a) and by a number mismatch in (14-b)), and thus in the information that the HSPM can use in diagnosing how to arrive at the correct structure.

While we do not yet have introduced the tools which are required to go into the details of how the difference between (14-a) and (14-b) comes about, we can at least note at this point that such a difference—and many more of a similar kind will be presented in due course—foreshadows the third major claim of the work presented in this book: The linking and checking processes of the HSPM act as a diagnostic device. That is, for certain garden-path sentences linking and checking will deliver the information necessary for successful second-pass parsing for free. In this case, revision will usually come with only very moderate costs. Garden-path sentences which cannot be immediately reanalyzed after linking and checking, in contrast, will usually cause much more severe processing difficulties because they require additional processes for arriving at the correct structure.

3.4 Summary: On the Universality of the HSPM

The major goal of this book is to develop a theory of the HSPM's linking and checking procedures. We will pursue this goal by developing a comprehensive model of how the HSPM processes syntactic function ambiguities in German. The three major claims made by this model are summarized in (15).

(15) a. The HSPM is a serial device.
b. The grammar of Case is reflected in a direct and transparent way in the working of the HSPM.
c. The linking and checking procedures of the HSPM act as a diagnostic device.

Although all of our experimental investigations will be carried out with German sentence materials, the theory we will present will not be just a theory of how German sentences are processed. Instead, it will be directly relevant for the important question as to how universal the HSPM is. A great deal of the recent explorations of the HSPM has been conducted under the implicit or explicit assumption that the processing routines that make use of our grammatical knowledge do not differ depending on the language they are applied to. That is, while languages differ from each other, the HSPM is always the same. However, this is not a necessary assumption, and proposals have been made to the effect that parsing routines might differ depending on grammatical or extra grammatical properties of languages, i.e., that not only grammars but also parsers are parameterized (e.g., Mazuka and Lust, 1987).

The universality of the HSPM might be approached in different ways. Given that the overwhelming bulk of psycholinguistic research is still done on the English language, one may either investigate languages that are completely different from English, or languages which differ from English in only a few circumscribed properties. By taking the German language as our object of inquiry, we will take the second route. Although there are some important differences between English and German, there are also lots of shared commonalities. After all, English and German have diverged quite recently (as measured by the time human languages are estimated to exist). Models of syntactic parsing developed for English should therefore be extendable to a language like German without much—if any—modification (the reverse, of course, is also true). This holds in particular for the processes we are concerned with here—the processes of linking and checking. Given that these processes have not received a great deal of attention within the work on English (with some notable exceptions, cf. Nicol et al., 1997; Pearlmutter et al., 1999; Deevy, 1999; Deevy, 2000), many models developed on the basis of English data make either no or no strong claims concerning linking and checking. However, any such model which aspires to be a model of the HSPM in general—and not just a model of how English might be processed—should be compatible with the findings to be reported in this monograph.

At the same time, the work reported here is also intended to build a bridge to languages which are more remote from English than German. There are many languages in which word order plays an even less important, and Case morphology an even more important role, in the identification of syntactic

functions than in German. For such languages, it might not be obvious how to relate them to parsing models which have been developed with nothing but English in mind. By taking a step towards languages with relatively free word-order, it is our hope that the investigations into linking and checking that we shall present in this monograph will inspire and aid future psycholinguistic investigations of languages with even more word-order freedom.[7]

4. Overview of the Book

Before starting with the presentation of our own model, we will provide two chapters containing background material on the HSPM and on the grammar of German in order to make the book accessible to an audience that goes beyond experts in human sentence processing or the syntactic structure of German (or both).

Chapter 2 (*Introducing the Human Sentence Processing Mechanism*) will give an overview of current conceptions of the HSPM, focusing on those issues which are of particular relevance to the development of our own model in later chapters. Chapter 3 (*An Introduction to Case and Word Order in German*), will provide the reader with those aspects of German grammar that are relevant for the later chapters on processing syntactic-function ambiguities. In addition, this chapter will also state the particular syntactic assumptions that will underlie our theory of how the HSPM processes syntactic function ambiguities.

The presentation of this theory will begin with Chapter 4. As already pointed out above, a major claim will be that the HSPM is a serial mechanism. The presentation of our theory will reflect this claim by proceeding from the discussion of first-pass parsing to the discussion of second-pass parsing, as shown in Figure 1.2.

As indicated in Figure 1.2, processes of first- and second-pass parsing are not completely separated according to the theory that we will put forward, but overlap to a substantial degree.

Chapter 4, as well as the following chapter 5, will be concerned with structure assembly, that is, the first-pass assignment of syntactic structures to sentences containing syntactic function ambiguities. In Chapter 4 (*First-Pass Preferences in Syntactic Function Ambiguities*), we will first summarize the already existing experimental evidence on the processing of syntactic function ambiguities in German. Based on this summary, we will specify the parsing principles that we believe to be responsible for the first-pass preferences established in the prior literature.

[7] Other free-word-order languages that have been investigated include Japanese (cf. the various contributions in Mazuka and Nagai, 1995) and Hindi (cf. Vasishth, 2003).

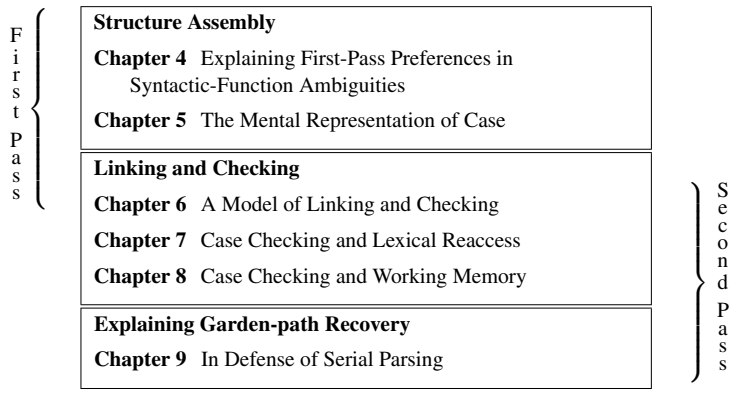


Figure 1.2. Overview of the core chapters

Chapter 5 (*The Mental Representation of Case*) will continue the discussion of first-pass parsing by considering a phenomenon which has been an important source of information with respect to the mental representation and processing of Case: the phenomenon of Case attraction. Case attraction refers to the finding that a DP can adopt the Case features of another DP with which it is coindexed (in particular, a DP can adopt the Case feature of an adjacent relative pronoun). In essence, the Case feature of one DP is attracted by another DP. This is not a licit operation within the grammar of German, but a kind of performance error. However, errors of this kind seem to be heavily constrained by the underlying grammar of Case. Existing evidence suggests that only dative Case can be attracted. In chapter 5, we will first describe what is already known about Case attraction, and then present new experimental evidence on the particular mechanisms underlying this phenomenon.

In Chapter 6 (*A Model of Linking and Checking*), we will present our theory of linking and checking. This chapter will be both about first- and second-pass parsing, and will thus "link" these two stages of sentence processing. For every sentence that the HSPM encounters, whether ambiguous or not, the phrases within the unfolding phrase-structure representation have to be linked to appropriate slots within the argument structure that is associated with each verb. Furthermore, the HSPM has to check whether the syntactic structure is well-formed with regard to the distribution of Case features and with regard to the requirements of subject-verb agreement. Ultimately, linking and checking will result in each argument receiving an interpretation in terms of thematic roles. Linking and checking are therefore indispensable steps in the transition from form to meaning, and as such a proper part of the first-pass parsing routines of the HSPM.

At the same time, processes of linking and checking play an important role in processes of second-pass parsing. In chapter 6, we will propose that for an important class of garden-path sentences, linking and checking automatically deliver the information which is necessary for successful second-pass parsing. In this case, revision will usually be associated with only very moderate costs. Chapter 6 will contain both a precise formulation of this proposal and several experiments which have tested it.

Chapter 7 (*Case Cecking and the HSPM I: On Lexical Reaccess*) will investigate how the HSPM processes Case violations. As the examples considered so far have already shown, when a sentence containing a syntactic function ambiguity is disambiguated toward the non-preferred reading, this will result in a temporary Case violation. For example, in sentences like (12), the HSPM will assign accusative Case on first-pass parsing. This will result in a temporary Case violation when, as in (12-b), the verb requires dative Case on its object. Removing such temporary Case violations is one of the major tasks of the second-pass parsing routines. We will propose in Chapter 7 that the particular processes used by the HSPM for checking Case depend on the particular type of temporary Case violation (e.g. whether dative has to be retracted or to be assigned in order to remedy a temporary Case violation). This proposal will be tested in a series of three experiments.

Chapter 8 (*Case Cecking and the HSPM II: The Role of Working Memory*) will explore the role of working memory for processes of the HSPM. This topic is of particular relevance for processes of Case checking given that these processes often have to operate on representations that had to be held in working memory for quite a while (as, for example, in verb-final sentences). Two experiments will be presented which investigate questions of Case checking and working memory. The results of these experiments will have several implications for the current debate about working memory and syntactic parsing.

Chapter 9 (*In Defense of Serial Parsing*) will address the current debate on serial versus parallel parsing. Given the garden-path phenomenon, the serial model of the HSPM is a prime candidate. Furthermore, it is also supported by a great deal of experimental evidence. Nevertheless, serial parsing has come under heavy attack recently. One of the major alternatives to serial parsing is parallel parsing, according to which the HSPM is able to compute more than a single analysis when faced with a syntactic ambiguity. In chapter 9, we will show that the experimental evidence presented in this monograph strongly supports the serial nature of the HSPM.

Finally, chapter 10 (*Summary and Conclusions*), will summarize our model of linking and checking and will point out some of its cross-linguistic implications.